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Yoshifumi Ikebuchi*

Takuro Murakami†

Aiji Ohtsuka‡

*Okayama University,

†Okayama University,

‡Okayama University,

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Yoshifumi Ikebuchi, Takuro Murakami, and Aiji Ohtsuka

Abstract

The interosseous and lumbrical muscles in twenty-five hands of Japanese adult cadavers were dissected. The palmar and dorsal interosseous muscles continued, with few exceptions, into the wing tendons. The dorsal interosseous muscles gave off tendons which pierced the transverse laminae or passed deep to the transverse laminae, and attached to the bases of the proximal phalanges. The palmar interosseous muscles seldom had such attachments. The palmar and dorsal interosseous muscles sometimes gave off additional tendons which passed superficial to the transverse laminae and attached to the bases of the proximal phalanges. These latter attachments were typical in the contrahentes muscles. Thus, the present findings suggest that the human dorsal interosseous muscles are composite muscles derived from the dorsal abductor, flexor brevis and contrahens muscles, and that the human palmar interosseous muscles are composite muscles derived from the flexor brevis and contrahens muscles. The lumbrical muscles rarely gave off accessory slips with atavistic attachments to the proximal phalanges.

KEYWORDS: human hand, palmar interosseous muscles, dorsal interosseous muscles, lumbrical muscles

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The Interosseous and Lumbrical Muscles in the Human Hand, with Special Reference to the Insertions of the Interosseous Muscles

Yoshifumi Ikebuchi*, Takuro Murakami and Aiji Ohtsuka

Department of Anatomy, Okayama University Medical School, Okayama 700, Japan

The interosseous and lumbrical muscles in twenty-five hands of Japanese adult cadavers were dissected. The palmar and dorsal interosseous muscles continued, with few exceptions, into the wing tendons. The dorsal interosseous muscles gave off tendons which pierced the transverse laminae or passed deep to the transverse laminae, and attached to the bases of the proximal phalanges. The palmar interosseous muscles seldom had such attachments. The palmar and dorsal interosseous muscles sometimes gave off additional tendons which passed superficial to the transverse laminae and attached to the bases of the proximal phalanges. These latter attachments were typical in the contrahentes muscles. Thus, the present findings suggest that the human dorsal interosseous muscles are composite muscles derived from the dorsal abductor, flexor brevis and contrahens muscles, and that the human palmar interosseous muscles are composite muscles derived from the flexor brevis and contrahens muscles. The lumbrical muscles rarely gave off accessory slips with atavistic attachments to the proximal phalanges.

Key words : human hand, palmar interosseous muscles, dorsal interosseous muscles, lumbrical muscles

The palmar and dorsal interosseous muscles of the human hand are generally regarded as being inserted into the wing tendons of the dorsal aponeuroses and into the bases of the proximal phalanges (1-5). However, our recent dissection of Japanese hands has revealed that the palmar interosseous muscles usually have no insertion into the bases of the proximal phalanges. This finding is reported in the present paper. Aberrant lumbrical muscles with atavistic attachments to the proximal phalanges are described.

*To whom correspondence should be addressed.

Materials and Methods

Twenty-five hands of Japanese adult cadavers of both sexes, which had been fixed with 10% formalin by vascular perfusion and dehydrated with 60-70% ethanol, were dissected with sharpened forceps under a light microscope.

Results

There are four palmar and four dorsal interosseous muscles in the human hand. They are schematically diagramed in Fig. 1. No morphological difference of the palmar

