A Case of an Accessory Palmaris Longus Muscle and a Duplicate Palmaris Longus Muscle with Special Reference to Their Nerve Supply

– Morphologic Significance of a Common Innervation Trunk –

By

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Summary: During a dissection of the forearm and hand, a duplicate palmaris longus muscle with an accessory palmaris longus muscle was observed on the right side of a 73-year-old Japanese male cadaver.

Duplications of the palmaris longus muscle have been reported by many authors. Humphry (1872) suggested the presence of radial, intermediate, and ulnar sectors in the superficial layers of the forearm flexor muscular angulus, based on a comparison of fore- and hind limbs and comparative anatomical theory. The palmaris longus muscle usually differentiates from the intermediate sector but differentiation from the other two sectors may also be possible.

Some authors have asserted that a common innervation trunk is critical for determining an ontogenetic relation between the muscles (Fuchino, 1960; Honma, 1980; Yamada, 1986).

We examined the nerve supply in addition to scrutinize these anomalous palmaris longus muscles. In our case, the ramification of the innervating nerves was specific. The branches to the second palmaris longus muscle and the flexor carpi radialis arose as a common trunk from the median nerve. The branches to the first palmaris longus muscle and the accessory palmaris longus muscle originated as another common trunk from the median nerve. From these observations, we speculated that the second palmaris longus muscle has differentiated from the flexor carpi radialis, while the accessory palmaris longus muscle has differentiated from the first palmaris longus muscle, based on Humphry's suggestion.

During a dissection of the forearm and hand, a duplicate palmaris longus muscle (PL) with an accessory PL was observed on the right side of a 73-year-old Japanese male cadaver.

Although several reports on PL variations have been published, very few discuss the nerve supply of these anomalous muscles. Nevertheless, the innervation of the muscles must examine to determine their ontogenetic origin. We therefore analyzed the nerve supply of the aberrant muscles in the present case.

Materials and Method

The aberrant muscles were observed on the right

side of a Japanese male cadaver (Cause of death: acute myocardial infarction) during the dissection of the forearm and hand. After careful examination, the muscles and their nerve supplies were excised en bloc. The bony elements were completely removed to facilitate a detailed dissection of the sites of muscle origin and to elucidate the relationships of the nerve supply.

Results

Origin and insertion

The duplicate palmaris longus muscle (PL) and the accessory PL arose from the medial epicondyle of the humerus with the pronator teres muscle

(PT), flexor carpi radialis (FCR), flexor carpi ulnaris (FCU), and a part of the superficial digital flexor (FDS) as a common flexor origin (Fig. 1).

The three aberrant muscles were located between the FCR and FCU, and originated as one muscle. The first PL (1) arose from the medial epicondyle of the humerus as a muscle proximally, became tendinous distally in the half way and ended in a palmar aponeurosis.

The accessory PL (1') arose from the dorsal aspect of the first PL as a tendon, became muscular distally, and attached to the flexor retinaculum.

The second PL (2) was located lateral to the first and accessory PL and was in contact with the FCR. This muscle was inserted at the flexor retinaculum as a tendon.

Innervation

Figure 2 shows the composition and ramification of the median and ulnar nerves. The FCU was innervated by the ulnar nerve, and the other superficial forearm flexor muscles (SFF) were innervated by the median nerve.

The branches to the second PL (2), FCR and FDS arose as a common trunk (B) from the median nerve, while the branches to the first PL (1), accessory PL (1'), FDS and the proximal part of the SFF arose as a common trunk (A) from the median nerve.

The nerve supply to the PT arose from the median nerve as a single branch.

Abbreviation for all figures

- BR: brachioradialis muscle
- FCU: Flexor carpi ulnar muscle
- FCR: Flexor carpi radialis muscle
- M: Median nerve
- U: Ulnar nerve
- R: Radial nerve
- Cal: Lateral antebrachial cutaneous nerve
- MC: Musculocutaneous nerve
- FDS: superficial digital flexor muscle
- FDP: profundus digital flexor muscle
- PL: palmaris longus muscle
- PT: pronator teres muscle

Fig. 1. Diagram showing the forearm flexor muscles and their surround structures. Ventral view. A duplicate palmaris longus muscles (1 and 2) and an accessory palmaris longus muscle (1') are observed.

