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Bilateral reversed palmaris longus muscle: a rare anatomical variation

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We report a case of bilateral reversed palmaris longus muscle (PLM). The muscle was tendinous in its upper portion and muscular in its lower portion in both arms. This rare variation has been mentioned only once in the literature as a surgical finding. According to the literature, a reversed PLM may cause a compartment syndrome in the wrist area, carpal tunnel, and Guyon's syndrome. The described variation is also useful to the hand surgeon as a tendon graft, a tendon for transfer, or as an anatomical landmark for operations at this area. (Folia Morphol 2012; 71, 1: 52–55)

Key words: palmaris longus muscle, reversed muscle, anatomical variation, forearm

INTRODUCTION

The palmaris longus muscle (PLM) is a fusiform and thin muscle that lies medial to the flexor carpi radialis (FCR) muscle. It shares a common origin with the flexor superficialis digitorum (FSD) muscle, the flexor carpi ulnaris (FCU) muscle, and the FCR, in the medial epicondyle of the humerus. It then projects toward the distal and lateral regions, exhibiting muscular qualities up to two thirds of the length of the forearm, finally ending in a long and slender tendon, which passes anteriorly to the flexor retinaculum. It is inserted into the distal half of the anterior surface of the palmar aponeurosis (although occasionally, into the retinaculum) [7, 15]. It frequently extends by means of a tendinous slip toward the muscles of the thenar region [9]. It is placed just beneath the skin, under subcutaneous adipose tissue and the deep fascia of the forearm — its deep surface in relation with the FDS muscle, between the FCU and the FCR muscles. It is functionally redundant [14, 15]. Because of this and its easy accessibility, it is frequently used as a tendinous graft or as a transference tendon with the thumb to obtain opposition and abduction [15].

The PLM is extremely variable. Its most frequent variation is agenesis, reported in 12.8% of the population [10, 15]. Other variations include differences in shape and position described as central, inverted, bifid, duplicated [11], and even triplicated [7, 15]. These variations affect 9% of the population [10]. The close topographic relation between the PLM and the median nerve makes such anatomical variations a common cause of median nerve entrapment and compression [5, 6].

A PLM displaying a tendinous proximal segment and a muscular distal segment was first described as an inverse PLM. It was later renamed to its current name, reversed PLM [14]. Many surgeons and anatomists have reported cases in which patients that endure repetitive tasks suffer from median nerve compression because of the presence of a reversed PLM [1, 2, 6, 8, 12, 15]. In such cases, surgical excision of the reversed muscle proved to be the appropriate treatment to relieve related symptoms [2, 3, 7, 9, 15].

Schuurman and van Gils [12] reported that, in patients diagnosed with median nerve compression, magnetic resonance imaging (MRI) could be used to unilat-

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erally determine if a reversed PLM is the source of such a condition instead of an inflammation in the carpal tunnel, which would normally be expected during median nerve compression. Thus, muscular variations, such as the reversed PLM, should be considered when evaluating both median and ulnar nerve neuropathy in the wrists. Most cases of reversed PLM descriptions and extirpations have been unilateral, on the right forearm [15].

The existence of a bilateral reversed PLM has only been described once in the literature as a clinical finding, in a patient showing symptoms indicating temporary median nerve compression in both forearms. In this study, we describe an inverse PLM found bilaterally on a cadaver and analyse its clinical significance.

CASE REPORT

During a routine educational dissection at the Pontificia Universidad Católica de Chile Medical School's Anatomy department, the flexor muscles on the forearms of a 78-year-old male cadaver whose death was caused by a pulmonary emphysema were exposed. An anatomical variation in the PLM was found on both forearms: the tendinous portion was oriented toward the proximal end, and the muscular portion was oriented toward the distal end, a condition described as a reversed PLM.

The reversed PLMs on both forearms were dissected along with their surrounding structures, exposing the PLM's proximal insertion into the humeral medial epicondyle, its musculotendinous junction, and its distal insertion into the palmar aponeurosis on the hand. The proximal and distal anatomical structures were identified, and all relevant anatomical relations were described (Figs. 1A, B).

On the right forearm, the reversed PLM was 284.54 mm in length. It arose from the humerus' medial epicondyle by means of a 150.37-mm-long and 7-mm-thick tendon (Fig. 1A). This tendon extended down to the forearm's lower two thirds, its deep surface in relation with the FDS muscle. The muscle then extended distally via a muscular belly, with a length of 119.17 mm and a maximum width of 18.4 mm at 197.37 mm from its proximal insertion in the medial epicondyle. The muscle finally inserted into the palmar aponeurosis in the hand through a small, 15-mm-long and 5.4-mm-wide tendon. The distance between the right reversed PLM and the FCU muscle's tendon was 9.9 mm. These muscles came together at the point where they both displayed their muscular belly. The right reversed PLM's muscular belly was located 5.2 mm from the ulnar artery, 10 mm from the ulnar nerve, 12.3 mm from the FCR muscle's tendon, and

