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Anatomy, Shoulder and Upper Limb, Hand Interossei Muscles

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Introduction

The interossei muscles are intrinsic muscles of the hand located between the metacarpals. They consist of four (or three) palmar and four dorsal muscles that, respectively. These muscles are responsible for finger adduction and abduction. Synchronously, the palmar and dorsal interossei assist in flexion of the metacarpophalangeal joints and extension of the interphalangeal joints. All interossei muscles receive innervation from the deep ulnar branch of the ulnar nerve. Therefore, any injury to the ulnar nerve may have debilitating implications on specific intrinsic hand muscle functions, including finger abduction and adduction, which is primarily controlled by the interossei muscles.

Structure and Function

Palmar (Volar) Interossei

The palmar interossei are unipennate muscles that originate from the metacarpals of the respective digit to which they are associated. These muscles adduct the first, second, fourth, and fifth digits about a long axis through the third digit. Adduction occurs at the metacarpophalangeal joints. Additionally, the palmar interossei contribute to flexion at the metacarpophalangeal joints and extension at the proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints of their respective digits.

When present as an individual entity, the first palmar interossei originates at the medial, palmar surface of the first metacarpal and inserts into the base of the proximal first phalanx as well as into the extensor hood or the first phalanx. The first palmar interosseus muscle is often considered rudimentary, with most anatomy texts deeming it to be often a component of either the adductor pollicis or the flexor pollicis brevis. Recent studies, however, dispute this notion and found that the first palmar interossei, termed the “pollical palmar interosseous,” is present in over 85% of specimens. [1][2][3] This muscle is thought to be derived from the oblique head of the adductor pollicis, with studies suggesting that it played a role in human evolution.[1]

The second palmar interosseous originates at the medial surface of the base of the second metacarpal and inserts onto the medial portion of the extensor hood of the first digit, as well as the base of the first phalanx.

The third and fourth palmar interossei originate at the lateral aspect of the fourth and fifth metacarpals and insert into the lateral aspect of their respective extensor hood. They additionally insert into the base of their respective proximal phalanx.

Dorsal Interossei

Of all the intrinsic muscles of the hand, the dorsal interossei are the most dorsally located. The bipennate dorsal interossei are the major abductors of the second, third, and fourth digits at the metacarpophalangeal joints. Moreover, they also contribute to flexion at the metacarpophalangeal joints, in addition to the extension of the PIP and DIP joints.

The first dorsal interosseous muscle has its origin on the adjacent surfaces of the first and second metacarpal bones and inserts into the lateral base of the second phalanx and extensor hood of the second digit.

The second dorsal interosseous muscle originates on the medial aspect of the second metacarpal and the lateral aspect of the third metacarpal bone. It inserts into the lateral base of the third phalanx as well as the respective extensor hood.

The third dorsal interosseous muscle originates at the medial portion of the third metacarpal and the lateral portion of the fourth metacarpal. Its insertion is at the medial aspect of the base of the third phalanx, in addition to the extensor hood of the third digit.

The fourth dorsal interosseous muscle originates at both the lateral aspect of the fourth metacarpal and medial side of the fifth metacarpal. This muscle inserts into the lateral base of the fourth phalanx and the extensor hood of the fourth digit.

Embryology

Upon completion of the fourth week of embryonic development, four limb buds arise from somites and mesenchyme of the lateral plate mesoderm that is covered by a layer of ectoderm.[4][5] Development of the upper extremities is propagated by a plethora of protein factors, with fibroblast growth factors (FGF) and Sonic hedgehog (Shh) playing vital roles. The gene expression and subsequent interactions of these various proteins contribute to the development of three spatial limb axes: proximodistal, anteroposterior, and dorsoventral.[4][5]

Development of the hand begins with flattening of the distal upper extremity buds around days 34-38 of embryonic development. Somites form the limb musculature while mesenchyme of the lateral plate mesoderm forms bone and cartilage. Somitic mesoderm of the hand divides into superficial and deep layers. Both palmar and dorsal interossei muscles develop from the deep layer of this mesoderm. By the twelfth week of development, tendons are fully developed and functional.[5]

Blood Supply and Lymphatics

Blood supply to the palmar interossei comes from the palmar metacarpal arteries and drains into the palmar metacarpal veins. The palmar metacarpal arteries derive from the deep palmar arch, which is comprised of the terminal portion of the radial artery and the deep branch of the ulnar artery. Furthermore, anastomoses are present between the palmar metacarpal arteries and the common palmar digital arteries that stem from the superficial palmar arch.