Fig. 2. Composition and ramification of the median and ulnar nerve. Ventral view. The superficial and middle layers of the antebrachii flexor muscles were reflected to clearly observed the nerve supply. The innervation of the first palmaris longus muscle (1) and the accessory palmaris longus muscle (1') originated as a common trunk from the median nerve. The innervation of the second palmaris longus muscle (2) and the flexor carpi radialis muscle (FCR) originated as a common trunk from the ulnar nerve.

Discussion

Clemente (1984) and Bergman (1988) mentioned that the PL is one of the most variable muscles in the body and is often absent (10%). It may be tendinous proximally and muscular distally or tendinous proximally and distally and muscular in the center. It may present as two muscular bundles with a central tendon, or even consist solely of a tendinous band. The muscle may also be duplicated. Anomalous origins and insertions have also been seen.

Absence of the palmaris longus muscle

Absence of PL has been reported by many authors. The frequency of the absence was as follows:

Japanese cadaver.

In the Japanese cadaver, 3.0% out of 579 dissected arm by Adachi (1910); 5.1% out of 198 dissected arm by Eguchi *et al.* (1959); 6.3% out of 32 dissected arm by Fuchino (1960); 8% out of 100 dissected arm by Inoue (1934); 6% out of 50 dissected arm by Hasegawa *et al.* (1959); 4% out of 50 dissected arm by Ishimi (1951); 3.9% out of 305 dissected arm by Koganei (1903); 3.7% out of 214 dissected arm by Takeda (1955); 4.2% out of 164 dissected arm by Takahuji (1985);

living observation.

In the living observation, 4.1% out of 1066 arm by Suzuki (1955); 5.0% out of 402 arm by Takahuji (1985)

Sina cadaver.

In the Sina cadaver, 2% out of 400 dissected arm by Li (1959)

Chinese cadavers.

In the Chinese cadaver, 2.1% out of 95 dissected arm by Nakano (1923)

White cadavers.

In the White cadavers, 15.2% out of 552 dissected arm by George (1953); 23.1% out of 104 dissected arm by Gigas (1941); 21.0% out of 624 dissected arm by Nikolajew (1932); 20.4% out of 520 dissected arm by Schwalbe (1894); 14.5% out of 352 dissected arm by Thomson (1921); 8.8% in out 102 dissected arm by Wood (1868)

Black cadavers.

In the Black cadavers, 5.1% in out of 118 dissected arm by Loth (1931).

During our dissection of 157 upper extremities, we encountered the absence of PL in 2 side.

Duplicacate or triplicate palmaris longus muscle

Duplicate PL have been reported by many authors (Hojo, 1976; Adachi, 1910; Hasegawa, 1959; King, 1950; Reimann, 1944; Sato, 1974; Takeda, 1955; Wood, 1864, 1968; Saadh and Bergman, 1986). The frequency of duplicate was as follows: 1.9% out of 305 dissected arm by Koganei *et al.* (1903); 2.1% out of 884 arms by Adachi (1910); 3.1% out of 1000 arms of Russians by Gruber (1868); 0.8% out of 530 arms of Americans by Reimann (1944); 2.5% out of 76 arms of Japanese by Sato Y (1974); 0.5% out of 214 arms of Japanese by Takeda R (1955); 5.9% out of 102 arms of White by Wood J (1868).

A triplicate PL was reported by Grubers (1 out of 1000 cases).

