Anatomic Variations of the Palmaris Longus Muscle

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Abstract

The palmaris longus muscle exhibits significant anatomical variance compared with other muscles of the upper extremity. The most frequent variation is complete absence of the muscle, but a number of other variations exist. These variations include reversed, duplicated, bifid, or hypertrophied palmaris longus muscles. Many authors have reported the variations in case reports and described them using their own terms.

In this case report and review of literature, we aim to consolidate the current knowledge regarding the anatomic variations of the palmaris longus muscle and its clinical relevance.

The palmaris longus muscle exhibits significant anatomical variance compared with other muscles of the upper extremity. The most frequent variation is complete absence of the muscle, but a number of other variations exist. These variations include reversed, duplicated, bifid, or hypertrophied palmaris longus muscles. Many authors have reported the variations in case reports and described them using their own terms.

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Case Report

A man in his early 70s presented to the office with approximately 12 months of symptoms typical for bilateral carpal tunnel syndrome (CTS), far worse in his left arm than in his right. The symptoms primarily included pain in the hands at night, which had been partially relieved with splinting; hand weakness; and decreased sensation over the distribution of the median nerve, especially the long finger. His symptoms were refractory to conservative measures such as splinting and activity modification.

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On physical examination, the patient had a positive Tinel's sign, negative Phalen's test, positive compression test, 4/5 abductor pollicis brevis strength with mild thenar atrophy, and decreased sensation throughout the median nerve distribution on the volar aspect of the hand. Semmes-Weinstein monofilament testing required a 3.61-size monofilament in the median nerve distribution and a 2.83-size monofilament in the ulnar nerve distribution. The patient underwent a nerve conduction velocity study and electromyogram (EMG), which found motor latency of the left median nerve of 6.1 milliseconds; the sensory nerve latency was non-recordable.

After a full discussion of therapeutic options, the patient decided to proceed with transverse carpal ligament release. During the preoperative evaluations, there were no clear signs that warranted further diagnostic testing.

In the operating room, the patient's left upper extremity was prepped and draped in a normal sterile fashion. A 2.5-cm incision was made in the interthenar crease, starting proximally at the distal wrist flexion crease and extended distally to Kaplan's cardinal line. The subcutaneous tissues were dissected down to the level of the palmar fascia, which was then incised sharply with a scalpel. This revealed the transverse carpal ligament, which was then similarly incised. The carpal tunnel was entered, and it was noted that the palmaris profundus tendon was within the tunnel. Severe compression of the median nerve was identified. Mild median neurolysis was performed. There was some significant amount of edema around the median nerve. The palmaris profundus was left in situ. After adequate release of the median nerve was verified both proximally and distally, the wound was copiously irrigated and closed.

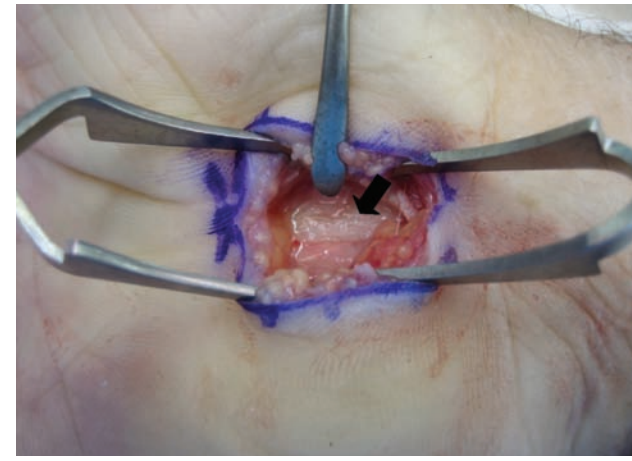


Figure 1. A normal palmaris longus tendon.

The patient had a normal postoperative course and was asymptomatic at the several follow-up visits, the last being at 6 months. Interestingly, the patient underwent a contralateral carpal tunnel release several weeks later, and there was no anomalous palmaris longus tendon anatomy identified on that side.

