A Biomechanical and Evolutionary Perspective on the Function of the Lumbrical Muscle

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The lumbrical muscles of the hand originate from the flexor digitorum profundus tendons and insert onto the lateral band of the extensor tendons. Owing to these movable attachments, the function of this muscle is difficult to visualize. To better determine the function of this muscle, we considered its relative anatomy, biomechanical characteristics, and evolution. With the smallest physiological cross-sectional area in the upper extremity, the lumbrical muscles have weak motor function, which is only 1/10 of the interosseous muscle. Because they are spindle rich, the lumbrical muscles play an important role in the sensory feedback of the distal interphalangeal, proximal interphalangeal, and metacarpophalangeal joints of the fingers. The first 2 lumbrical muscles have lower variation in anatomy and higher density of muscle spindles compared to the ulnar 2 lumbricals. In addition, the index and middle finger lumbrical muscles are innervated by the median nerve, which also innervates the thenar muscles of the thumb. Therefore, it is possible that the first 2 lumbricals are functionally more important than the 2 ulnar lumbricals, specifically for precision pinch movements. *(J Hand Surg Am. 2014;39(1):149–155. Copyright © 2014 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Intrinsic hand muscles, lumbrical muscle, muscle spindles.

THE LUMBRICAL MUSCLES of the hand are *intrinsic* muscles, meaning that they both originate and insert within the hand. The lumbrical muscles arise from the flexor digitorum profundus (FDP) and insert into the lateral band of the extensor tendon mechanism. Named after the Latin word *lumbricus*, meaning earthworm, these muscles are thin and elongated. The lumbricals are unique because, although most muscles originate and insert onto bones, the lumbrical muscles both originate from and insert onto tendons, giving the lumbricals moveable attachments. This distinctive feature makes determining the function of this muscle difficult because the utility of the lumbricals depends on the activity of the common extensor tendon and the position of the finger joints.

Multiple studies have been conducted to test the function of the lumbrical muscles acting on the hand, mainly for the metacarpophalangeal(MCP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints.[1–4] These studies included EMG and electrical stimulation studies, as well as biomechanical studies on cadaver hands. Collectively, these studies show that the lumbrical muscles are involved in PIP and DIP joint extension and may contribute slightly to MCP joint flexion.

Besides in humans, the lumbrical muscles can be found in animals including primates and most nonprimate mammals. Specifically, these muscles have been studied in various primates, rats, horses, dogs, and cats.[5–8] In these species, the lumbrical muscles play an important role in locomotion.[7] For example, chimpanzees move across the ground by walking on the distal

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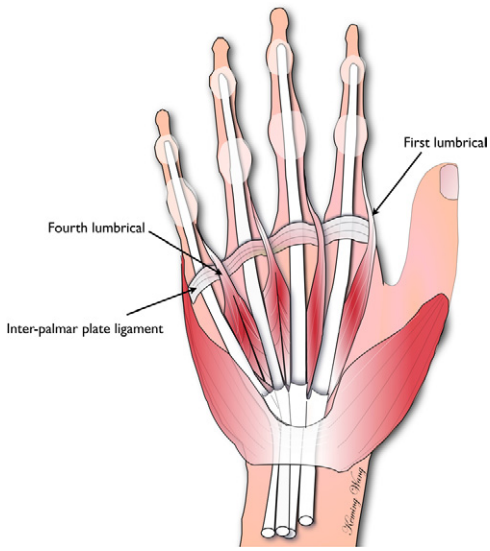

FIGURE 1: Palmar view, showing the origins of the lumbricals.

surface of the middle phalanx (called *knuckle walking*). The interosseous and lumbrical muscles provide resistance to flexion of the PIP joint during this motion.[9] To better understand the function of lumbricals in humans, it is critical to consider the evolution and function of these muscles in other animals, particularly regarding the role of the lumbrical muscles in sensory feedback and fine movement coordination.

Despite the uniqueness of these muscles, surgeons have largely ignored the function of the lumbricals in humans, and some have even suggested using the lumbrical as a muscle flap for coverage of defects.[10] Before dismissing these muscles as unimportant, it is necessary to investigate their function and their importance for function of the human hand. We took a new perspective on these muscles by reviewing their anatomy, biomechanics, and evolution to investigate the significance of the lumbrical muscles in humans.