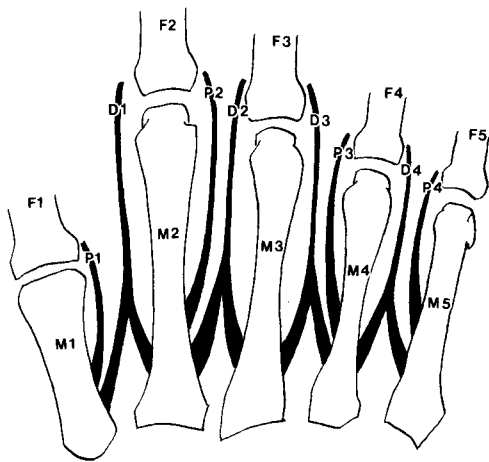


Fig. 1 A diagram showing the arrangement of the interosseous muscles in the human hand. D1-D4 first-fourth dorsal interosseous muscles, F1-F5 first-fifth fingers, M1-M5 first-fifth metacarpal bones, P1-P4 first-fourth palmar interosseous muscles.

and dorsal interosseous muscles was observed between the male and female cadavers.

The palmar (P2-P4) and dorsal (D1-D4) interosseous muscles of the second to fifth fingers (F2-F5) were clearly identified in each hand (Fig. 1). However, the palmar interosseous muscle (P1) of the thumb or first finger (F1) blended so complexly with the adductor pollicis muscle (AO, AT), in particular with its oblique head (AO), that it was not always identified as an independent muscle (Fig. 2). Thus, the present descriptions are concentrated on the interosseous muscles of the second to fifth fingers.

Each of the second palmar (P2), third palmar (P3), fourth palmar (P4), first dorsal (D1), second dorsal (D2), third dorsal (D3) and fourth dorsal (D4) interosseous muscles arose from a metacarpal bone or bones (Fig. 1) and converged, near the metacarpophalangeal joints, into one to four membranous tendons. Insertion patterns of these tendons varied from tendon to tendon as well as from hand to hand. As an example, the findings obtained from the right hand of a 76-year-old

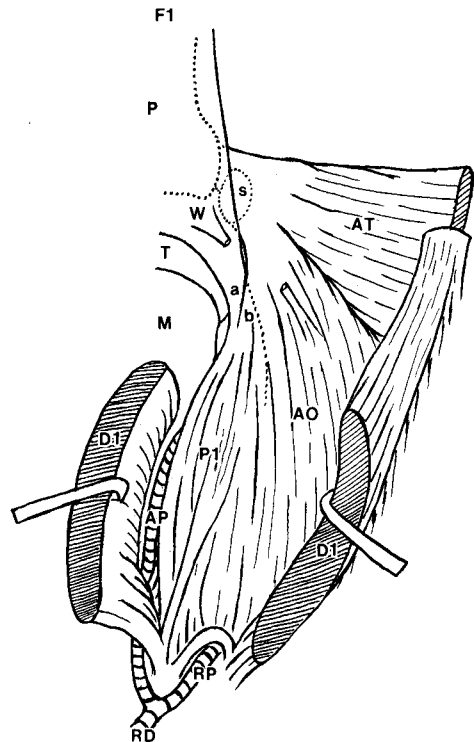


Fig. 2 Drawing of a dissected hand of an adult male (dorsal view) (see text). M first metacarpal bone, P proximal phalanx of the thumb, T transverse lamina, W wing tendon, AO and AT oblique and transverse heads of the adductor pollicis muscle, AP princeps pollicis artery, D1 first dorsal interosseous muscle, F1 first finger, P1 first palmar interosseous muscle, RD dorsal branch of the radial artery, RP deep palmar branch of the radial artery, a and b insertion tendons of the first palmar interosseous muscle (P1), s sesamoid bone.

man are shown in Figs. 3-6.

As shown in Figs. 3-6 and typologically diagrammed in Fig. 7, the insertion-tendons of the interosseous muscles could be classified into seven types according to their courses and terminations: type a tendon, which passed superficial to the transverse lamina (T) and continued into the wing tendon (W); type b tendon, which passed superficial to the transverse lamina and attached to the base of the proximal phalanx (P); type c tendon, which pierced the transverse lamina and continued into the transverse lamina or wing tendon; type d tendon,

