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RESEARCH ARTICLE

Morphological Variation in Lumbricals of Hand

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ABSTRACT

Background: The lumbrical muscles of the hand are unique intrinsic muscles responsible for coordinated finger movements and fine motor functions. Variations in their morphology, origin, insertion, and innervation may influence hand biomechanics and surgical outcomes.

Aim: To analyze the morphological variations of lumbrical muscles of the hand in terms of number, origin, insertion, and morphometry.

Materials and Methods: This cross-sectional cadaveric observational study was conducted in the Department of Anatomy, Jawaharlal Nehru Medical College, Bhagalpur, from 2023–2026. Forty hands obtained from 20 formalin-fixed adult cadavers were dissected. Morphological parameters including number of lumbricals, origin, insertion, muscle belly length, tendon length, and variations were documented. Measurements were taken using digital Vernier calipers. Statistical analysis was performed using Microsoft Excel and descriptive statistics.

Results: All four lumbricals were present in 80% of hands, while 12.5% showed only three lumbricals and 7.5% demonstrated supernumerary lumbricals. The first and second lumbricals were predominantly unipennate, whereas the third and fourth lumbricals were mainly bipennate. Accessory insertions and bifid insertions were observed in a few specimens. The mean muscle belly lengths of the first, second, third, and fourth lumbricals were 3.5 ± 0.5 cm, 3.3 ± 0.6 cm, 3.0 ± 0.5 cm, and 2.8 ± 0.5 cm respectively.

Conclusion: Considerable morphological variations exist in the lumbrical muscles of the hand. Awareness of these variations is important for anatomists, hand surgeons, and clinicians during surgical procedures, diagnosis of entrapment neuropathies, and rehabilitation.

Keywords: Lumbricals, Hand anatomy, Morphological variation, Cadaveric study, Intrinsic muscles, Morphometry.

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Introduction

The human hand is a highly specialised anatomical structure that can carry out intricate motor tasks that call for strength, coordination, and accuracy. The lumbricals hold a special place among the hand's intrinsic muscles due to their dual effect on finger joints and their peculiar genesis from tendons rather than bones. These muscles are crucial for flexion at the metacarpophalangeal joints and extension at the interphalangeal joints, which enable fine motor skills and precise gripping[1].

The hand typically contains four lumbrical muscles. The third and fourth lumbricals are bipennate and originate from adjacent sides of nearby flexor digitorum profundus tendons, but the first and second lumbricals are often unipennate and originate from the radial sides of the tendons. They fit into the corresponding fingers' lateral aspect of the extensor expansion.Because of their function in hand biomechanics and its connection to the median and ulnar nerves, lumbricals are clinically significant. Variations in their morphology may make them more susceptible to problems including intrinsic muscle imbalance, lumbrical-plus deformity, carpal tunnel syndrome, and challenges

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during reconstructive surgery. Numerous cadaveric studies have identified anatomical differences related to origin, insertion, number, and innervation[2].

Lumbricals originate from the mesoderm of the upper limb bud during embryonic development. Changes in differentiation, aberrant myogenic cell migration, or the maintenance of primitive muscle slips during development can all lead to variations.The need for a thorough understanding of lumbrical morphology is highlighted by the growing significance of microsurgical operations, tendon transfers, reconstructive surgeries, and radiological imaging of the hand. However, there is still a dearth of population-based anatomical evidence on lumbrical differences[3].

In order to assess the potential anatomical and clinical importance of the morphological changes in the hand's lumbricals in cadaveric specimens from Bhagalpur, the current study was conducted.

Materials and Methods

Study Design

This was a cross-sectional observational cadaveric study conducted in the Department of Anatomy, Jawaharlal Nehru Medical College, Bhagalpur, from 2023–2026.

Study Sample

The study included 40 hands obtained from 20 formalin-fixed adult cadavers.

- Male cadavers: 15
- Female cadavers: 5
- Right hands: 20
- Left hands: 20

Inclusion Criteria

- Adult cadavers aged above 18 years.
- Well-preserved upper limbs.
- Hands without congenital anomalies or previous surgeries.

