THE INTEROSSEOUS MUSCLES OF THE HAND

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THE writer of this article, both as an industrial surgeon and as a teacher of anatomy, has been greatly interested in the tendons of the fingers. The actual mechanism of flexion and extension of the middle and distal phalanges has never seemed sufficiently clear to explain all clinical observations and considerable thought and work have been devoted to the subject. One cannot go deeply into the physiology of finger movement without coming to the question, "What, exactly, are the function and action of the interossei?" To answer this, one must know their insertions. At this point, one looks to the textbooks in vain.

Brash (1931) states that the palmar interossei are inserted "into the capsule of the metacarpophalangeal articulation, the side of the base of the first phalanx of the finger and into the dorsal expansion of the extensor tendon", and the dorsal "exactly like the tendon of a volar muscle, into the dorsal aspect of each of the four fingers".

According to Lewis (1930), the dorsal interossei "are inserted into the bases of the first phalanges and into the aponeuroses of the tendons of the extensor digitorum communis", while the palmar group are "inserted into the side of the base of the first phalanx and aponeurotic expansion of the extensor communis tendon to the same finger".

Both of the authors, quoted above, give the usually accepted actions; flexion of the metacarpophalangeal joints and extension of the interphalangeal, with the additional action of adduction for the palmar and abduction for the dorsal group.

A little thought will show that the above descriptions of insertion and action are quite inconsistent. A tendon inserting into the proximal phalanx cannot possibly move either of the other phalanges independently of the proximal one, no matter how clearly defined the anatomical attachment to the extensor expansion. Hence, if an interosseous muscle be inserted into the proximal phalanx, it cannot act as an extensor of the middle phalanx on the proximal, nor of the distal on the middle.

Although only two texts were quoted above, the same error, or omission, occurs in the others. Bardeen (1933), it is true, adds the statement that the dorsal interossei have more attachment to the proximal phalanges than have the palmar, and that the lateral ones have more than the medial ones. These facts have been thoroughly substantiated in the investigation to be presently described, but they do not assist in the solution of the insertion-action paradox. Even Wood Jones (1920), in his excellent monograph, does not mention this phase of the problem.

Clearly, then, there must be some fallacy of description and it is possible, even on theory alone, to indicate some of the directions in which it must lie. For any interosseous muscle, one or more of the following must be true:

(1) It may insert wholly into the proximal phalanx.

(2) It may insert wholly into the extensor expansion.

(3) If a single tendon inserts into both the proximal phalanx and the extensor expansion, the insertion into the expansion must be functionally useless and that particular muscle is not an extensor of the interphalangeal joints.

(4) If an interosseous muscle, inserting into both the proximal phalanx and the extensor expansion, is able to exert an independent action on the two, then that muscle must have two separate tendons of insertion, activated by two separate fleshy bellies.

In the above argument, action on the proximal phalanx is considered only as that due to direct insertion into it. This bone must, of course, be subject to the indirect influence of the interosseous insertion into the extensor expansion.

In an attempt to shed some light into this dark corner of anatomy and as a part of the major problem of the extensor mechanism, an investigation of the interossei was undertaken. Both hands of fifteen subjects were carefully dissected and the findings recorded. These hands had been partially used by students and, in some cases, it was impossible to be quite certain of a muscle. All such doubtful muscles were omitted and are represented, in the table below, by a blank space. By coincidence, two specimens of each muscle were unsatisfactory and, although thirty hands were examined, only twenty-eight examples of each muscle were accepted.

Since we were interested in function as well as in structure, an attempt was made to ascertain the possible actions of each muscle. These are recorded as to whether or not they were capable of extension of the interphalangeal joints. It is admitted that every interosseous muscle is able to act on the proximal phalanx, even in the complete absence of any direct attachment to it.

The following symbols are used in Table I:

P. represents the palmar portion of a muscle.

D. represents the dorsal portion of a muscle.

* able to extend the interphalangeal joints.

— not able to extend the interphalangeal joints.

*? action uncertain but probably *.

—? action uncertain but probably —.

? quite unable to decide whether * or —.

It should be remembered that these were embalmed specimens and, although relatively little formalin had been used, this introduces a possibility of error. Any such error, however, must be toward — and away from *.

The classification of the palmar interossei used here is that which accepts

only three. The slip in association with the thumb is not considered, since there is no question of its action.