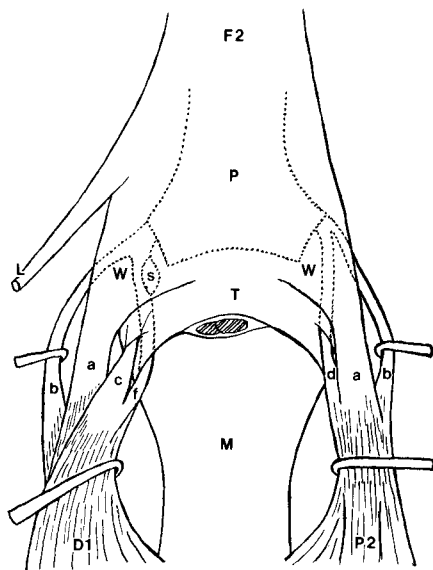


Fig. 3 A diagram showing the insertion patterns of the first dorsal and second palmar interosseous muscles (dorsal view, the same hand as shown in Fig. 2). Note that the first dorsal interosseous muscle (D1) gives off four tendons (a, b, c and f) which continue into the wing tendon (W) (or transverse lamina, T) or attach to the base of the proximal phalanx (P), and that the second palmar interosseous muscle (P2) gives off three tendons (a, b and d) which continue into the wing tendon (W) or attach to the base of the proximal phalanx (P). L lumbrical muscle, M metacarpal bone, F2 second finger, a-f (see text), s sesamoid bone.

which pierced the transverse lamina and attached to the base of the proximal phalanx; type e tendon, which passed deep to the transverse lamina and continued into the transverse lamina or wing tendon; type f tendon, which passed deep to the transverse lamina and attached to the base of the proximal phalanx; and type g tendon, which directly attached to the distal end of the metacarpal bone (M).

The interosseous muscles inserted into the fingers with various combinations of these seven types of tendons. The observed combinations and their occurrences are shown in Table 1. Total occurrences of the type a-g tendons abstracted from Table 1 are shown in Table 2. Occurrences of the type d, f

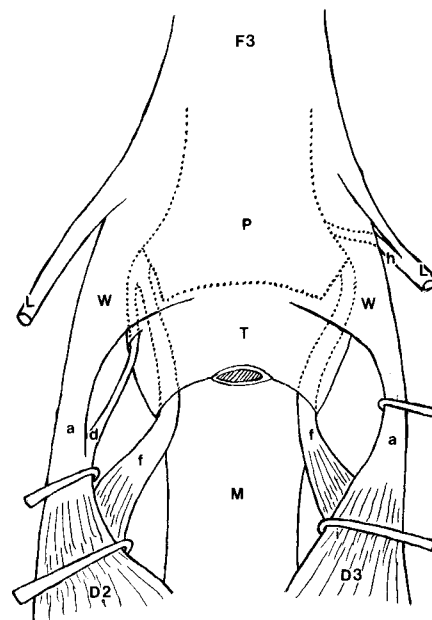


Fig. 4 A diagram showing the insertion patterns of the second and third dorsal interosseous muscles (dorsal view, the same hand as shown in Figs. 2 and 3). Note that the second dorsal interosseous muscle (D2) gives off three tendons (a, d and f) which continue into the wing tendon (W) or attach to the base of the proximal phalanx (P), and that the third dorsal interosseous muscle (D3) gives off two tendons (a and f) which continue into the wing tendon (W) or attach to the base of the proximal phalanx (P). Also note that one of the lumbrical muscles (L) gives off an accessory slips (h) which attaches to the basal area of the proximal phalanx (P). M metacarpal bone, F3 third finger, a-f (see text).

or d+f tendons abstracted from Table 1 are shown in Table 3. As shown in Table 2, the palmar and dorsal interosseous muscles of the second to fifth fingers had, with few exceptions, the type a tendon. In each case, the type a tendon was usually well developed and received one to two thirds of the muscle belly of the interosseous muscle (Figs. 3-6). When fully developed, the type a tendon received all of the slips of the interosseous muscle (Fig. 5, P3). Table 3 shows that the dorsal interosseous muscles had, with some exceptions, either or both of the type d and f tendons which attached to the base of the

