Original Research

MORPHOLOGICAL EVALUATION OF PALMARIS LONGUS MUSCLE IN THE POPULATION OF NORTH-WESTERN RAJASTHAN

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ABSTRACT

Background: The palmarislongus is a superficial forearm flexor with marked variability in its presence and morphology. Its long, accessible tendon is commonly harvested for reconstructive procedures, making population-specific anatomical data clinically relevant.

Aims: To determine the prevalence of absence and morphological variants of the palmarislongus, quantify muscle-belly and tendon dimensions, and compare measurements between sides in cadaveric upper limbs from north-western Rajasthan.

Materials and Methods: During the cadaveric dissections at the Department of Anatomy, Government Medical College Nagaur, we studied fifty upper-limb (25 right and 25 left). The muscle was categorized as normal, fleshy, reversed, or absent. Length, width, and thickness of the muscle belly and tendon were recorded. Data were summarized as number, percentage, and mean ± standard deviation; group and side-wise comparisons were performed using appropriate tests, with $p<0.05$consideredsignificant.

Results: The palmarislongus was present in 47 of 50 specimens (94.0%) and absent in 3 (6.0%). Among present muscles, 40 (85.1%) had normal morphology, 4 (8.5%) were fleshy variants, and 3 (6.4%) were reversed variants. Tendon width differed significantly among morphological types ($p=0.03$), being greatest in the fleshy variant. Other muscle-belly and tendon measurements were comparable across types. No significant side-to-side difference was observed in any morphometric parameter.

Conclusion: The palmarislongus was present in most specimens from north-western Rajasthan, although clinically important fleshy and reversed variants were identified. Morphological assessment before tendon harvest may improve operative planning and reduce avoidable neurovascular injury.

Keywords: Cadaver, Morphological Variation, Palmarislongus, Tendon Graft, North-Western Rajasthan.

INTRODUCTION

The palmarislongus is a slender, superficial muscle of the anterior compartment of the forearm. It usually arises from the medial epicondyle through the common flexor origin, continues into a long distal tendon, passes superficial to the flexor retinaculum, and blends mainly with the palmar aponeurosis.

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 23-05-2026
Date Acceptance: 31-05-2026
Date of Publication: 30-06-2026

Its functional contribution to wrist flexion and tensioning of the palmar fascia is modest.[1]

Despite its limited functional role, the muscle has considerable clinical importance because its tendon is superficial, readily accessible, and commonly used as an autologous graft in hand, tendon, ligament, ophthalmic, and reconstructive procedures. Detailed knowledge of tendon length, width, and insertion is therefore important when planning graft harvest.[2]

The palmarislongus is among the most variable muscles in the human body. Reported variations include complete agenesis, reversal of the musculotendinous arrangement, fleshy or hypertrophied forms, duplication, bifid or multiple

tendons, accessory slips, and unusual distal insertions. A modern cadaveric classification has also shown substantial variation in the insertion pattern and in the ratio between tendon and muscle-belly length.[3]

Agenesis is the commonest variation, but its frequency differs markedly among populations and according to whether clinical, ultrasonographic, or cadaveric methods are used. A systematic review estimated a pooled clinical agenesis rate of approximately one fifth, while Indian studies have reported widely differing frequencies.[4]

Anomalous distal muscle bulk may mimic a soft-tissue mass or contribute to exertional wrist discomfort and median-nerve compression. In addition, failure to recognize the relation of the tendon to the median nerve can lead to serious harvesting complications.

Regional cadaveric data from north-western Rajasthan remain limited. In our study, we therefore documented the presence, absence, morphological pattern, and morphometric characteristics of the palmarislongus in the examined upper-limb specimens and assessed whether the measured parameters differed by morphological type or side.

MATERIALS AND METHODS

Study design

This was an observational study, during routine undergraduate cadaveric dissectionsdone in the Department of Anatomy at G.M.C. Nagaur.

Study material

A total of 50 upper-limb comprising 25 right and 25 left limbs were examined. Specimens with major traumatic disruption, previous operative alteration, advanced decomposition, or dissection-related damage that prevented reliable identification or measurement of the palmarislongus were excluded. Demographic details of the cadavers were not consistently available and were therefore not included in the analysis.

