International Journal of Anatomy and Research,
Int J Anat Res 2022, Vol 10(3):8457-62. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2022.200

Original Research Article

Morphological Variations of Lumbrical Muscles of Hand in Sri Lankan Cadavers

Lanka Ranaweera *[1], Prabath Wijesooriya [2], Susantha Vithanage [3], Eranda Cabral [4].

[*1] Department of Anatomy, Faculty of Medicine, University of Kelaniya, Sri Lanka.

[2] Colombo North Teaching Hospital, Ragama, Sri Lanka.

[3] District General Hospital, Negombo, Sri Lanka.

[4] Base Hospital, Dambadeniya, Sri Lanka.

ABSTRACT

Introduction: Lumbricals are the small, worm-like, intrinsic muscles responsible for performing the precision pinch movements of the hand. These are quite unique in their position owing to movable proximal and distal tendon attachments.

Purpose of the study: The aim of the study was to identify anomalies of lumbrical muscle present in the Sri Lankan people.

Materials and Methods: A sample of 39 formalin preserved cadaveric human hands were subjected to the gross morphological study.

Results: It was encountered that 59% of the lumbricals were normal in proximal and distal attachments whereas the rest of the lumbicals (41%) indicated the morphological variations. Among the hands, unipennate third lumbrical was seen in 7.7% (Left-15.7%: Right 0%) and unipennate fourth lumbrical was seen in 5.1% (Left-10.5%: Right 0%). The bipennate second lumbrical was seen in 5.1% (Left 5.3%: Right 5.1%). The 10.3% of split insertion was encountered in third lumbricals (Left 10.5%: Right 10%) as well as in fourth lumbricals (Left 5.3%: Right 15%). The third lumbrical insertion on the medial side of the middle finger was seen in 2.5% (Left 5.3%: Right 0%).

Conclusion: The left hand is having more lumbrical variations than the right hand of the subjected human cadavers. The most common variation site is the insertion site. The variants are numerous in third and fourth lumbricals. The most common type of variation is the split insertion.

KEY WORDS: Lumbrical, Bipennate, Unipennate, Variations, Sri Lanka.

Corresponding Author: Dr. Lanka Ranaweera, Department of Anatomy, Faculty of Medicine, University of Kelaniya, Ragama, Sri Lanka. Telephone : +94777585321
Fax : +94112958337 **E-Mail:** lanka@kln.ac.lk

Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research** ISSN (E) 2321-4287 | ISSN (P) 2321-8967 **https://www.ijmhr.org/ijar.htm** **DOI-Prefix:** https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2022.200	**Article Information**
	Received: 22 May 2022 Accepted: 12 Jul 2022 Peer Review: 26 May 2022 Published (O): 05 Sep 2022 Revised: 02 Jun 2022 Published (P): 05 Sep 2022

INTRODUCTION

The human hand is the prehensile organ that occupies a unique position in evolution. Unlike the small thumb and long, curled fingers of the great apes, who are the closest living relatives of human beings the human hand has a significantly larger, muscular, mobile, and completely opposable thumb with shortened and straightened fingers [1]. This remarkable deviation from the ape pattern necessitates a biological explanation. Despite the lack of a complete explanation, there is widespread agreement that the anatomical reconstruction of the hand during human evolution was linked

to tool handling behaviour in some way [2].

The present human hand contains a shorter palm and fingers. The curvature of the fingers has been lost. Large apical tufts have developed on the distal phalanges, which support palmar fibro fatty pads that distribute pressure during strong grasping and whose deformation allows the pads to adapt to uneven surfaces [3,4].

Initiation of hand movements is mostly done by the extrinsic muscle of the hand and the rest of the movements are facilitated by the intrinsic muscles where both the origin and insertion of them lie within the hand. Intrinsic muscles are organized into three groups with a superficial muscle and a deep muscle. The first group is the thenar muscles and it includes flexor pollicis brevis, abductor pollicis brevis and opponens pollicis. The second group is the hypothenar muscles and it includes flexor digiti minimi, abductor digiti minimi, and opponens digiti minimi. The third group includes the interossei and lumbricals. Palmaris brevis is a superficial muscle underneath the ulnar palmar skin and adductor pollicis is a deep muscle that lies deep in the palm. Interestingly, among the intrinsic muscles, the most striking muscle type is the lumbricals. Unlike most of the other skeletal muscle in the body lumbrical muscle both originate and insert into tendons. This distinctive feature gives the lumbricals more moveable in action.