Normal Anatomy of the Palmaris Longus Muscle

The palmaris longus muscle shares its origin with the flexor digitorum superficialis (FDS) muscle, the flexor carpi radialis (FCR) muscle, and the flexor carpi ulnaris (FCU) muscle. These superficial flexors originate from the medial epicondyle. The palmaris longus muscle is usually located superficial to the FDS muscle, and between the FCU and the FCR muscles, often lying just medial to the FCR muscle. Depending on the individual, the length of the muscle belly varies. Most frequently, the tendinous portion begins at the mid-forearm and inserts distally into the palmar aponeurosis, after passing volar to the flexor retinaculum (Figure 1). Although the palmaris longus muscle tendon is commonly in continuum with the palmar aponeurosis, histological and developmental studies revealed that the 2 structures arise independently and do not share the same origin.[1] Most often, the primary vascular supply for the palmaris longus is provided by the branches of the ulnar artery, but less frequently the muscle may be supplied by branches of the brachial artery.[2] Its innervation is derived from branches of the median nerve. The palmaris longus is also commonly utilized landmark during volar approaches to the wrist and forearm. The tendon may be readily visualized in individuals with normal anatomy by bringing the tips of the thumb and the small finger together while actively flexing the wrist joint. The palmaris longus muscle is also commonly used for various reconstructive surgeries because it is easily accessible, it is adequate in length and diameter, and the absence of the muscle does not compromise flexion or any other motion at the wrist.[3,4] Because of the numerous anatomic variations reported and a relative absence of contribution to function in human beings, the palmaris longus muscle is often thought to be on its way to phylogenetic degeneration.[5]

Absent Palmaris Longus

The most common variant of the palmaris longus is absence of the muscle altogether. The reported prevalence of absent palmaris longus muscle ranges from 2% to 23.1%, and Caucasian population studies consistently demonstrate higher percentages than found in Asian and African-American populations.[6-9] There is a reported positive association of Dupuytren's disease and the presence of palmaris longus muscle.[10] This finding seemingly contradicts the above-mentioned population trend, because Dupuytren's disease is known to be more prevalent in the Caucasian population. There seems to be no significant association between laterality or sex and the absence or presence of the palmaris longus muscle.[8]

Since most surgeons use the palmaris longus tendon as a landmark during the volar approach to the wrist/forearm, and use the muscle in various reconstructive surgeries, it is important to identify the presence or absence of the muscle preoperatively. A number of diagnostic tools are available, including ultrasound and magnetic resonance imaging (MRI). Both imaging modalities may reliably provide information about the anatomy of the palmaris longus muscle.[11-13] However, most surgeons determine the presence or absence of the palmaris longus muscle simply by performing the physical exam maneuver described above, and MRI or ultrasound imaging is not routinely utilized in diagnosing carpal tunnel syndrome. There may be other subtle physical exam findings, such as a bluish discoloration on the skin with the reversed palmaris longus.[14]

Multiple Palmaris Longus Muscle Bellies

"Duplicated," "bifid," or "bitendinous" palmaris longus muscle may be accompanied by/or referred to as an "accessory" palmaris longus muscle.[7,15-20] The term duplicated should be reserved for cases in which there is a completely separate muscle belly that does not share the common origin with the normal-appearing palmaris longus muscle. The accessory, bifid, or bitendinous muscles do, most commonly, share the origin with the normal-appearing palmaris longus muscle, or they branch off from the muscle itself. One of the muscle bellies may be located in the epifascial plane and masquerade as a subcutaneous mass.[18] Extra muscle bellies may also appear distally as a digastric configuration, sharing the same tendon.[21] When present, extra palmaris longus muscle bellies seem to be found in 2 separate fascial sheaths. Since the muscle belly and the tendon can travel along the same fascial sheath with the median nerve, the tendon is thought to contribute to median nerve compression (ie, carpal tunnel syndrome) symptoms, and the symptoms may be relieved by excising the muscle from its origin and distal insertion.[22] Extra muscle bellies are thought to give off their tendons toward the hypothenar fascia, thenar fascia, or carpal bones.[23] The muscle bellies maintain their innervations from the branches of the median nerve, but they may not share the same median nerve branch. There is a report suspecting that the second belly of the palmaris longus may have arisen from the FCR, as it was reported to share the same median nerve branch with the FCR, while the other palmaris longus muscle was innervated by a separate branch.[7] Duplicated palmaris longus muscles may be associated with the accumulation of connective tissue within the median nerve when it courses through the carpal tunnel.[5] This histologic finding may also further explain carpal tunnel syndrome symptoms experienced by the patients with a duplicated palmaris longus muscle. The prevalence of duplication of palmaris longus muscles is reported as 0.5% to 5.9%, showing higher percentages in Caucasian population studies than in studies in other populations.[7,24]

