ISSN 2563-7142

CASE REPORT

Palmaris Longus Inversus Muscle Present Bilaterally in an 82-Year-old Cadaver and Unilaterally in a 68-Year-old Cadaver

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Granite G, Wind G, Leighton X. Palmaris Longus Inversus Muscle Present Bilaterally in an 82-Year-old Cadaver and Unilaterally in a 68-Year-old Cadaver. Int J Cadaver Stud Ant Var. 2021;2(1):18-23.

Abstract

The palmaris longus muscle is one of the most variable muscles in the human body. Palmaris longus muscle anatomical variations include reversed (palmaris longus inversus muscle), duplicated, triplicated, bifid, hypertrophied, accessory (additional) slips, and/or complete absence. During anatomical dissection of fifty cadavers in the 2019 undergraduate first-year anatomy course at the Uniformed Services University of the Health Sciences, we found a palmaris longus inversus muscle bilaterally on an 82-year-old white female cadaver and a unilateral palmaris longus inversus muscle on the right forearm of a 68-year-old white female cadaver. Due to the prevalence of anatomical variations in the palmaris longus muscle, adequate knowledge of such prevalence and clinical significance is necessary in various medical specialties for its use in reconstructive surgery, and the possibility and treatment of clinical syndromes. An accessory (additional) palmaris longus muscle, hypertrophied palmaris longus muscle, hypertrophied palmaris longus inversus muscle, or just the presence of a palmaris longus inversus muscle, can all cause compression to adjacent neurovascular structures, such as the median nerve, ulnar nerve, ulnar artery, and/or the anterior interosseous artery, in the distal forearm and wrist. Palmaris longus tendons are used as grafts in a variety of surgeries, such as extensor tendon repair in rheumatoid arthritis patients, injuries of flexor tendons and repair, lip augmentation, reconstructive hand surgery, frontalis suspension sling in ptosis correction, plastic surgery, and pulley reconstructions. Surgeons, physicians, radiologists, and physiotherapists must be knowledgeable of the many palmaris longus muscle anatomical variations and their possible contributions to pathological processes.

Key Words: *Palmaris longus inversus muscle; Inverted palmaris longus muscle; Reversed palmaris longus muscle; Palmaris longus muscle anatomical variations; Forearm muscle anatomical variations*

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Received: February 24, 2021, Accepted: March 09, 2021, Published: March 30, 2021

ISSN 2563-7142

Introduction

The palmaris longus muscle (PLM) is the most superficial muscle of the superficial volar compartment forearm muscles [1-7] (Figure 1a). It is located between the flexor carpi ulnaris muscle (FCUM) and the flexor carpi radialis muscle (FCRM) [2,3,8,9]. PLM shares a common flexor origin at the medial epicondyle with the flexor digitorum superficialis muscle (FDSM), the FCRM, and the FCUM. It also arises from the adjacent intermuscular septum and the antebrachial fascia. The median nerve of the brachial plexus innervates the PLM via the C7 and C8 segments of the spinal cord [2,3,4,9-13].