Exclusion Criteria

- Deformed or damaged hands.
- Poorly embalmed specimens.
- Hands with traumatic injuries.

Dissection Procedure

The palm was dissected after reflecting the skin, superficial fascia, and palmar aponeurosis. Flexor tendons were identified and lumbrical muscles were traced from origin to insertion. Variations in morphology were carefully documented.

Parameters Studied

The following observations were recorded:

- Number of lumbricals.
- Type of origin.
- Type of insertion.
- Muscle belly length.
- Tendon length.
- Presence of accessory slips.
- Morphological variations.

Instruments Used

- Scalpel.
- Forceps.
- Dissecting scissors.
- Digital Vernier caliper.
- Measuring scale.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using descriptive statistics. Results were expressed as percentages, mean, and standard deviation.

Results

Table 1: Distribution of Lumbricals

Observation	*Frequency*	*Percentage*
All four lumbricals present	32	80%
Three lumbricals present	5	12.5%
Supernumerary lumbrical	3	7.5%

Two hands showed absence of the fourth lumbrical, while one hand demonstrated an accessory fifth lumbrical.

Table 2: Origin of First Lumbrical

Origin type	*Frequency*	*Percentage*
Unipennate	37	92.5%
Bipennate	2	5.0%
Atypical	1	2.5%

Table 3: Origin of Second Lumbrical

Origin type	*Frequency*	*Percentage*
Unipennate	36	90%
Bipennate	4	10%

Table 4: Origin of Third Lumbrical

Origin type	*Frequency*	*Percentage*
Bipennate	38	95%
Tripennate	1	2.5%
Fused origin	1	2.5%

Table 5: Origin of Fourth Lumbrical

Origin type	*Frequency*	*Percentage*
Bipennate	39	97.5%
Absent	1	2.5%

Table 6: Insertion Variations

Insertion pattern	*Observation*
Standard extensor expansion	Majority of specimens
Bifid insertion	Observed in 3 hands
Accessory insertion	Observed in 1 hand

Table 7: Muscle Belly Length

Lumbrical	*Mean ± SD (cm)*
First	3.5 ± 0.5
Second	3.3 ± 0.6
Third	3.0 ± 0.5
Fourth	2.8 ± 0.5

Table 8: Tendon Length

Lumbrical	*Mean ± SD (cm)*
First	2.7 ± 0.4
Second	2.5 ± 0.5
Third	2.3 ± 0.5
Fourth	2.1 ± 0.4