Palmaris Profundus

The palmaris profundus may exist in addition to the normal palmaris longus muscle[22,25-27] or as a lone entity in place of the normal palmaris longus muscle.[28] It is one of the vari-

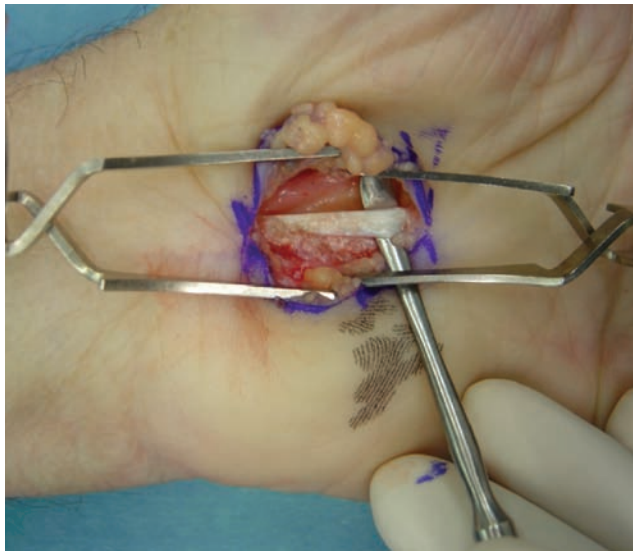


Figure 2. The palmaris profundus tendon.

ants that may truly be categorized as a duplicated palmaris longus muscle. Its distal tendon passes deep to the flexor retinaculum and inserts on the dorsal aspect of the superficial palmar aponeurosis (Figure 2). The muscle is known to originate from the palmar side of the proximal radius,[29] but it can originate from neighboring muscle bellies as well.[26] The origin of the palmaris profundus muscle is not well established, because the presence of the variant of the palmaris longus is most often identified as an incidental finding intraoperatively and proximal exploration is rarely indicated. When existing together with the palmaris longus, the palmaris profundus tends to travel deep to the palmaris longus[30] (Figure 3).

The presence of the palmaris profundus may be associated with the median nerve compression symptoms.[25,28,31] Because there is no physical exam maneuver that reliably

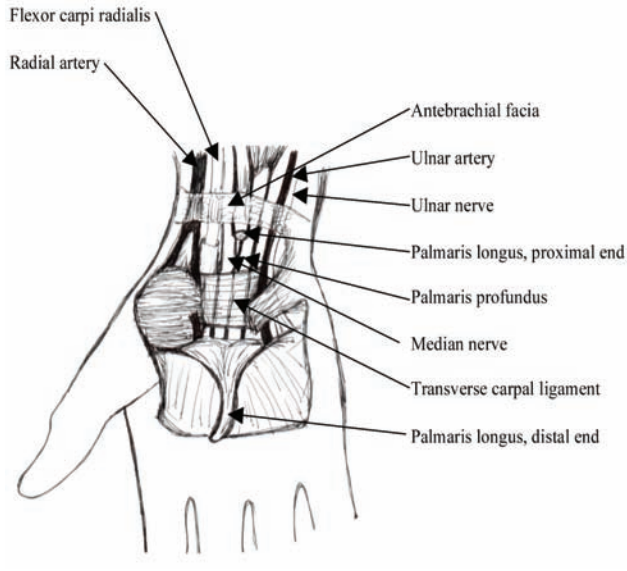


Figure 3. The palmaris longus and palmaris profundus shown in relation to the location of median nerve. Copyright 2010, Min Jung Park.