There are four small, earthworm-shaped lumbrical muscles where all arise from the tendons of flexor digitorum profundus. The first and second lumbricals arise from the radial sides and palmar surfaces of the tendons of the index and middle fingers, respectively. The third lumbrical arises from the adjacent sides of the tendons of the middle and ring fingers, and the fourth from the adjoining sides of the tendons of the ring and little fingers. Each of these bipinate muscle passes to the radial side of the corresponding finger and is attached to the lateral margin of the dorsal digital expansion of the extensor digitorum covering the dorsal surface of the finger. A small physiological cross-sectional area of a lumbrical muscle indicates that it is not a strong muscle.

Interestingly, its muscle fibers could extend 85% to 90% of the muscle length which indicated that it is designed for long excursions [5]. The presence of numerous muscle spindles (specialized sensory receptors) indicates that lumbrical muscle responsible for performing precision pinch movements or proprioceptive feedback regarding proximal interphalangeal, and distal interphalangeal joints movements.

Although lumbricals are unique as they perform a dynamic controlled extension of the interphalangeal joints, surgeons' attention towards lumbricals has merely low. It does have some clinical relevance especially in certain surgeries such as transmetacarpal amputations. In such cases, if the surgeon attempted to repair the lumbrical muscles it can lead to a decrease in functional deficiency, particularly fine motor function in hand due to intrinsic contracture. The scholarly research related to the lumbrical muscles is not uncommon according to the literature and its history goes back a long time. In 1961, Mehta and Gardner reported that the radial and ulnar collateral arteries are compressed by hypertrophy of the lumbrical muscles, resulting in persistent sub-ischemia [6]. There were several studies concluded that carpal tunnel syndrome resulted due to presence of abnormally long lumbrical muscles [7] and aberrant tendinous origin [8] hypertrophied nature [9-11] and lumbrical muscle incursion into carpal tunnel [12]. Regarding the variations of the lumbrical muscle, it has been found that the 3rd and 4th lumbricals variations are more common than the 1st and 2nd lumbricals [13-14]. The split insertion has been described to be the most common and it has been seen the most frequently in 3rd lumbricals compared to the 4th lumbrical [13-14].

These findings indicate that the knowledge on the variation of lumbricals has a significant value in the design of surgical procedures. In Sri Lankan context, there is lacunae related to research studies of the lumbrical muscle. Therefore, the current study is aimed to determine the morphological variations of lumbrical muscles of the hand in Sri Lankan

cadaveric subjects.

MATERIALS AND METHODS

This research was done on 39 formalin preserved human hands in the Department of Anatomy, Faculty of Medicine, University of Kelaniya, Sri Lanka. The dissection was carried out according to Cunningham's manual of practical anatomy [15]. A longitudinal incision was made from the distal end of the flexor retinaculum, up to the level of the metacarpophalangeal joint of the middle finger. The skin, the superficial fascia, the deep fascia, and the flexor retinaculum were dissected in order and reflected. Next, the palmar aponeurosis and the slips which pass from its distal margin to each of the fingers were dissected and reflected. After that, the tendons of the flexor digitorum superficialis and the flexor digitorum profundus were divided and reflected distally. The morphological features of the lumbrical muscles which were situated at the distal end of the flexor digitorum profundus tendons were observed macroscopically and confirmed by observing through a hand lens. The lumbrical muscles were followed to their tendons which pass with the proper digital vessels and nerves to the lateral side of the base of each finger and later, the tendons of each of the lumbrical muscles were traced up to their insertion. All the specimens were photographed using a digital camera. The collected data were analyzed using Microsoft Excel-2016.

RESULTS

Nineteen left hands and twenty right hands were available for the analysis. Lumbrical muscle variations according to the sides of the hand are indicated in Figure 1. Out of 19 left hands, 10 (52.6%) indicated anomalies of the lumbrical attachments. Regarding the proximal attachments of the left hand, the third lumbrical was unipennate in 3 (15.7%) whereas the same architecture for the fourth lumbrical encountered was 2 (10.5%) (Figure 2). Moreover, it was found that 1 (5.3%) of the second lumbricals was bipennate. Regarding the distal attachments of the left hand, the split insertion of the third lumbrical and fourthlumbrical was observed as 2 (10.5%) and 1 (5.3%), respectively (Figure 3). Interestingly, 1 (5.3%) of the third lumbricals was inserted on the medial side of the middle finger (Figure 4).