Table 1 Combinations and occurrence of seven tendon types of the interosseous muscles in 25 human hands^a

Observed combination of tendon types a-g	Interosseous muscles ^b							
	P1	P2	P3	P4	D1	D2	D3	D4
	Occurrence							
a	- ^c	9	18 (Fig. 5)	12 (Fig. 6)	-	-	4	1
ab	15 (Fig. 2)	8	2	6	-	-	-	-
abc	6	-	-	-	-	-	1	-
abcf	-	-	-	-	1 (Fig. 3)	-	-	-
abd	2	1 (Fig. 3)	2	2	1	3	-	-
abef	-	-	-	-	1	-	-	1
abefg	-	-	-	-	-	-	-	1 (Fig. 5)
abf	1	-	-	-	3	2	2	6
abg	1	-	-	-	-	-	-	-
ac	-	1	2	-	-	2	1	-
acd	-	-	-	-	-	-	-	2
acf	-	-	-	1	4	2	4	3
ad	-	4	-	2	3	2	3	4
adf	-	-	-	-	8	5	-	-
adfg	-	-	-	-	-	-	-	1
ae	-	1	-	-	-	-	3	-
aef	-	-	-	-	3	1	4	1
af	-	1	1	2	1	7	3 (Fig. 4)	5
bf	-	-	-	-	-	1	-	-
Total	25	25	25	25	25	25	25	25

a: First to fifth fingers of 25 human hands were examined. The cases shown in Figs. 2-6 are included in this table and indicated in parentheses.

b: First to fourth palmar (P1-P4) and dorsal (D1-D4) interosseous muscles.

c: Not observed.

Table 2 Occurrence of seven tendon types of interosseous muscles in 25 human hands^a

Tendon type	Interosseous muscles							
	P1	P2	P3	P4	D1	D2	D3	D4
	Occurrence							
a	25	25	25	25	25	24	25	25
b	25	9	4	8	6	5	3	8
c	6	1	2	1	5	4	6	5
d	2	5	2	4	12	10	3	7
e	-	1	-	-	4	1	7	3
f	1	1	1	3	19	18	13	18
g	1	-	-	-	-	-	-	2

a: See text and legends to Table 1.

Table 3 Occurrence of tendon types d, f and a combination of d and f of interosseous muscles in 25 human hands^a

Tendon type	Interosseous muscles							
	P1	P2	P3	P4	D1	D2	D3	D4
d, f or d and f	3	6	3	7	25	23	16	24

a: See text and legends to Table 1.

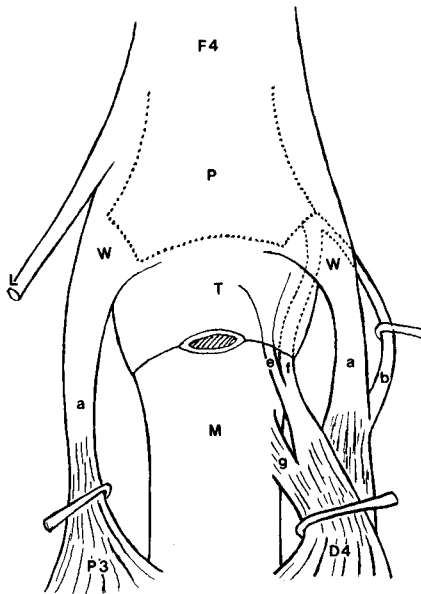


Fig. 5 A diagram showing the insertion patterns of the third palmar and fourth dorsal interosseous muscles (dorsal view, the same hand as shown in Figs. 2-4). Note that all slips of the third palmar interosseous muscle (P3) continue into the wing tendon (W), and that the fourth dorsal interosseous muscle (D4) gives off five tendons (a, b, e, f and g) which continue into the wing tendon (W) (or transverse lamina, T) and attach to the base of the proximal phalanx (P) or to the distal part of the metacarpal bone (M). L lumbrical muscle, F4 fourth finger.