The first dorsal interosseous muscle is supplied by the first dorsal metacarpal artery, which arises directly from the radial artery. The second, third, and fourth dorsal interossei receive blood supply from the second, third, and fourth dorsal metacarpal arteries; these vessels arise from the dorsal carpal arch. All dorsal metacarpal arteries bifurcate into their respective dorsal digital arteries and anastomose with the common palmar digital arteries.

Lymphatic drainage of the upper limbs is divided into superficial and deep lymphatic drainage. Lymphatic plexuses of the skin of the palm and dorsum of the hand ascend with the cephalic and basilic veins towards the axillary and cubital lymph nodes, respectively. Deep lymphatic vessels follow the primary deep veins and eventually terminate in the humeral lymph nodes.

Nerves

Both palmar and dorsal interossei receive their nerve supply via the deep branch of the ulnar nerve. The deep branch of the ulnar nerve finds its origin in the nerve roots of C8 and T1, with T1 being the primary innervating segment.

Physiologic Variants

Classically, students are taught that all dorsal interossei, except for the third, have two heads (bipennate) and all palmar interossei possess one head (unipennate). One retrospective study found that approximately 25 percent of dorsal interossei and only 62 percent of palmar interossei were unipennate.[6] This study also concluded that textbooks had oversimplified the attachment sites of both palmar and dorsal interossei, which possess a high degree of variability.[6]

As previously mentioned, most contemporary anatomy texts teach that the first palmar interosseous muscle is commonly a component of either the adductor pollicis or the flexor pollicis brevis and rarely functional on its own. The notion that the first palmar interosseous muscle is an independent and function intrinsic hand muscle was first suggested by Henle (1858), with several recent studies supporting this claim.[1][2][3] One study dissected 72 hands and found that the first palmar interosseous, referred to as the “pollical palmar interosseous” (PPI) muscle of Henle, was present in 67 hands (93%). The authors also analyzed six other, similar studies and found that the PPI was present in over 80 percent of cadaveric hands.[1] The presence of the PPI in humans, researchers believe, had great implications on the development of the human species from non-humanoid primates, due to its significant contribution to dexterous movements of the thumb.[1][2][3]

Surgical Considerations

Metacarpal fractures are commonly treated by hand surgery, with metacarpal shortening ranging from 2mm to 10mm. Researchers have found that in metacarpal shortening of 2 mm, there is an approximate 8 percent in strength reduction of the respective interossei. Moreover, a 10mm shortening can reduce the respective interossei strength of roughly 55 percent.[7]

Compartment syndromes of hand interossei are uncommon and are difficult to diagnose due to their atypical presentations.[8] One case study found a first dorsal interosseous compartment syndrome in a teacher, likely through overuse injury due to writing. This injury went undiagnosed for eight years but was ameliorated through a simple fasciotomy.[8] Another case report found a first dorsal interosseous compartment syndrome in a young, healthy male, also due to overuse injury. The authors measured the compartment pressure at rest and after activity and found a rise in pressure from 12 mmHg to 60 mmHg after 10 minutes of hand exercise.[9] This rise in pressure coincided with the patient's hand pain and swelling. After unsuccessful oral pain management, fasciotomy was performed with a subsequent resolution of the patient's symptoms.[9]

Clinical Significance

Both palmar and dorsal interossei receive innervation from the deep palmar branch of the ulnar nerve. As such, injury to the ulnar nerve can manifest as weakness or even atrophy of the interossei muscles and is typically caused by nerve root impingement, brachial plexus compression, or nerve entrapment at the elbow, forearm, or wrist. Ulnar nerve entrapment has been determined to be the second most common presenting compression neuropathy in patients. [10] Depending on which nerve fibers are compromised, patients may have weakness in abduction or adduction of the fingers. The lumbricals are the primary contributors to flexion at the metacarpophalangeal joints as well as extension at the DIP and PIP joints; however, the interossei also play a minor role in these movements. A late manifestation of ulnar nerve injury, the ulnar claw hand deformity is caused by weakness of the third and fourth lumbricals, in addition to the interossei, which manifests as an extension of the fourth and fifth metacarpophalangeal joints and flexion of the fourth and fifth PIP and DIP joints at rest.[10]