Out of 20 right hands, only 6 (30%) indicated the differences of the lumbrical attachments. Regarding the proximal attachments of the right hands hand, the second lumbrical was bipennate in 1 (5%) (Figure 5). Regarding the distal attachments of the right hand, the split insertion of the third lumbrical and fourth lumbrical was observed as 2 (10%) and 3 (15%), respectively. The comparison of frequencies of left and right hand lumbrical variations is given in the Table 1.

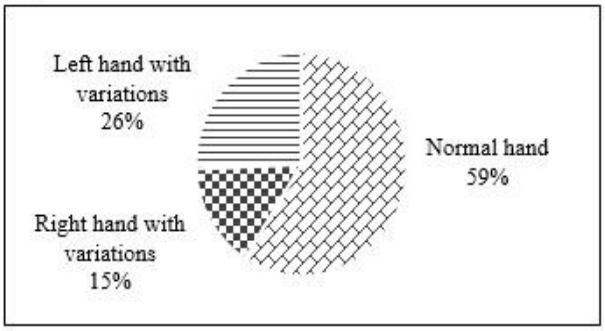

Fig.1: Lumbrical muscle variations according to the sides of the upper limb.

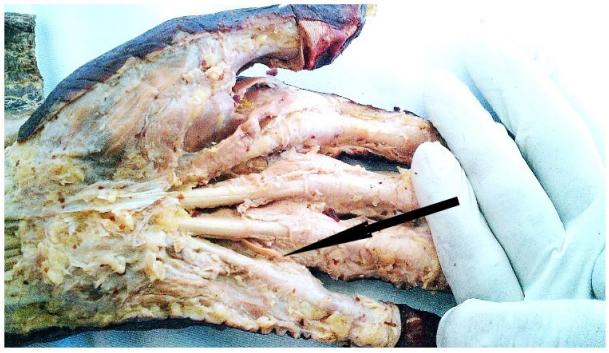

Fig. 2: The left hand fourth lumbrical origin as a unipennate muscle.

Fig. 3: The left hand third lumbrical slips insertion to 3rd and 4th digits.

Fig. 4: The left hand third lumbrical insertion to the medial side of the middle finger.

Fig. 5: The right hand second lumbrical origin as a bipennate muscle.

Table 1: Comparison among the lumbrical muscle variations of left and right hands.

Lumbricals	Left hand frequency	Left hand (%)	Right hand frequency	Right hand (%)	Total frequency	Total (%)
Normal	9	47.40%	14	70%	23	59%
Unipennate 3rd lumbrical	3	15.70%	-	-	3	7.70%
Unipennate 4th lumbrical	2	10.50%	-	-	2	5.10%
Bipennate 2nd lumbrical	1	5.30%	1	5%	2	5.10%
Split insertion 3rd lumbrical	2	10.50%	2	10%	4	10.30%
Split insertion 4th lumbrical	1	5.30%	3	15%	4	10.30%
3rd lumbrical insertion on medial side of middle finger	1	5.30%	-	-	1	2.50%

DISCUSSION

Human occupies a very special place among the animal kingdom as they execute bipedalism. As a result of this, hands were less involved in locomotion and significantly free. Hence, hands were used for various other purposes and philosophically it may be said that the actions of the small muscles or intrinsic muscles of the hand are the indices of civilization of a human race [16]. Among the intrinsic muscle of the hand, the lumbricals perform much intricate and highly skilled precision movements. The variation of this muscle may lead to functional difficulties such as the inability to extend the interphalangeal joint of the ring or the little finger due to the lack of related lumbrical. Therefore, the knowledge of the variations of human lumbricals is very important in clinical and surgical practice.

Variations in the attachments of the lumbricals are not uncommon in the literature survey and the present study also follows the same pattern. Interestingly, it was found that except for the first lumbrical muscle, at least one muscle of all the other number of lumbrical muscles (second, third and fourth lumbrical) indicated anomalies. In the case of the second lumbrical, when they are bipennate, the two heads arise from adjoining tendons of flexor digitorum profundus. Out of 16 hands with abnormal lumbrical only 2 hands indicated a second lumbrical abnormality of bipinate nature. This represents 5.1% of the total sample size which is somewhat closer to the percentages (3.3%) of that of the same variation reported by Mutalik [17]. A similar finding of 3.3% bipinate second lumbrical was reported from a couple of studies [18-19]. In contrast to this, another study reported quite a high percentage (45%) of second lumbrical bipinate nature [20]. In the present study, unipinate origin of third and fourth lumbricals were 7.7% and 5.1%, respectively. A study done by Goldberg S quoted evidence of 12% and 26% for unipinate origin of third and fourth lumbricals, respectively [21]. Singh and colleagues reported that the third and fourth lumbrical variations are common than the first

and second lumbricals in their study [14].