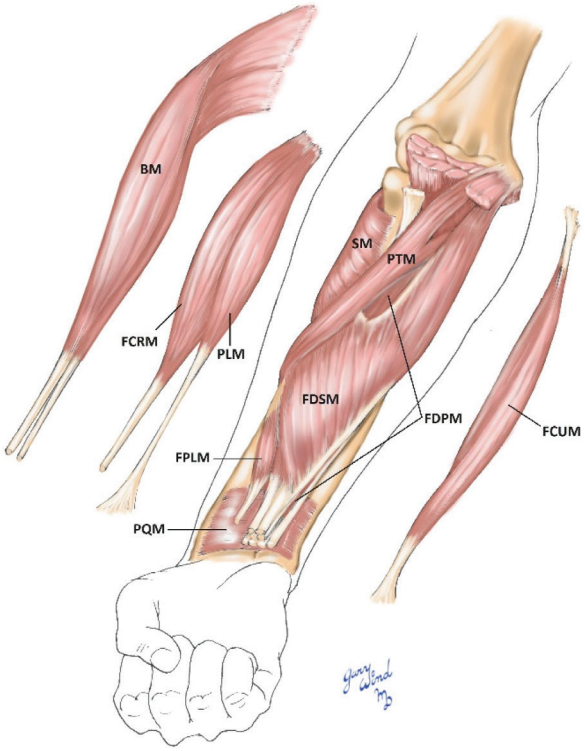

Figure 1a) *Schematic illustration of the superficial volar compartment forearm muscles: the right pronator teres muscle (PTM), flexor carpi radialis muscle (FCRM), palmaris longus muscle (PLM), and the flexor carpi ulnaris muscle (FCUM), along with the right brachioradialis muscle (BM). Several of these muscles have been detached for visibility of the underlying forearm muscles: the right supinator muscle (SM), flexor digitorum superificalis muscle (FDSM) (cut), flexor digitorum profundus muscle (FDPM) (cut), flexor pollicis longus muscle (FPLM) (cut), and the pronator quadratus muscle (PQM). Schematic illustration created by author Gary Wind MD, FACS.*

The PLM is one of the most variable muscles in the human body with an incidence ranging from 0% to 63% [2-5,7-9,11,14-19]. There is wide variation in the reported prevalence and anatomical characteristics of PLM in different ethnic groups [2,4,8,10,12,15,19]. Reimann et al. 1944 first classified PLM variations [17,18]. PLM anatomical variation classifications include reversed (palmaris longus inversus muscle or PLIM), duplicated, triplicated, bifid, hypertrophied, accessory (additional) slips, and/or complete absence [1-4,6,8-11,13-22]. PLM variations are generally more common in females [1,15]. PLM is a weak flexor of the wrist (at the metacarpophalangeal and carpometacarpal joints) and a tensor of the palmar aponeurosis (PA). Its absence does not significantly affect the strength or grip of the hands. PLM anatomical variants, however, can cause clinical syndromes [1-5,8,10].

The insertion of PLM is also quite variable [1,10,15]. It can attach to the forearm, the flexor carpi ulnaris muscle tendon, the pisiform bone, the scaphoid bone, the abductor pollicis brevis muscle (APBM), the hypothenar eminence fascia and muscles, one of the flexor tendons, or near the metacarpophalangeal joint [1,10,15]. The PLM most commonly inserts onto the PA or the flexor retinaculum (FR) [2,4,9,11,12,17].

The PLIM is characterized by a tendinous origin located on the medial epicondyle of the humerus and an origin of its muscle belly on the lower two-thirds of the forearm, inserting onto the FR and/or the pisiform bone [2,4,5] (Figure 1b). Captain John T. Morrison first described PLIM in 1916 as an incidental post-amputation finding [4,23].

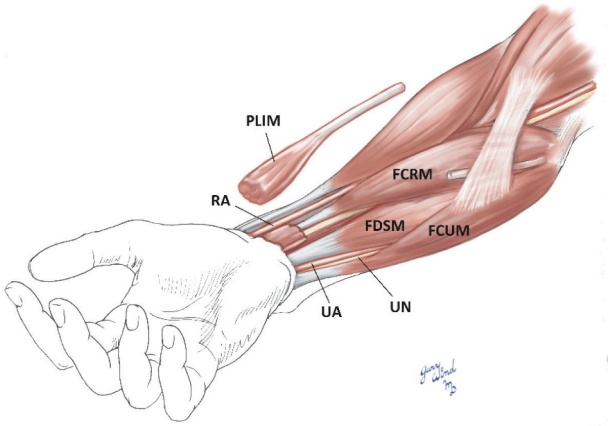

Figure 1b) *Figure 1b) Schematic illustration of the right palmaris longus inversus muscle (PLIM) (cut and detached with elevation), radial artery (RA), flexor digitorum superficialis muscle (FDSM), flexor carpi radialis muscle (FCRM), flexor carpi ulnaris muscle (FCUM), ulnar artery (UA), and the ulnar nerve (UN). Schematic illustration created by author Gary Wind MD, FACS.*