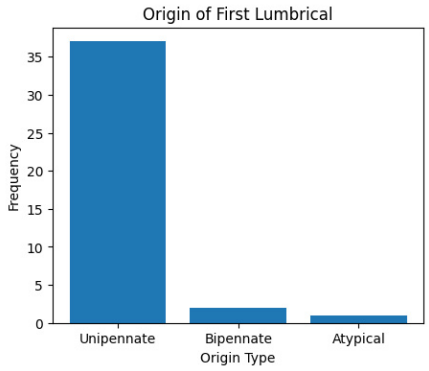

Figure 1: Origin of first lumbrical

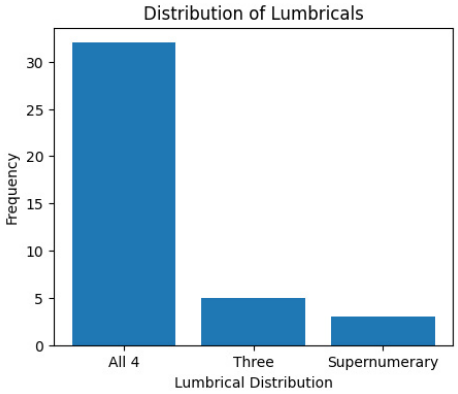

Figure 2: Distribution of lumbricals

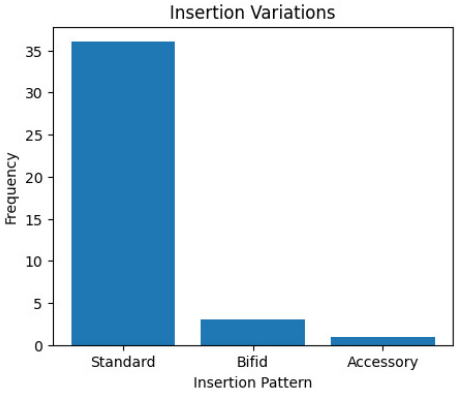

Figure 3: Insertion variations

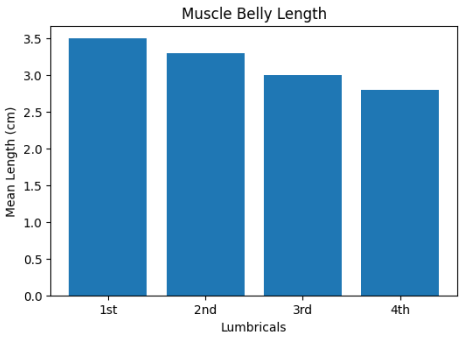

Figure 4: Muscle belly length

Discussion

The lumbrical muscles are unique intrinsic muscles of the hand because of their tendon-to-tendon arrangement and

important role in coordinated finger movement. Variations in their morphology have attracted considerable attention among anatomists and clinicians due to their relevance in hand surgery and nerve compression syndromes[4].In the present study, all four lumbricals were present in 80% of the specimens. Similar findings were published by Chitra and Rao *et al*., demonstrating that the majority of cadaveric hands possessed a typical lumbrical shape[5]. However, variations like accessory and absent lumbricals have also been noted in the literature[6].

The first and second lumbricals in the present study were mostly unipennate. This result is consistent with conventional anatomical theories. Bipennate morphology was more common in the third and fourth lumbricals, which is consistent with previous studies by Georgiev *et al*[7].Accessory lumbricals were present in 7.5% of the specimens. Mehta and Gardner also discovered that additional lumbricals were present in approximately 4% of cadavers. These auxiliary muscles may be clinically significant because they can compress the median nerve and occupy additional space in the carpal tunnel[8].

The existence of additional slips and bifid insertion seen in this study further highlights the intricacy of lumbrical morphology. Similar insertional variations, including several slips and insertions into adjacent structures, were reported by Yoshida *et al*[9].The first lumbrical exhibited the longest mean muscle belly lengths, which progressively decreased medially, according to the study. This pattern is comparable to the morphometric observations made by Rao et al. Variations in tendon length and muscle bellies may have an impact on finger biomechanics and grip accuracy[10].

From an embryological point of view, lumbrical variations may be the consequence of either modified myogenic cell migration or the persistence of primitive muscle slips during foetal development. These developmental changes can account for the existence or absence of lumbricals.For flap, nerve decompression, reconstructive, and tendon repair surgery, a comprehensive grasp of lumbrical morphology is essential. Hypertrophied lumbricals can make carpal tunnel syndrome worse, and irregular insertions can make tendon transfer procedures more difficult[11].

Radiological imaging methods, such as MRI and ultrasound, are increasingly identifying lumbrical malformations in living humans. Anatomical studies continue to provide crucial baseline information for radiologists and surgeons. Important population-specific anatomical information on lumbrical variations in Bihar cadavers is provided by the current study. However, disadvantages include the extremely small sample size and the absence of histology relationship in each item. Further comprehensive research encompassing radiographic and functional examination is recommended to completely understand the biomechanical and therapeutic consequences of lumbrical variations[12].

Conclusion

There is considerable morphological variation in the number, origin, insertion, and morphometric characteristics of the hand's lumbrical muscles. The first and second lumbricals were mostly unipennate, whilst the third and fourth lumbricals were mostly bipennate.

Many specimens had accessory lumbricals, absent lumbricals, bifid insertions, and unusual origins. In hand surgery, tendon transfer procedures, nerve decompression surgeries, and the diagnosis of intrinsic muscle diseases, these variances have significant clinical significance.

These anatomical variations must be understood by anatomists, surgeons, radiologists, and physiotherapists who treat hand issues.

The current study offers helpful anatomical information about lumbrical morphology in the population being studied and highlights the importance of comprehensive anatomical knowledge for improved therapeutic practice.

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