The anomalous insertion of the lumbrical was quite numerous in our study and commonly reported types were the split insertions and misplaced insertions. In split insertion, the variant lumbrical tendon divides and inserts on the surrounding fingers' extensor expansion in addition to its typical insertion. Interestingly, all the first and second lumbricals of the study population were normal in insertion. Eyler and Markee had reported 100% normal insertion of second lumbrical [22]. The same percentage of 10.3% split insertion was encountered in both 3rd and 4th lumbricals. However, somewhat higher percentages of split insertion of medial lumbrical muscles were identified by several authors. In 2013, Parminder had reported higher percentages of split insertion of 28%-3rd lumbrical with 16%-4th lumbrical [13]. Similar results were reported by Mehetha and Gardner (37.8%-3rd lumbrical & 8%-4th lumbrical) and Singh (27.1%-3rd lumbrical & 25.2%-4th lumbrical [6,14]. The rare variation of the misplaced insertion was seen related to the third lumbrical muscle insertion which was attached to the ulnar side of the middle finger. When considering the number of muscle variations on insertion of the medial two lumbricals, it was noted that more insertion variations present on the third lumbrical when compared to the fourth lumbrical. These results are well accordance with the world picture [13-14].

The lateral two lumbricals have lower morphology variation in anatomy and higher density of muscle spindles compared to the medial two lumbricals [23-24]. Therefore, it is possible to hypothesize that the first two lumbricals are functionally more important than the two ulnar lumbricals, specifically for precision pinch movements. Although not present in this study, variations of the lumbrical muscles have also been revealed to be relevant in carpal tunnel syndrome. Hypertrophic lumbrical muscles and a much larger and proximal origin of lumbrical muscles in the carpal tunnel were found to be the main causes of a later mentioned syndrome [11]. Moreover, the absence of lumbrical has been mentioned in many research notes [20].

Although the lumbrical muscles contain unique features the surgeons' attention towards it very less. This is reflected by using the lumbrical as a muscle flap for coverage of defects in certain areas of the body. Moreover, the advance research such as finding of the number of motor units contained in the lumbrical muscles have been developed [25]. Therefore, it is really necessary to execute more research on lumbricals both on the anatomical and functional aspect to vaster the information regarding lumbrical muscles and give them due attention in hand surgeries.

CONCLUSION

The present study on the lumbrical muscle of the Sri Lankan cadervers indicates that the left hand lumbrical variations are commoner than right hand variations. It reveals that lumbrical insertions are more variable than their origin. The commonest variation type is the split insertion and the number of variations is more on the third and fourth lumbricals. The information related to the anatomical variations of lumbrical muscle is vital to all the resource personalities involved in hand surgeries and invasive procedures to avoid unnecessary complications.

Author Contributions

Lanka Ranaweera: Conception, design & drafting of manuscript

Prabath Wijesooriya: Dissection of specimens and analysis of data

Susantha Vithanage: Dissection of specimens and analysis of data

Eranda Cabral: Rechecking the analysed data and photography

ACKNOWLEDGEMENTS

We would like to extend our gratitude to all the technical and non-academic staff members of the Department of Anatomy at the Faculty of Medicine, University of Kelaniya for their constant help and cooperation towards the research work.

Conflicts of Interests: **None**

REFERENCES

[1]. MIDLO C. Form of Hand and Foot in Primates. Am J Phys Anthropol 2005;19(3):337–389.

[2]. MARZKE MW, MARZKE RF. Evolution of the human hand: approaches to acquiring, analysing and interpreting the anatomical evidence. J Anat 2000;197:121–140.