During anatomical dissection of fifty cadavers in the 2019 undergraduate first-year anatomy course at the Uniformed Services University of Health Sciences (USUHS), we found a PLIM bilaterally on an 82-year-old white female cadaver and a unilateral PLIM on the right forearm of a 68-year-old white female cadaver. Both cadavers were provided by the Maryland State Anatomy Board.

Case 1

PLIM were found bilaterally on an 82-year-old white Female cadaver (listed cause of death: sepsis and heart failure). Both PLIMs originated on the medial epicondyle of the humerus and inserted onto the FR (Figures 2-4). The left PLIM belly length was approximately 10 cm and its tendon length were approximately 10.5 cm (Figure 2). The right PLIM belly was approximately 7.5 cm and its tendon length were approximately 5.5 cm (Figures 4). During student dissection, the right PLIM was detached from its insertion onto the FR that was removed (Figure 4). The flexor pollicis brevis muscle (FPBM) and the APBM were bisected for the students to view the opponens pollicis muscle (OPM) on each hand. The flexor digiti minimi brevis muscle (FDMBM) and abductor digiti minimi muscle (ADMM) were bisected for the students to view the opponens digiti minimi muscle (ODMM) on each hand. The PA was removed, and the carpal tunnel opened for the students to follow the neurovasculature and muscle tendons into the hand (Figure 3). The tendons of the FDSM were cut for the students to view the flexor digitorum profundus muscle (FDPM) (Figure 4).

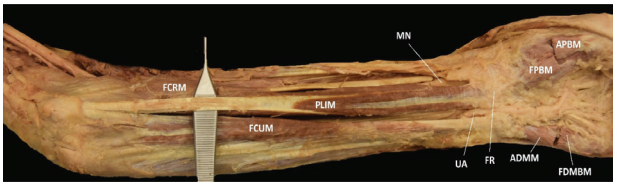

Figure 2) *Facilitated display highlighting the left palmaris longus inversus muscle (PLIM) (displayed by forceps), flexor carpi radialis muscle (FCRM), flexor carpi ulnaris muscle (FCUM), median nerve (MN), ulnar artery (UA), flexor retinaculum (FR), abductor pollicis brevis muscle (APBM), flexor pollicis brevis muscle (FPBM), abductor digiti minimi muscle (ADMM), and the flexor digiti minimi brevis muscle (FDMBM).*

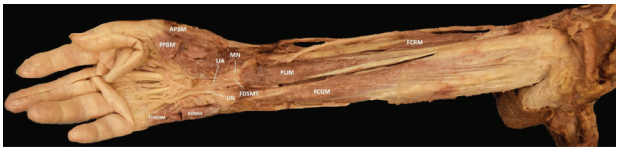

Figure 3) *Facilitated display highlighting the right palmaris longus inversus muscle (PLIM), flexor carpi radialis muscle (FCRM), flexor carpi ulnaris muscle (FCUM), median nerve (MN), flexor digitorum superficialis muscle tendons (FDSMT), ulnar artery (UA), ulnar nerve (UN), abductor pollicis brevis muscle (APBM), flexor pollicis brevis muscle (FPBM), abductor digiti minimi muscle (ADMM), and the flexor digiti minimi brevis muscle (FDMBM).*

Figure 4) *Facilitated display highlighting the right palmaris longus inversus muscle (PLIM) (cut and reflected superiorly with forceps), flexor digitorum superficialis muscle (FDSM) (cut), and the flexor carpi ulnaris muscle (FCUM).*

Case 2

A unilateral PLIM was found on the right forearm of a 68-year-old white female cadaver (listed cause of death: septic shock and necrotizing pancreatitis). The left PLM did not present with any anatomical variations. Both the left PLM and right PLIM originated from the medial epicondyle of the humerus and inserted onto the FR. The right PLIM belly was approximately 5.5 cm and its tendon length were approximately 6 cm (Figures 5,6). The FPBM and APBM were bisected for the students to view the OPM on each hand. The tendons for the FCUM and the FCRM were inadvertently cut by the students (Figures 5,6). The tendons for the FDSM were cut for the students to view the FDPM (Figures 5,6).