Table I

Palmar interossei

Body	Side	First	Second	Third
1	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
2	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *	Exp. 100 % *	
3	R.	Exp. 100 % *?	Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
4	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *	Exp. 100 % *	75 % to exp. * 25 % from deep surface to proximal phalanx —
5	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *?
	L.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
6	R.	D. 30 % bone — P. 70 % exp. *	Exp. 100 % *	
	L.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
7	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *	Exp. 100 % *?	Exp. 100 % *
8	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
9	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
10	R.	Exp. 100 % *	Exp. 100 % *?	Bone 100 % —
	L.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
11	R.	Exp. 100 % *		Bone 100 % —
	L.	Exp. 100 % *	Exp. 100 % *	Deep 70 % to bone — Sup. 30 % to exp. —
12	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
	L.		Exp. 100 % *	Exp. 100 % *
13	R.		Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *		Exp. 100 % *

Table I (*continued*)

Body	Side	First	Second	Third
14	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
15	R.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *
	L.	Exp. 100 % *	Exp. 100 % *	Exp. 100 % *

Dorsal interossei

Body	Side	First	Second	Third	Fourth
1	R.	Bone 100 % —	D. 60 % bone — P. 40 % exp. *	Exp. 100 % *	D. 70 % bone — P. 30 % exp. *
	L.	Bone 100 % —	D. 70 % bone — P. 30 % exp. *	Exp. 100 % *	Exp. 100 % *
2	R.	Bone 100 % —	D. 50 % bone — P. 50 % exp. *	Exp. 100 % *	D. 50 % bone — P. 50 % exp. *
	L.	Bone 100 % —	D. 60 % bone — P. 40 % exp. *	Exp. 100 % *	D. 10 % exp. } P. 10 % exp. } * 80 % bone —
3	R.	Bone 100 % —	D. 80 % bone — P. 20 % exp. —?	Exp. 100 % *?	D. 50 % exp. — P. 50 % exp. *?
	L.	Bone 100 %	D. 70 % bone — P. 30 % exp. *	D. 15 % bone — P. 85 % exp. *?	D. 60 % exp. * P. 40 % bone —
4	R.		D. 50 % bone — P. 50 % exp. *	Exp. 100 % *?	D. 60 % bone — P. 40 % exp. *?
	L.	Bone 100 % —	Bone 100 % —	D. 70 % bone — P. 30 % exp. *	D. 60 % bone — P. 40 % exp. *
5	R.	Bone 100 % —	Exp. 100 % *	Exp. 100 % *	D. 60 % bone — P. 40 % exp. *
	L.	Bone 100 % —	D. 75 % bone — P. 25 % exp. —	D. 50 % bone — P. 50 % exp. ?	D. 75 % bone — P. 25 % exp. *
6	R.	Bone 100 % —	D. 50 % bone — P. 50 % exp. *	Exp. 100 % *	Exp. 100 % *
	L.	Bone 100 % —			D. 50 % bone — P. 50 % exp. *
	R.	Bone 100 % —	D. 70 % bone — P. 30 % exp. *	Exp. 100 % *	D. 50 % bone — P. 50 % exp. *

Table I (*continued*)

Body	Side	First	Second	Third	Fourth
7	L.	Bone 100 % —	D. 20 % bone — P. 80 % exp. *	Exp. 100 % *	Exp. 100 % —
8	R.	Bone 100 % —	D. 70 % bone — P. 30 % exp. *	Exp. 100 % *	Exp. 100 % *
	L.	Bone 100 % —	D. 70 % bone — P. 30 % exp. *	Exp. 100 % *	Exp. 100 % *
9	R.	Bone 100 % —	D. 50 % bone — P. 50 % exp. *	Exp. 100 % *	
	L.	Bone 100 % —	Exp. 100 % ?	Exp. 100 % *	Exp. 100 % *?
10	R.	Bone 100 % —	D. 50 % bone — P. 50 % exp. —?	Exp. 100 % ?	Exp. 100 % *?
	L.	Bone 100 % —	D. 70 % bone — P. 30 % exp. *	Exp. 100 % *	Exp. 100 % *
11	R.	Bone 100 % —			D. 50 % bone — P. 50 % exp. *
	L.	Bone 100 % —	Bone 100 % —	D. 50 % bone — P. 50 % exp. *	D. 30 % bone — P. 70 % exp. *?
12	R.	Bone 100 % —	Exp. 100 % *	Exp. 100 % *	D. 70 % bone — P. 30 % exp. *
	L.	Bone 100 % —	Exp. 100 % *	Exp. 100 % *	D. 60 % bone — P. 40 % exp. *
13	R.		Exp. 100 % *	Exp. 100 % *	D. 95 % exp. * P. 5 % bone —
	L.	Bone 100 % —	D. 80 % bone — P. 20 % exp. *	Exp. 100 % *	
14	R.	Bone 100 % —	D. 50 % bone — P. 50 % exp. *	D. 10 % bone — P. 90 % exp. *	Exp. 100 % *
	L.	Bone 100 % —	D. 70 % bone — P. 30 % exp. *	Exp. 100 % *	D. 30 % exp. *? P. 70 % exp. *
15	R.	Bone 100 % —	D. 80 % bone — P. 20 % exp. *	Exp. 100 % *	Exp. 100 % *
	L.	Bone 100 %	Exp. 100 % *	Exp. 100 % *	D. 50 % bone — P. 50 % exp. *