[3]. MARZKE MW, SHACKLEY MS. Hominid Hand Use in the Pliocene and Pleistocene: Evidence from Experimental Archaeology and Comparative Morphology, J Hum Evol 1986;15:439–460.
[4]. YOUNG RW. Evolution of the Human Hand: The Role of Throwing and Clubbing J Anat 2003;202:165–174.
[5]. JACOBSON MD, RAAB R, FAZELÝ BM, ABRAMS RA, BOTTE MJ, LÝEBER RL. Architectural design of the human intrinsic hand muscles. J Hand Surg 1992;17:804–809.
[6]. MEHTA HJ, GARDNER WU. A Study of Lumbrical Muscles in the Human Hand. Am J Anat 1961;109:227–238.
[7]. ERÝKSEN J. A Case of Carpal Tunnel Syndrome on the Basis of an Abnormally Long Lumbrical Muscle. Acta Orthop 1973;44(3):275–277.
[8]. BUTLER BJr, BÝGLEY ECJr. Aberrant Index (First) Lumbrical Tendinous Origin Associated with Carpal-Tunnel Syndrome. A Case Report. J Bone Joint Surg 1971;53: 160–162.
[9]. SCHULTZ RJ, ENDLE PM, HUDDLESTON HD. Anomalous Median Nerve and an Anomalous Muscle Belly of the First Lumbrical Associated with Carpal-Tunnel Syndrome. J Bone Joint Surg 1973;55:1744–1746.
[10]. STÝLL JMJR, KLEÝNERT HE. Anomalous Muscles and Nerve Entrapment in the Wrist and Hand. Plast Reconstr Surg 1973;52:394–400.
[11]. ROBÝNSON D, AGHASÝ M, HALPERÝN N. The Treatment of Carpal Tunnel Syndrome Caused by Hypertrophied Lumbrical Muscles. Case Reports. J Plast Surg Hand Surg 1989;23:149–151.
[12]. COBB TK, AN KN, COONEY WP. Effect of Lumbrical Muscle Incursion within the Carpal Tunnel on Carpal Tunnel Pressure: A Cadaveric Study. J Hand Surg 1995;20: 186–192.
[13]. PARMÝNDER K. Morphological Study of Lumbricals - a Cadaveric Study. J Clin Diagn Res 2013;7:1558–1560.
[14]. SÝNGH JD, RAJU PB, SÝNGH S. Anomalous Insertion of Hand Lumbricals. J Anat Soc India 1975;24:122–125.
[15]. CUNNÝNGHAM DJ, ROBÝNSON A. Cunningham's Manual of Practical Anatomy Vol. 1, 1,. Edinburgh: Hodder & Stoughton, 1910.
[16]. BASU SS, HAZARY S. Variations of the Lumbrical Muscles of the Hand. Anat Rec 1960;136:501–504.
[17]. MUTALÝK AM. Morphological Variations in the Origin and Insertion of Lumbricals of the Upper Limb in Cadavers. J Clin Diagn Res 2011;5:278–281.
[18]. KUMAR A, MÝSHRA A, GOSWAMÝ G, GANESH E. Morphological Variations in Lumbricals of Upper Limb: A Cadaveric Study. Anat Physiol 2015;5 :5–8.
[19]. HOSAPATNA M, BANGERA H, KUMAR N, SUMALATHA S, HOSAPATNA N. Morphological Variations in Lumbricals of Hand – A Cadaveric Study. Plast Surg Int 2013;2013:1–7.
[20]. JOSHÝ SD, JOSHÝ SS, ATHAVALE SA. Lumbrical Muscles and Carpal Tunnel. J Anat Soc India 2005;54(1):12–15.
[21]. GOLDBERG S. The Origin of the Lumbrical Muscles in the Hand of the South African Native. Hand 1970;2:168-171.
[22]. EYLER DL, MARKEE JE. The Anatomy and Function of the Intrinsic Musculature of the Fingers. J Bone Joint Surg 1954;36:1–9.
[23]. WANG K, MCGLÝNN EP, CHUNG KC. A Biomechanical and Evolutionary Perspective on the Function of the Lumbrical Muscle. J Hand Surg 2014;39:149–155.
[24]. SÝEGEL DB, KUZMA G, EAKÝNS D. Anatomic Investigation of the Role of the Lumbrical Muscles in Carpal Tunnel Syndrome. J Hand Surg 1995;20:860–863.
[25]. ZONG Y, LU Z, CHEN M, DENG L, XÝE Q, ZHOU P. Motor Unit Number Estimation of the Second Lumbrical Muscle in Human Hand. Front Physiol 2022;13:854385.

How to cite this article:

Lanka Ranaweera, Prabath Wijesooriya, Susantha Vithanage, Eranda Cabral. Morphological Variations of Lumbrical Muscles of Hand in Sri Lankan Cadavers. Int J Anat Res 2022;10(3):8457-8462. **DOI:** 10.16965/ijar.2022.200