proximal phalanx. The development of these tendons varied in each case. However, it was usual that the type f tendon was more developed than the type d tendon (Fig. 4). Furthermore, it should be noted in Table 2 that the dorsal and palmar interosseous muscles occasionally had the type b tendon. In some cases, this type b tendon was well developed and received one third of the mus-

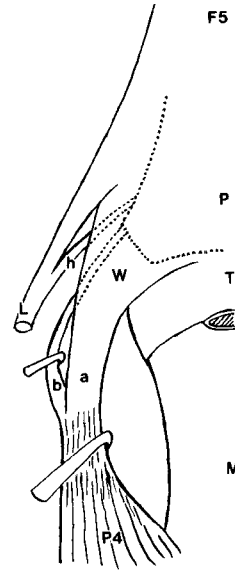


Fig. 6 A diagram showing the insertion pattern of the fourth palmar interosseous muscle (dorsal view, the same hand as shown in Figs. 2-5). Note that the fourth palmar interosseous muscle gives off two tendons (a and b) which continue into the wing tendon (W) or attach to the base of the proximal phalanx (P), and that the lumbrical muscle (L) gives off an accessory slip (h) which attaches to the basal area of the proximal phalanx (P). M metacarpal bone, T transverse lamina, F5 fifth finger, a and b (see text).

cle belly of the interosseous muscle (Fig. 3, D1 and P2). The type c, e and g tendons were rather sporadic in occurrence (Table 2), and also small in size (Figs. 3, 5).

There were four lumbrical muscles, each of which arose from the radial side of the corresponding tendon of the flexor digitorum profundus muscle and connected to the radial wing tendon of the corresponding finger. No morphological difference of the lumbrical

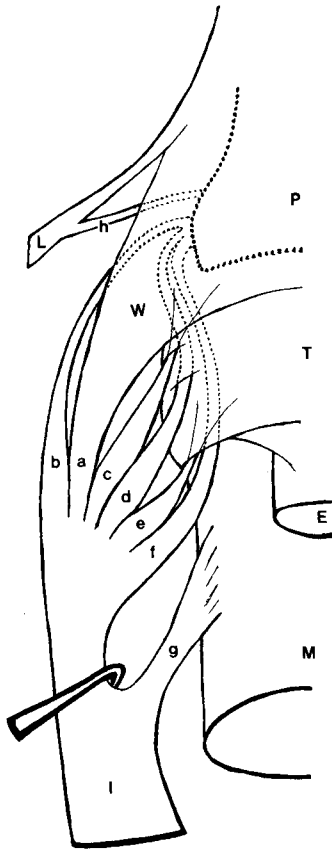


Fig. 7 A typological diagram showing the courses and terminations of the insertion-tendons of the interosseous muscles in the human hand. E extensor tendon of the finger, I interosseous muscle, L lumbrical muscle, M metacarpal bone, P proximal phalanx, T transverse lamina, W wing tendon, a-g (see text).

muscles was noted between the male and female cadavers. The lumbrical muscle was sometimes split into two heads, which were inserted into the contiguous sides of the adjacent fingers (Figs. 4, 5). It was further observed that the lumbrical muscle on rare occasion gave off an accessory slip which passed palmar to the wing tendon and attached to the basal area of the shaft of the proximal phalanx (Figs. 4, 6).

Discussion

The present dissection study revealed

that insertion patterns of the human palmar and dorsal interosseous muscles vary widely between individual fingers and hands, and that the insertion tendons of the human palmar and dorsal interosseous muscles may be classified into seven types of tendons according to their courses and terminations. It also showed that the human palmar and dorsal interosseous muscles almost always have the type a tendon which runs superficial to the transverse lamina and continues into the wing tendon, and that the human dorsal interosseous muscles have, with some exceptions, the type d or f tendon which attaches to the base of the proximal phalanx by piercing the transverse lamina or passing deep to the transverse lamina. These findings suggest the generalization that the human palmar interosseous muscles basically continue into the wing tendon, and that the human dorsal interosseous muscles basically have two insertions, one into the wing tendons and the other into the bases of the proximal phalanges. These findings are consistent with those of Salsbury (6), Eyler and Markee (7), Landsmeer (8) and Nakano (9), and disagree with the usual textbook descriptions that the human palmar and dorsal interosseous muscles have insertions into both the wing tendons and the bases of the proximal phalanges (1-5). These textbook descriptions have been supported by Omodaka (10) and Yukishita (11). As far as we know, a few textbook authors have cited the works of Salsbury (6) and others (7-9) or made descriptions which agree with our generalization (12, 13).