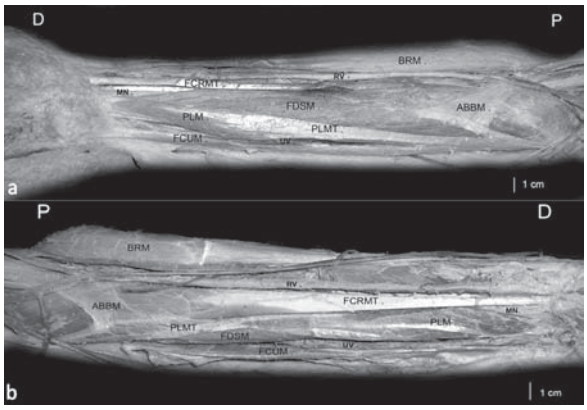

Figure 1. Anatomical image of the right and left upper limbs. The reversed palmaris longus muscles (PLM) on both forearms were dissected exposing the proximal and distal insertion; **A.** The right reversed PLM with surrounding structures; **B.** The left reversed PLM with surrounding structures; PLMT — reversed palmaris longus muscle tendon; FDSM — flexor superficialis digitorum muscle; FCUM — flexor carpi ulnaris muscle; FCRMT — flexor carpi radialis muscle tendon; BRM — brachioradialis muscle; MN — median nerve; RV — radial vessels; UV — ulnar vessels; ABBM — bicipital aponeurosis.

20 mm from the radial artery. The right reversed PLM's muscular belly and distal tendon were laterally related to the median nerve, which, at this point, showed a diameter of 4.47 mm. At the flexor retinaculum these structures were 5 mm apart (Fig. 2A).

The left reversed PLM was 273.69 mm in length, arising from the humerus' medial epicondyle as a 125.13-mm-long and 5.5-mm-wide tendon located superficially with respect to the FDS muscle (Fig. 1B). It then continued displaying a 148.56-mm-long muscular belly, which reached its maximum width (18 mm) at 238.69 mm from its proximal insertion into the humerus' medial epicondyle. These muscular fibres continued until inserted directly into the palmar aponeurosis. At the flexor retinaculum, the left reversed PLM was located 10 mm medially from the FCR muscle, disposed at 8.6 mm medially from the radial artery, 8 mm laterally from the FCU tendon, 4.5 mm laterally from the ulnar nerve, and 2 mm laterally from the ulnar artery. At two thirds of the forearms, the ulnar artery came into direct contact with the left reversed PLMs' muscular belly (Fig. 2B). During its proximal trajectory, the left reversed PLM was located medially with respect to the median nerve. However, on the forearms' distal third, the muscle came into direct contact with the PLM's muscular belly, displaying median nerve compression and torsion. Proximal to the compression site, the median nerve showed a diameter of 4.56 mm and, at the site of compression, exhibited a diameter of 2.78 mm, and toward the distal region it recovered its original diameter (4.41 mm).

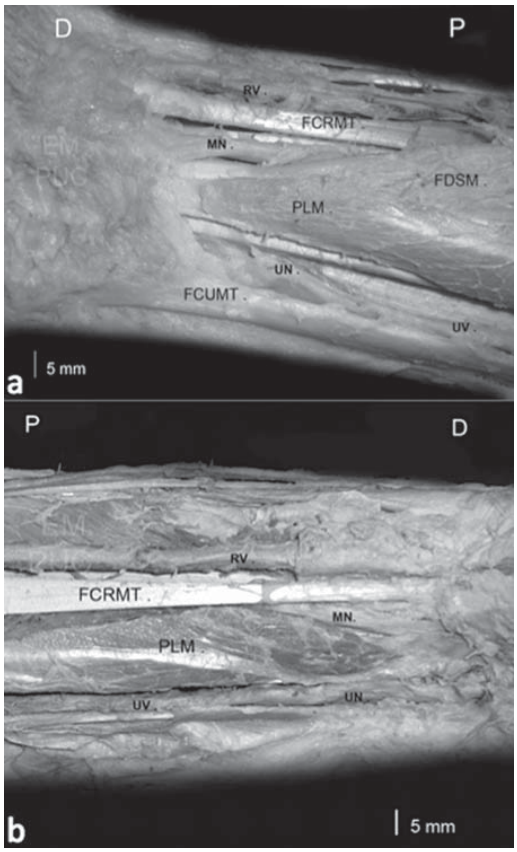

Figure 2. A. Distal insertion of the right reversed palmaris longus muscle (PLM); **B.** Distal insertion of the left reversed PLM; MN — median nerve; RV — radial vein; UN — ulnar nerve; UV — ulnar vessels; FDSM — flexor superficialis digitorum muscle; FCUMT — flexor carpi ulnaris muscle tendon; FCRMT — flexor carpi radialis muscle tendon.

DISCUSSION

The PLM is extremely variable in both number and shape [15]. The presence or absence of the PLM has no effect on hand grip strength [13]. However, it has been shown that the thumb's abduction strength is larger in hands where the PLM can be found [4]. These observations are controversial as they question the current idea that the PLM is redundant and that its main advantage arises when used as material for grafts or tendon transplantation to recover thumb movement [3].