According to Reimann *et al.* (1944), PL variations may be classified as follows: complete agensis, variation in the location and form of the fleshy portion, aberrancy in the attachment at either extremity, duplication or triplication, accesssory slips, or substitutions of similar form or position. Various types of duplicate PL have also been reported, and classification according to origin, insertion and form is required to demonstrate certain racial differences. Despite the numerous reports about PL as mentioned above, only a few reports have discussed the nerve supply of these muscles.

Aberrant muscles located on the ulnar side of the true PL tend to be innervated by the ulnar nerve (Morrison, 1916; Hojo, 1976; King, 1950; Sato, 1974). Only one case of an aberrant muscle located on the radial side of the true PL has been reported Moriya (1956), but the innervation of this aberrant muscle was not mentioned.

Morphogenesis of the anomalous palmaris longus muscle

Humphry (1872) proposed the presence of radial, intermediate, and ulnar sectors in the superficial layers of the forearm flexor muscular angulus, based on a comparision of fore- and hind limbs and comparative anatomical theory. He believed that the PT and FCR differentiated from the radial sector, the FCU from the ulnar sector, and the PL from the intermediate sector. The authors also believe that the PL usually differentiates from the intermediate sector, although differentiation from the other two sectors may also be possible. However, no evidence to support this hyposis has been obtained. Since the radial sector and the intermediate sector are both innervated from the median nerve, the origin of anomalous muscles that derive from either the radial or intermediate sectors, can not determine by the nerve supply in general.

Authores have not examined nerve supply in the

Fig. 3. Possible model for the development of the flexor carpi radialis (FCR), palmaris longus (PL), and flexor carpi ulnaris muscle (FCU) based on Humphry (1872) and the present innervation findings. (A): Initial stage. The anlagen of the superficial forearm flexor muscles are the radial, intermediate, and ulnar sectors. Each sector contains a muscle anlage, and all of the structures in each anlage are innervated at the same time. (B): Definitive stage. The positional relationship between the flexor carpi radialis, palmaris longus and flexor carpi ulnaris muscle and their innervation is shown. The palmaris longus muscle is sometimes multiplied if derivations from more than one sector occur, but the innervation of these aberrant muscles will be the same as that of the other muscles deriving from the particular sector in question.

cases of the anomalous PL until now, but some detailed analyses of the nerve supply in the normal forearm flexor muscles have been published (Fuchino, 1960; Homma, 1980; Yamada, 1986). These latter reports insisted that a common trunk of innervation is crucial for deciding that two muscles are closely related.

According to their descriptions,

- 1) The branches to PL and FDS usually arose as a common trunk from the median nerve (Fuchino, 100%; Yamada, 100%); thus, they concluded that the PL and FDS were closely related.
- 2) The nerve branches to the PT and FCR rarely arose as a common trunk from the median nerve (Fuchino, 18.4%; Yamada, 10.0%) but the branch to PT did not arise as common trunk except FCR (Fuchino, 100%). They concluded that the PT usually arose independently, but the PT and FCR were closely related.

We examined the branching pattern of the nerves in the anomalous PL observed in the present case. PL that extended to the palmar aponeurosis

was regarded as the original PL. The second PL (2) was located on the radial side of the original muscle. In our case, its ramification of the innervation was specific and very interesting. The branches to the second PL (2) and FCR arose as a common trunk from the median nerve, while the branches to the first PL (1) and accessory PL (1') arose as another common trunk from the median nerve. These results are very significant from the viewpoint of muscle differentiation.

Based on our findings and those of previous papers, we speculated that the second PL (2) differentiated from FCR belonging to the radial sector, while accessory PL (1') differentiated from first PL (1) belonging to the intermediate sector on the basis of Humphry's idea, and summarized as one schema (Fig. 3).

If the PL differentiated from the FCU, the innervating branch to the anomalous muscle and the branch to the FCU may have had a common trunk from the ulnar nerve.

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Explanation of Figures

Plate I

A photograph showing the duplicate palmaris longus muscle and the accessory palmaris longus muscle. This photograph corresponds to the conditions shown in Fig. 1 (A) and Fig. 2 (B).