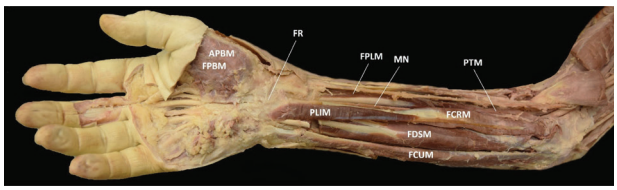

Figure 5) *Facilitated display highlighting the right palmaris longus inversus muscle (PLIM), flexor retinaculum (FR), pronator teres muscle (PTM), flexor carpi radialis muscle (FCRM) (cut), flexor digitorum superficialis muscle (FDSM) (cut), flexor carpi ulnaris muscle (FCUM) (cut), median nerve (MN), flexor pollicis longus muscle (FPLM), abductor pollicis brevis muscle (APBM), and the flexor pollicis brevis muscle (FPBM).*

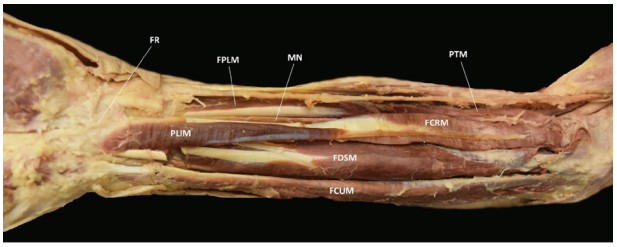

Figure 6) *Facilitated display highlighting the right palmaris longus inversus muscle (PLIM), flexor retinaculum (FR), pronator teres muscle (PTM), flexor carpi radialis muscle (FCRM) (cut), flexor digitorum superficialis muscle (FDSM) (cut), flexor carpi ulnaris muscle (FCUM) (cut), median nerve (MN), and the flexor pollicis longus muscle (FPLM).*

Discussion

An accessory (additional) PLM, hypertrophied PLM, hypertrophied PLIM, or just the presence of a PLIM, can all cause compression to adjacent neurovascular structures, such as the median nerve, ulnar nerve, ulnar artery, and/or the anterior interosseous artery, in the distal forearm and wrist [2-5,11,14-16,24,25]. These variant manifestations of the PLM can present as volar swelling or pseudomass (or soft tissue tumor), it can cause or aggravate Dupuytren's contracture, Volkmann's ischemic contracture, carpal tunnel syndrome, or Guyon's canal syndrome [1,3,4,10,11,15]. Although compression caused by a hypertrophied PLM, hypertrophied PLIM, or PLIM is rare, each of these variations should always be considered in the differential diagnosis. One can use Doppler ultrasonography and other radiological imaging to determine if nearby neurovascular structures are being compressed [4,9,16]. It is important to note, however, that several reports of PLIM causing symptoms of pain with exertion did not involve median nerve compression symptoms [9,26,27]. Additionally, PLIM, as well as the other aforementioned PLM variations, may also cause difficulties in radiological image interpretation by radiologists [5,9,10].