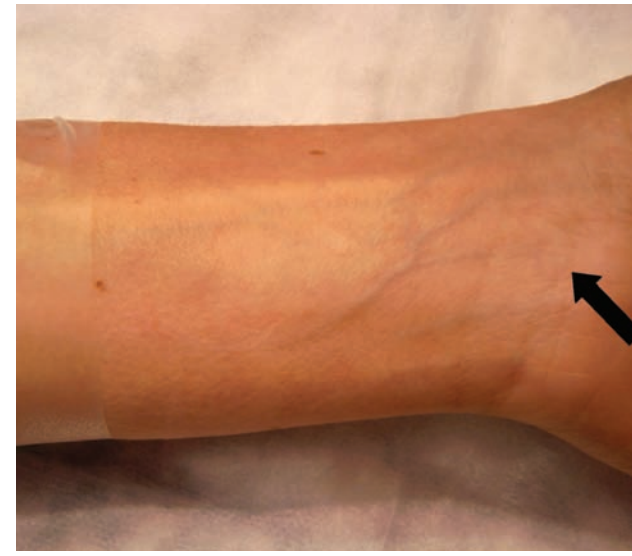


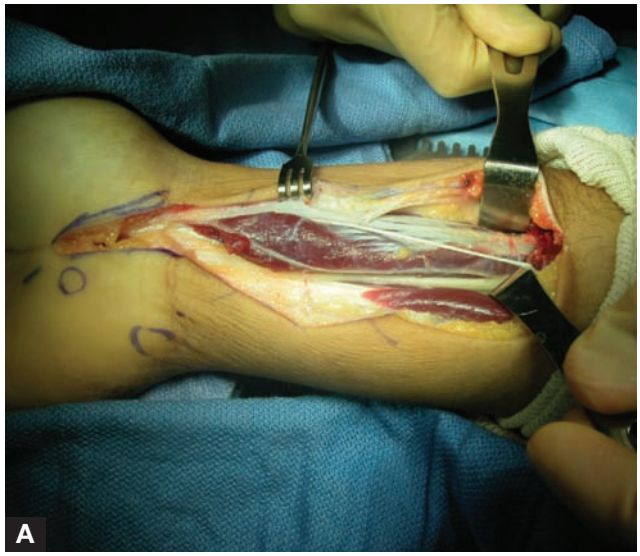
Figure 4. A patient with a reversed palmaris longus with a bluish tinge toward the distal-volar aspect of forearm.

detects the presence of the palmaris profundus muscle, it is difficult to identify the muscle as the cause of the symptoms. However, since median nerve compression symptoms may be relieved by either excision or splitting part of the muscle or its tendon, the structure is thought to be at least partially responsible for the symptoms. Furthermore, the failure to adequately recognize this variant may often be the cause of a failed standard carpal tunnel release procedure. The degree of median nerve compression may be associated with how deep the palmaris profundus tendon travels to reach its distal insertion, as the tendon can divide or press upon the median nerve.[26,27] Authors have described the tendon traveling along with the median nerve, enclosed within the same fascial tissue,[31,32] but it may travel independently of the median nerve and just compress the nerve at the level of wrist when it crosses directly over it.[25,26,33]

When one encounters a palmaris profundus during a carpal tunnel release, the current recommendation is to excise this tendon. This procedure will eliminate the potential for recurrent compression over the median nerve with little to no functional morbidity. Currently, there is no preoperative diagnostic protocol that reliably establishes the presence of palmaris profundus tendon in the setting of carpal tunnel syndrome.

Reversed Palmaris

A reversed palmaris longus, possessing a distal musculotendinous junction, was first reported by Captain John T. Morrison in 1916 as an incidental, post-amputation finding.[34] Generally, variations in palmaris longus anatomy are thought to be asymptomatic; however, several authors have described variations of the reversed palmaris, many of which may cause symptomatic median nerve compression.[12,20,22,35,36] A number of reports have described patients presenting to the office with complaints of a volar distal forearm swelling that can possess a characteristic



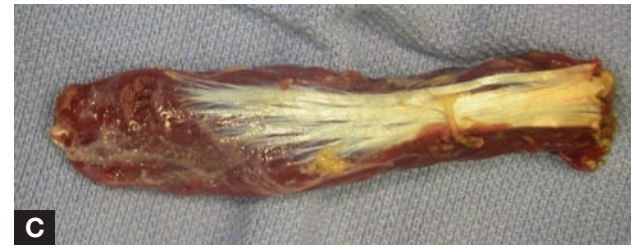


Figure 5. The reversed palmaris longus; (A) the muscle belly exposed intraoperatively, (B) the muscle belly removed, and (C) the removed specimen.

diffuse, bluish discoloration (Figure 4). Pain exacerbated by wrist flexion and the presence of median nerve compression symptoms in these patients appear to be a direct result of this anatomic variation.