RELATIVE ANATOMY

According to standard anatomy textbooks, the index and middle finger lumbricals are unipennate muscles originating from the radial side of the FDP tendon[11,12] (Fig. 1). The ring and small finger lumbrical muscles arise from bipennate muscle bellies on the adjacent surfaces of the FDP tendons, pass volar to the interpalmar plate ligament, and distally insert into the radial side of the lateral band of the extensor tendon[13] (Figs. 2, 3). From origin to insertion, the lumbricals pass volar to dorsal (Fig. 4). Similar to the FDP muscles, the nerve supply of the 4 lumbrical muscles is from 2 sources. The index and middle finger lumbricals are innervated by the median nerve, whereas the ring and small finger lumbricals are innervated by the deep division of the

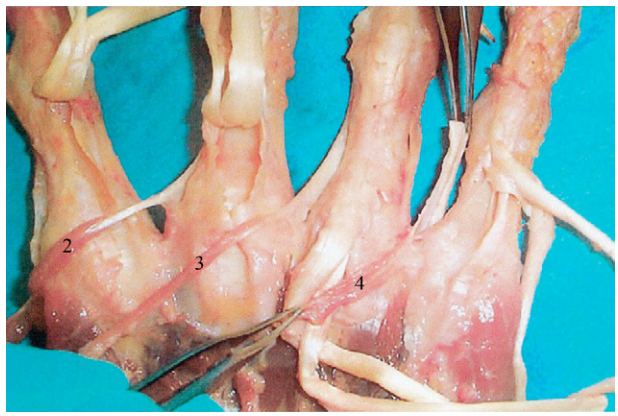

FIGURE 2: Palmar view of a left cadaver hand; 2, second lumbrical; 3, third lumbrical; 4, fourth lumbrical. [Adapted with permission from Eladoumikdachi F, Valkov PL, Thomas J, Netscher DT. Anatomy of the intrinsic hand muscles revisited: part II. Lumbricals. *Plast Reconstr Surg.* 2002;110(5):1225–1231].

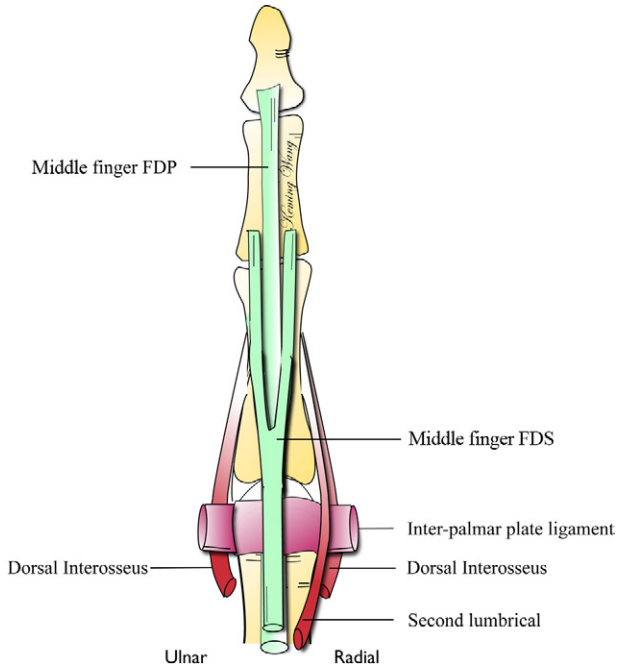

FIGURE 3: Palmar view of the middle finger, showing the anatomy of the lumbrical and interosseous muscles.

ulnar nerve. The origins and insertions of the lumbrical muscles vary considerably among individuals. The majority of individuals slightly deviate from the textbook anatomy. For example, individuals have been found to have unipennate third and/or fourth lumbricals. Individuals have also been found to have deviations in the origins and insertions of the lumbrical muscles.[14] In a study of 75 cadaveric hands, Mehta and Gardner found that the first and second lumbrical muscles had the most constant anatomy. The first lumbrical adhered to the