In our dissection, the reversed PLMs, both right and left, showed a tendinous origin at the site of the medial epicondyle and a muscular insertion at the site of the palmar aponeurosis. These findings correlate with the description in the literature regarding this type of variation [15]. According to Natsis et al. [7] the muscle exhibits a thin and wide tendon, which, in our case, showed to be 150.37 mm long and 7 mm wide on the right tendon, while showing to be 125.15 mm long and 5.5 mm wide on the left tendon. In both cases, the reversed PLM was located superficially in relation to the FSD muscle, displaying the required characteristics for it to be considered useful as a donor site.

Many cases of reverse PLM have been described, either as an anatomical or surgical finding [1, 2, 5, 9, 11, 12, 15]. However, the co-existence of this anomaly on both limbs in the same individual is extremely rare, and the existence of a bilateral reversed PLM has only once been described in the specialised literature, on a 21-year-old male patient. This study points out that the patient showed symptoms of temporal median nerve compression in both forearms, outside the carpal tunnel, and in the distal segment of the forearm, which was caused by the reversed PLM's hypertrophy. Resection of the PLM's muscular belly relieved the symptoms immediately [5].

Reimann et al. [10] studied reversed PLMs in 1600 upper limbs, classifying their anatomical variations. Agenesis was found to be the most common (12.8%). All other PLM variations amounted to 9%. The existence of two separate PLMs and variations in shape also were included. After agenesis, variations in muscle form were the most common, summing up almost 50% of cases previously mentioned and representing 4.5% of the total cases. These variations make reference to the disposition of the muscular mass along the muscle, which may be found on its upper portion, in the middle, or even on its inferior extreme.

Although the PLM's muscular belly passes over the flexor retinaculum, it may produce symptoms because of compression on the median nerve before it becomes inserted in the carpal tunnel. When used excessively, this may cause a compartment syndrome (effort-related compartment syndrome) [8]. In the case of the reversed PLM, it is the antebrachial fascia that creates a closed muscular compartment. As a result of this, compression is transferred to all adjacent structures, whereas the local hypertrophy of the PLM's muscular belly (due to excessive use) only worsens this condition [1, 2, 5, 7, 12, 15].

The correlation between the presence of a reversed PLM and carpal tunnel syndrome has been confirmed in the literature. The symptoms developed by patients include inflammation on the palmar surface of the wrist, reduced muscle strength in the hand, and pain and numbing in the area of distribution of the median nerve [7].

Schuurman and van Gils [12] have reported the presence of a unilateral reversed PLM as a plausible source of pressure in patients diagnosed with median nerve compression. In our report, the right reversed PLM was

located laterally with respect to the median nerve. The nerve showed no signs of compression. However, the left reversed PLM was located medially with respect to the median nerve, and on the distal third of the forearm it came in direct contact with the muscular belly, generating both compression and torsion on the median nerve and reducing its diameter from 4.56 to 2.78 mm. Distally, past the compression zone, it recovered its diameter to 4.41 mm. Many studies have confirmed that the presence of a reversed PLM can be a source of compression with the median nerve when enduring repetitive work-related tasks [1, 2, 6, 7, 15]. In such cases, surgical removal of the reversed muscle has been used to relieve related symptoms [1, 2, 9, 12, 15].

In recent studies, MRI has been used to evaluate the cause of symptoms and oedemas in patients in whom the diagnosis of a reversed PLM was problematic [2, 12]. This may be explained because of the fact that the reversed PLM's muscular belly shows the same signs in the MRI as the rest of the muscles in the forearm but also by a lack of awareness of the existence of such anatomical variation [2].

Considering the presence of these muscular anomalies, it seems reasonable to indicate a routine ultrasound scan or MRI to study the PLM in patients who express symptoms but cannot be clinically observed [8]. Therefore, the reversed PLM variation must be considered not only while evaluating a possible median nerve neuropathy but also while evaluating an ulnar nerve neuropathy in the wrist, such as Guyon's canal syndrome [9].

The case previously described is both the second report describing a bilateral reversed PLM in the literature and the first report describing it as an anatomical finding. Knowledge of this variation is useful for orthopaedic surgeons when evaluating symptoms of median or ulnar nerve compression, which tends to get worse during hand movements. Radiologists should also be aware of this variation, as its diagnosis is made difficult because of the large number of muscles in the forearm. Also, PLM variations are useful to both plastic surgeons, which may use the tendon as a graft, and surgeons that work in that area, as the PLM's tendons act as an important landmark used as an anatomical reference during surgical procedures.

Lastly, finding these anatomical variations in cadavers dissected with educational purposes at our Anatomy Department poses great educational value to our undergraduate medical students, who get to experience first hand the human body's immense variability, ridding their minds of the fictitious and unreal archetype shown in anatomical models, educational tools of widespread use in many medical schools in our country today. Likewise, these observations are attractive to postgraduate students (subtends doing their internship in anaesthesia, traumatology, etc.), who, because of their high-level profession training, are able to appraise the implications of this anatomical knowledge in their daily clinical work. Also, it allows us to contribute to the knowledge of anatomical vitiations and their medical and clinical implications.

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