Lewis reviewed the phylogenetic history of the interosseous muscles, and described the primitive mammalian (marsupial) precursors of these muscles as having a bilaminar arrangement: a dorsal layer of bipennate dorsal abductor muscles overlaid ventrally by a sheet of the flexor brevis muscles (14). He also stated that in phylogenetic develop-

ment, the dorsal abductor muscles show a tendency to merge with the subjacent flexor brevis muscles, and that the human dorsal interosseous muscles are composite muscles resulting from the amalgamation of the flexor brevis muscles with the dorsal abductor muscles (14).

In the hands or forepaws of the monkeys and other animals, the sheet of the flexor brevis muscles is overlaid ventrally by a sheet of the *contrahentes* muscles (15). Preliminary dissections in this study have shown that in the kangaroo, dog, rabbit, cat and some monkeys, the *contrahentes* muscles constantly give off a well-developed type b tendon though they may additionally gave off a type a tendon, and that, in these animals, the flexor brevis and dorsal abductor muscles do not gave off the type b tendon (data, not shown). Furthermore, our previous study has shown that in the monkey, the *contrahentes* muscles can fuse with flexor brevis muscles (16). As described above, the human interosseous muscles occasionally give off the type b tendon, which characteristically occurs in the *contrahentes* muscles. These findings tend to support the view of Lewis (14) and suggest that the human second-fourth palmar interosseous muscles are composite muscles derived from the flexor brevis and *contrahens* muscles, and that the human first-fourth dorsal interosseous muscles are composite muscles derived from the flexor brevis, dorsal abductor and *contrahens* muscles. Judging from their courses or positions, the type c and e tendons are homologous with the type d and f tendons, respectively, though the former have no attachment to the bases of the proximal phalanges. The type g tendon is aberrant and may be called the head of Brooks (17).

The first palmar interosseous muscle (or palmar interosseous muscle of the thumb) is sometimes referred to as the deep head of the flexor pollicis brevis muscle (3, 18).

This muscle blends with the adductor pollicis muscle, in particular with its oblique head (see above). Despite this blending, we have defined muscular slips located dorsal to the palmar-penetrating twig of the ulnar nerve as the first palmar interosseous muscle (18). In the hands dissected in the present study, the first palmar interosseous muscle thus designated always continued into the ulnar wing tendon of the thumb and also attached to the ulnar base of the proximal phalanx of the thumb; namely, it constantly gave off type a and b tendons (see Tables 1 and 2). Our previous study has indicated that the human adductor pollicis muscle, like that in the monkey, is the *contrahens* muscle of the thumb (16). This finding, together with the present one (constant occurrence of type a and b tendons), suggests that the human first palmar interosseous muscle as designated by us is a composite muscle derived from the flexor brevis of the thumb and a part of the adductor (or *contrahens*) pollicis muscle.

It is well known that the human lumbrical muscle continues into the wing tendon, and that this muscle is sometimes divided into two heads which insert into the contiguous sides of the adjacent fingers (19, 20). Preliminary dissections have proved that such division of the lumbrical muscle is usual in the dog, cat, rabbit and kangaroo (data, not shown). In the kangaroo, the lumbrical muscle constantly attaches to the basal area of the proximal phalanx (data, not shown). Thus, the accessory slip of the lumbrical muscle with attachment to the proximal phalanx may be an atavistic anomaly. The division of the lumbrical muscle may also be an atavistic anomaly since it constantly appears in the dog, cat, rabbit and kangaroo.

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