Several clinical examinations can be used to assess the integrity of ulnar nerve function. In a positive Wartenberg's sign, patients are instructed to adduct all fingers. A positive test will produce abduction of the fifth finger relative to all other digits, implying weakness of the third palmar interosseous muscle and fourth lumbrical.[10] To examine the palmar interossei, a patient can be instructed to hold a sheet of paper between any of the second through fifth digits, with dropping of the piece of paper indicating palmar interossei weakness. Furthermore, clinicians can evaluate the dorsal interossei by instruction a patient to abduct their second through fifth digits against the clinician's resistance. [10]

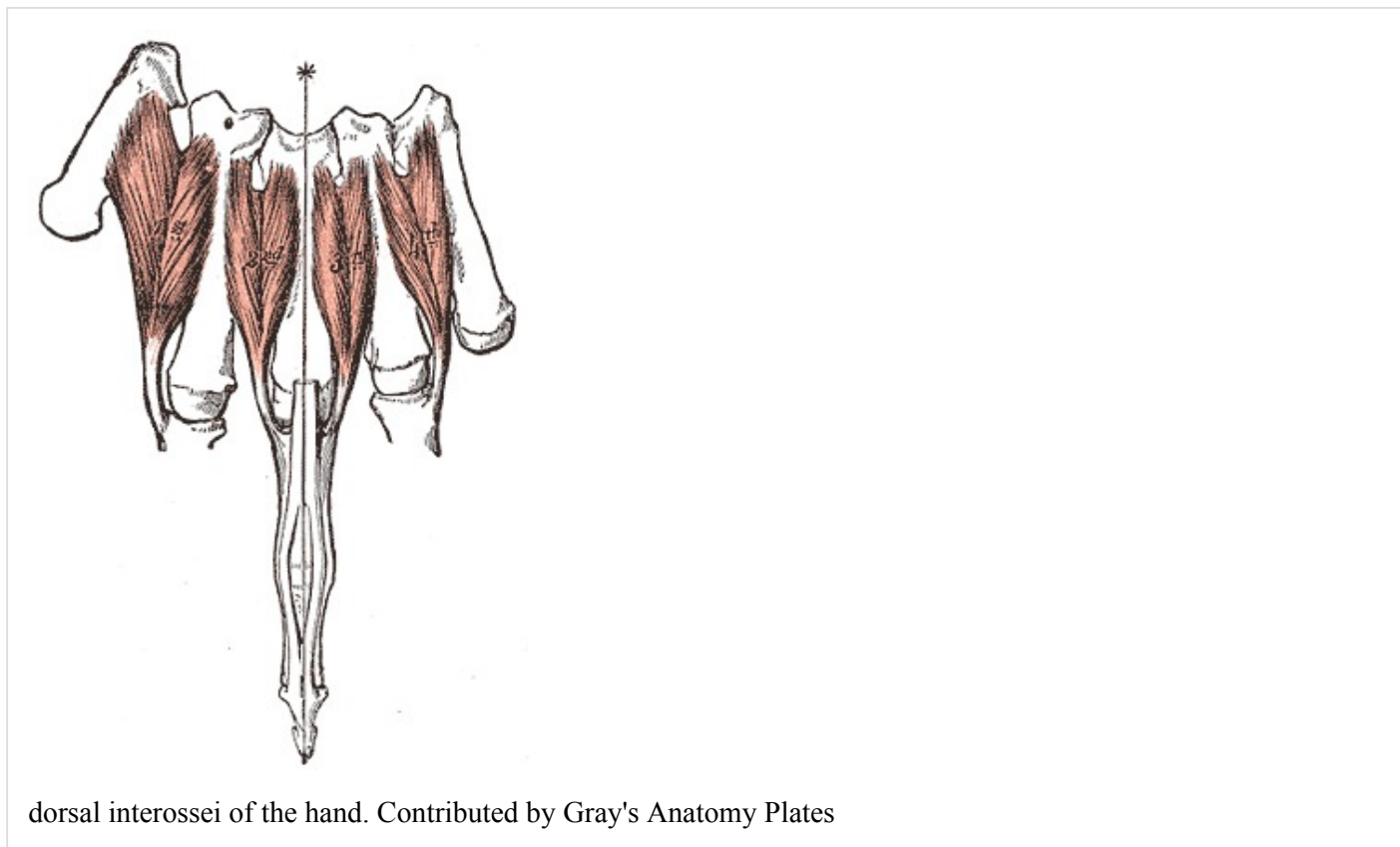
Questions

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Figures



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