Although the palmaris longus normally inserts into the palmar aponeurosis, the reversed muscle belly can hypertrophy and/or divide distally into 2 or 3 separate attachments. Accessory digitations have been reported to insert most commonly deep to the flexor retinaculum; however, branches have also been found on the FCR tendon and volar carpal ligament.[11,37] Several surgeons describe cases of distal muscle bellies that branch into 2 or 3 heads and extend ulnarly, inserting with the flexor carpi ulnaris onto the pisiform, or traversing Guyon's canal with the abductor digit minimi.[13,37,38] Acikel and colleagues[37] described a case of effort-induced median and ulnar nerve compressive symptoms in a patient with a reversed, 3-headed and hypertrophied palmaris longus muscle with extension into Guyon's canal. This is 1 of 2 cases with dual-nerve compression that have been described in the literature.[13,37] Regan and colleagues[38] described the only case of isolated ulnar nerve compression at the wrist caused by a reversed bifid palmaris longus muscle.

Like other skeletal muscles, the reversed palmaris longus has the potential to hypertrophy at the muscle belly as a result of repetitive exercise (Figure 5). This hypertrophy may lead to an effort-related compartment syndrome similar to that which has been well characterized in the lower extremity.[39,40] In general, it is the stiff antebrachial fascia's inability to respond to the rising pressure within the compartment that allows for the abnormal increase in pressure during muscle activity. Similar conditions, in which heightened intracompartmental pressures impede blood flow and compromise metabolic demands of the tissues within the space, may be seen in the distal forearm.[41,42] This phenomenon may explain both the bluish, cyanotic discoloration and the muscle pain experienced by patients presenting with a symptomatic reversed palmaris longus.

Cobb and colleagues,[43] in their evaluation of pressure dynamics of the carpal tunnel and flexor compartment, noted that the carpal tunnel is an anatomically open compartment that functions as a closed compartment. The carpal tunnel's close proximity to the flexor muscles may lead to transfer of pressure from the flexor compartment to the carpal tunnel. Depudyt and colleagues[35] reported a reversed palmaris longus muscle that caused dynamic, effort-related compression of the median nerve at the wrist without entering the carpal tunnel. It is likely that cases with 2-headed or 3-headed palmaris longus branches that extend below the flexor retinaculum and coexisting hypertrophy are most prone to directly increasing volume and pressure within the carpal tunnel. However, it is important to note that several reports of reversed palmaris longus causing symptoms of pain with exertion have not included median nerve compression symptoms.[11,44]

Physical examination findings, including Tinel's and Phalen's tests, have been unreliable in eliciting carpal tunnel symptoms in these patients. It has been proposed that full wrist extension followed by resisted flexion may cause the volar swelling to stiffen, become more prominent, and elicit pain and paresthesias in the proper nerve distribution.[37] EMG studies have been similarly variable, perhaps because exams are generally conducted at rest and not during or following exertion. MRI has been shown to reliably identify a reversed palmaris longus and to reveal signs of median nerve compression.[11,13,45] However, awareness of muscle anomalies at the wrist remains essential, as several