The findings shown in detail in Table I are summarized below.

Table II

Palmar 1

28 studied.
27 (96·4 per cent) wholly to expansion.
1 (3·6 per cent) to expansion and bone.
Actual amount of tendon going to expansion 98·8 per cent.
Actual amount of tendon going to bone 1·2 per cent.

Palmar 2

28 studied.
28 (100 per cent) wholly to expansion.

Palmar 3

28 studied.
24 (85·7 per cent) wholly to expansion.
2 (7·1 per cent) wholly to bone.
2 (7·1 per cent) to expansion and bone.
Actual amount of tendon going to expansion 89·1 per cent.
Actual amount of tendon going to bone 10·9 per cent.

Dorsal 1

In every hand examined the first dorsal interosseous inserted wholly into the proximal phalanx. No insertion into the extensor expansion was found in any case.

Dorsal 2

28 examined.
2 (7·1 per cent) wholly to bone.
6 (21·4 per cent) wholly to expansion.
20 (71·4 per cent) to bone and expansion.
Actual amount of tendon going to bone 51·6 per cent.
Actual amount of tendon going to expansion 48·4 per cent.

Dorsal 3

28 examined.
0 wholly to bone.
23 (82·1 per cent) wholly to expansion.
5 (17·9 per cent) to bone and expansion.
Actual amount of tendon going to bone 7 per cent.
Actual amount of tendon going to expansion 93 per cent.

Dorsal 4

28 examined.
0 wholly to bone.
10 (35·7 per cent) wholly to expansion.
18 (64·3 per cent) to bone and expansion.
Actual amount of tendon going to bone 33·6 per cent.
Actual amount of tendon going to expansion 66·3 per cent.

Note that the insertion into the expansion is listed first in the case of the palmar group, but that into the bone first for the dorsal group. This simplifies references as will be seen later.

A consideration of the summary, as outlined above, brings certain points into prominence:

(1) The palmar interossei have very little insertion into the proximal phalanges.

(2) The dorsal interossei are attached to the proximal phalanges much more extensively than are the palmar.

(3) Dorsal 1 is inserted wholly into the proximal phalanx.

(4) Dorsal 2 and dorsal 4 have a greater insertion into the proximal phalanx than has dorsal 3. The order of the dorsal interossei, arranged according to their insertion into the proximal phalanx, is 1, 2, 4, 3. This order remains the same whether one considers the numerical percentage of tendons having an insertion into the bone or the average amount of the total bony insertion.

(5) Except for the first, there is a wide variation in the individual dorsal interossei of the different hands.

In addition to the above conclusions drawn directly from Tables I and II, several other interesting facts were noted during the course of the dissection.

(1) All those dorsal interossei that attached to both the extensor expansion and the proximal phalanx *and were able to act on both* had two separate insertions.

(2) In the majority of such cases, a palmar tendinous band passed to the expansion while a dorsal fleshy part inserted directly into the base of the proximal phalanx. Occasionally, the palmar part went to the phalanx, the dorsal to the expansion.

(3) With two exceptions, all insertions into the proximal phalanx could function only in abduction or adduction. One was so situated as to be able to act as a flexor, one as an extensor.

(4) In many cases, the deep surface of the tendon of a palmar interosseous, or the palmar tendinous band of a dorsal muscle, was loosely or firmly attached to the surface of the joint capsule.

(5) The adjacent edges of the volar and dorsal parts were sometimes adherent. This, together with the adhesions mentioned in (4), was responsible for the uncertainties regarding action, as shown by "?" in Table I.

(6) Most tendinous insertion into the proximal phalanx was intimately fused with the capsule of the metacarpophalangeal joint.