Variant insertion of PLM deep to the FR, accessory PLM, and duplicated PLM can also cause carpal tunnel syndrome, compressing the median and/or ulnar nerve [1]. One should suspect a variant muscle whenever a patient complains of effort related carpal tunnel symptoms despite adequate tunnel release or wrist pain with swelling at the volar wrist [10,24]. While considering the possibility of a variant muscle, PLM variations must be differentiated from other anatomical variants such as palmaris profundus muscle (PPM) and epifascial accessory PLM. PPM is a muscle originating from the lateral edge of the radius bone, in its middle third, lateral to the FDSM and deep to the pronator teres muscle (PTM) or from the FDSM fascia. Its tendon passes beneath the FR to enter the carpal tunnel and inserts deep to the PA. The median nerve and PPM tendon are ensheathed in a common connective tissue sheath. This can produce similar symptoms as that of a PLIM, hypertrophied PLM, or hypertrophied PLIM compressing the median nerve and reducing the muscular power of the hand, causing pain and numbness [4,9,10,15,28]. An epifascial accessory PLM involves additional slips of insertion to hypothenar muscles and fascia that may compress the ulnar nerve and vessels in Guyon's canal. This can lead to syndromes mimicking claw hand and compartment syndromes leading to Volkmann's ischemic contracture or aggravate, modify, or hasten the signs and symptoms of Dupuytren's contracture affecting the forearm and hand [10].

The long tendon and short belly of the PLM indicates it is phylogenetically a degenerative muscle. In addition, its common absence is an indication of its gradual disappearance in humans. The regressive structural characteristics of PLM, however, make it a muscle of interest for surgeons in tendon transfers and other reconstructive surgeries [1,2,7-10,13,19,20]. In addition, removal of the PLM tendon is suggested to have no effect on hand functionality [2,11,21]. PLM tendons are used as grafts and tendon transfer procedures in a variety of surgeries, such as extensor tendon repair in rheumatoid arthritis patients, injuries of flexor tendons and repair, lip augmentation, reconstructive hand surgery, frontalis suspension sling in ptosis correction, plastic surgery, and pulley reconstructions [1-5,7-10,12,13,19,29-32]. Bifid PLM with a 'V' shaped tendon arrangement is commonly used in correcting oral and lid angles in facial palsy [1,4,10,33]. Lack of awareness of possible PLM variations can lead to iatrogenic injury to the

median nerve, ulnar nerve, or ulnar artery during harvest of the PLM tendon [17,34]. In addition, the PLM tendon is an important clinical landmark for corticosteroid injections during treatment of carpal tunnel syndrome, distal radial fracture, median nerve block, and Guyon's canal syndrome treatment [2,4,7,9]. Another important clinical attribute of the PLM is it overlies and protects the median nerve [12,34]. A detailed knowledge of PLM variations is useful for orthopedic and plastic surgeons during the differential diagnosis of tumor or ganglion on MRI or clinical examination [10]. The unexpected presence of a PLIM belly at the distal end of the forearm may cause complications in the interpretation of radiological images, wrist endoscopic and electromyographic procedures during carpal tunnel syndrome treatment [4,5,9,10]. Mathew et al. 2015 reported the occurrence of a PLIM in 2.08% of its 48 studied upper limbs [2,4]. In our cohort, the incidence of a PLIM was 3% (three of the one-hundred studied upper limbs).

Conclusion

Due to the prevalence of anatomical variations in the palmaris longus muscle, adequate knowledge of such prevalence and clinical significance is necessary in multiple medical specialties for its reconstructive use and the possibility and treatment of clinical syndromes. The use of radiological imaging is important when establishing a diagnosis of PLM hypertrophy, PLIM hypertrophy or PLIM causing or aggravating Dupuytren's contracture, Volkmann's ischemic contracture, carpal tunnel syndrome, or Guyon's canal syndrome. Surgeons, physicians, radiologists, and physiotherapists must be knowledgeable of the many PLM anatomical variations and their possible contributions to pathological processes.

Acknowledgement

We would like to thank the families of our donors for their beneficent contribution. Without their generosity, this article would not have been possible. We would also like to thank Ms. Sara Chae for assisting us in our literature review.

Disclaimer

The opinions or assertions contained herein are the private ones of the author/speaker and are not to be construed as official or reflecting the views of the Department of Defense, the Uniformed Services University of the Health Sciences or any other agency of the U.S. Government.

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