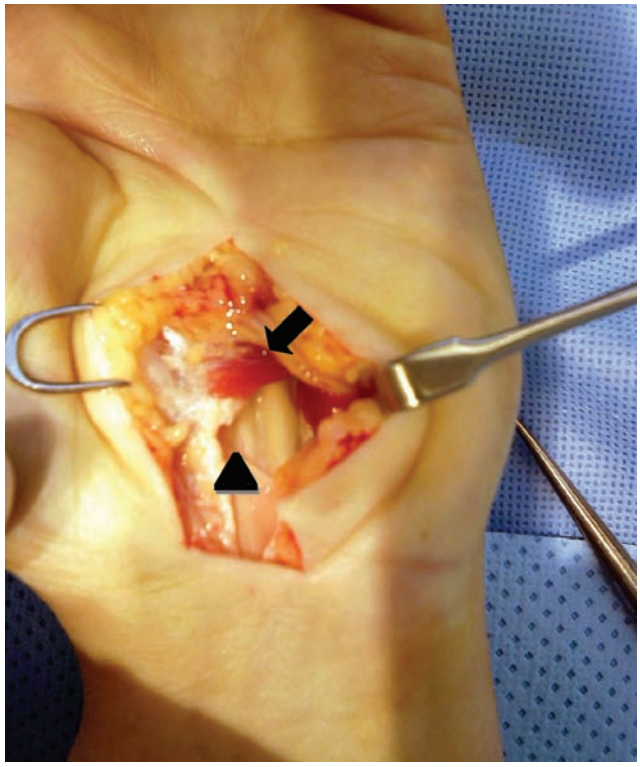


Figure 6. The palmaris brevis muscle (black arrow), and the extension of palmaris longus tendon (arrow head).

reports have described cases in which MRI findings were initially missed and recognized retrospectively only after surgical exploration.[12,35] Although conservative management with rest and anti-inflammatory medications should be attempted initially, symptoms likely will recur. Simple excision of the anomalous muscle may reliably eliminate pain and paresthesias without significant functional loss.

Palmaris Brevis

The palmaris brevis muscle is thought to originate from the flexor retinaculum and palmar aponeurosis and to insert ulnarly onto the hypothenar dermis and proximally to the pisiform. However, as can be seen in Figure 6, the muscle is known to have a variable origin and insertion.

Although the palmaris brevis muscle has not been shown to contribute to median nerve pathology, it may create problems often confused with such a diagnosis. If the origin of the muscle is very proximal, one may mistakenly identify the muscle as an accessory palmaris longus or as an extension of a reversed palmaris longus. Its innervation is thought to come from the superficial branch of the ulnar nerve. The muscle is most often divided into the 2 distinct heads: proximal and distal. The 2 muscle bellies are thought to be innervated by separate branches of the ulnar nerve. Because of its proximity to Guyon's canal, the muscle may cause ulnar neuropathy symptoms.[46,47] The palmaris brevis spasm syndrome and cyclist or crutch palsy are associated nerve compression injuries, and these conditions may be diagnosed with EMG studies.[48] Functionally, the muscle is thought to retract the hypothenar skin to augment grasping motion and protect the ulnar neurovascular bundle.

Discussion

Recognizing the possibility of atypical variants of palmaris longus can be challenging preoperatively. Unless there is very high suspicion of mass effect, most surgeons would not consider imaging studies as part of their diagnostic workup of carpal tunnel syndrome. As in the case presented, a hand surgeon will encounter aberrant variations of palmaris longus during carpal tunnel release. There is no clearly established clinical indication to further work up patients with suspected carpal tunnel syndrome. Most of the time, a diagnosis of carpal tunnel syndrome is based on clinical findings along with the results of EMG studies. A recent study suggests that MRI may predict the patient's outcome from carpal tunnel release as well as EMG studies do.[49] However, the cost-effectiveness of MRI for the purpose of diagnosing carpal tunnel syndrome should be carefully considered before substituting MRI for the EMG. MRI imaging would be more appropriately used for preoperative planning for various reconstructive procedures. Furthermore, a recent study showed that EMG may not even add significant value in the diagnosis of carpal tunnel syndrome if an adequate history and physical exam are obtained.[50]

The normal palmaris longus muscle is functionally insignificant in human beings—although there is no doubt regarding its utility in various reconstructive surgeries. Nonetheless, the less common variants of the muscle may contribute to various pathologic processes that may surprise inexperienced eyes. All hand surgeons should be familiar with the potential anatomic variations of the palmaris longus muscle, not only because of the utility of the palmaris longus tendon as a valuable conduit in surgical procedures but also for the rare cases in which early recognition of the variant muscle can help avoid repetitive, unsuccessful surgical exploration or other nontherapeutic measures. When in doubt, surgeons should not hesitate to explore the possibility of the anatomic variation of the muscle.

With this case report and literature review, we have sought to consolidate current knowledge of the anatomic variations of the palmaris longus muscle and their pathologic ramifications.

Authors' Disclosure Statement and Acknowledgment

The authors report no actual or potential conflict of interest in relation to this article.

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