(7) There is a very prominent and, it seems, a very important part of the deep fascia not specifically mentioned in the text-books. This extends across the dorsum, intimately bound to the extensor tendon, down into the web, and is firmly attached to the interosseous tendon of the two sides. On the side where there is a lumbrical, it ends by fusing with that tendon; where there is no lumbrical, it ends at the corresponding interosseous tendon. This fascia is shown in many illustrations, including Luschka's well-known diagram of

the tendons of the middle finger, but I have never seen it described. Mention is justified, however, because we can easily deduce a definite function for it. In flexion of the metacarpophalangeal joint, this fascial sheet anchors the tendons of the interossei and lumbricals. Without it, extension of the interphalangeal joints would probably be impossible while the metacarpophalangeal joint is flexed. This interpretation of its action is greatly strengthened by the very evident fact that the fibres run transversely. It is interesting to note, also, that this sheet of fascia gives an extensive insertion to the common extensor tendon and is probably the most important factor in preventing its functioning as an extensor of the interphalangeal joints. In view of this functional importance, it would seem advisable to have a name and "Transverse metacarpophalangeal fascia" is suggested.

(8) An interosseous tendon, whether a palmar or the palmar part of a dorsal, is usually flattened and, as it crosses the side of the metacarpophalangeal joint, it lies in a plane approximately at a right angle to that of the palm. Very commonly, there is a well-defined band passing between the palmar edge of the tendon and the side of the capsule. Although strong, it was sufficiently loose to permit free play of the tendon and seldom interfered with its movement, but more frequently restricting the dorsal than the palmar. In fact, it seemed to be most highly developed in association with those tendons that were most definitely extensors of the middle and distal phalanges. The following tabulation shows its frequency in 28 specimens of each muscle:

Palmar 1	Palmar 2	Palmar 3	Dorsal 1	Dorsal 2	Dorsal 3	Dorsal 4
14	7	7	0	0	6	4

This is in marked contrast with the statement of Brash and Jamieson (1935) that "Except for the first palmar, they are all bound to the capsule of a metacarpophalangeal joint".

The exact significance of this attachment is not, at present, clear, but it seems to keep the tendon of the palmar interossei, especially, from slipping dorsally.

The differences in the insertions of the various interossei appear too definite to be of no importance. In a search for the factors underlying them, our first interest centred on the lumbricals. Certain facts suggest that they may have an important influence:

(1) Reference to Table II shows that the insertion of dorsal interossei into the extensor expansion increases in the order dorsal 1, 2, 4, 3. Dorsal 1 and 2 are on the same side as a lumbrical, dorsal 3 and 4 are not. Those interossei located on the same side of the digit as the lumbricals have a greater insertion into the proximal phalanx, and a correspondingly lesser insertion into the expansion, than have those on the side without a lumbrical.

(2) In 88 per cent[1] of cases, the first lumbrical is larger than any other. The first dorsal interosseous inserted wholly into the phalanx in all cases studied.

[1] Personal data, unpublished.

In this series, eight lumbricals had an anomalous insertion. There was no evidence that the anomalies in any way affected the arrangement of the interossei.

Although some evidence might be advanced to support a claim that the position of the lumbricals is the factor responsible for the differences in the attachment of the dorsal interossei, such evidence is not sufficiently convincing. It has been shown that the lumbricals are on the side of the interossei with the greater insertion into the proximal phalanges. May this not be accepted as evidence that the lumbricals do assist in interphalangeal extension, being more highly developed where the dorsal interossei are unable to act on the extensor expansion?

A complete tabulation of the lumbricals of these hands will not be presented in this communication, as it seems better to confine our attention to the interossei. A detailed study of the lumbricals may be offered at some later date.

No attempt to explain the functional or developmental significance of these findings will be made at the present time. Certain collateral investigations have been initiated and, should the results appear of sufficient importance, a supplementary report will be offered.

SUMMARY

A study of the interossei of thirty hands brought out certain points not in agreement with the usual textbook descriptions.

1. The palmar interossei are inserted, with few exceptions, wholly into the extensor expansions.

2. The first dorsal interosseous inserts wholly into the proximal phalanx.

3. The other three of the dorsal group have a variable insertion, more frequently into both extensor expansion and proximal phalanx. As a rule, these two insertions are from functionally separate fleshy portions and this separation may be so complete as to form an extra palmar interosseous.

4. The second dorsal interosseous has a greater insertion into the proximal phalanx than has the fourth, and the fourth has more than the third.

5. Several minor anatomical features are described and an attempt made to correlate structure and function.

REFERENCES

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