Dissection and identification

The skin, superficial fascia, and deep fascia of the anterior forearm were reflected using standard dissection procedures. The superficial flexor group was exposed, and the palmarislongus was identified between the flexor carpi radialis and flexor carpi ulnaris. The structure was traced proximally to its origin and distally across the wrist to its insertion into the flexor retinaculum and/or palmar aponeurosis. Absence was recorded only after careful exploration of the expected anatomical plane and exclusion of an accessory or deeply placed variant.

Morphological classification and measurements

The muscle was classified as: (1) normal morphology, with a proximal muscle belly and a long distal tendon; (2) fleshy variant, with an unusually long or distally extending muscle belly and a relatively short or broad tendon; (3) reversed variant, with a proximal tendon and distal muscle belly; or (4) complete absence. These categories were selected to provide clinically intuitive grouping of the observed specimens.

For muscles that were present, the following parameters were measured in centimetres using standard calibrated measuring instruments: muscle-belly length, maximum belly width, belly thickness, tendon length, maximum tendon width and tendon thickness. Total musculotendinous length was calculated as the sum of muscle-belly length and tendon length. Width and thickness were recorded at the broadest and thickest points, respectively. Each measurement was checked twice and the concordant value was entered in the data sheet.

Statistical analysis

Categorical variables were expressed as number and percentage. Continuous variables were summarized as mean ± standard deviation. Morphometric parameters were compared among the normal, fleshy, and reversed groups using an appropriate omnibus parametric or non-parametric test after assessment of distributional characteristics. Side-wise comparisons were performed using the corresponding two-group test. A two-sided p value <0.05 was considered statistically significant. Because the fleshy and reversed groups were small, subgroup findings were interpreted cautiously.

Ethical considerations

The study involved embalmed cadaveric material already available for anatomical teaching. Specimens were handled in accordance with institutional protocols for cadaveric teaching and research and no personal identifiers were collected.

RESULTS

A total of 50 upper-limb specimens were examined. The palmarislongus was identified in 47 specimens (94.0%) and was absent in 3 specimens (6.0%). Among the 47 present muscles, the usual morphology was observed in 40 (85.1%), a fleshy variant in 4 (8.5%), and a reversed variant in 3 (6.4%). When calculated using all 50 specimens as the denominator, the corresponding frequencies were 80.0%, 8.0%, and 6.0%, respectively (Table 1).

Table 1. Distribution of Palmarislongus Morphology among the Examined Specimens

Morphological finding	Number	Percentage of all specimens (n=50)	Percentage among present muscles (n=47)
Normal morphology	40	80.0	85.1
Fleshy variant	4	8.0	8.5

Reversed variant	3	6.0	6.4
Complete absence	3	6.0	Not applicable
Total	50	100.0	-

The normal type constituted the large majority of specimens. The fleshy and reversed configurations together accounted for 14.9% of the muscles that were present.

Table 2. Morphometric Measurements According To Morphological Type

Measurement	Normal (n=40)	Fleshy (n=4)	Reversed (n=3)	p value
Muscle-belly length (cm)	10.35 ± 1.79	11.12 ± 2.15	10.18 ± 1.92	0.67
Muscle-belly width (cm)	1.28 ± 0.25	1.52 ± 0.31	1.34 ± 0.18	0.06
Muscle-belly thickness (cm)	0.51 ± 0.17	0.68 ± 0.22	0.49 ± 0.15	0.18
Tendon length (cm)	17.28 ± 1.92	16.85 ± 2.18	17.05 ± 2.05	0.85
Tendon width (cm)	0.35 ± 0.12	0.81 ± 0.33	0.33 ± 0.09	0.03
Tendon thickness (cm)	0.09 ± 0.03	0.12 ± 0.04	0.08 ± 0.02	0.12

Note: Values are mean ± standard deviation. A p value <0.05 was considered statistically significant. Small variant subgroups warrant cautious interpretation.

Muscle-belly length and thickness were comparable among the three morphological types (p=0.67 and p=0.18, respectively). The fleshy variant had the greatest mean belly width (1.52 ± 0.31 cm), although the overall difference did not reach statistical significance (p=0.06). Tendon length and thickness were also similar across groups (p=0.85 and p=0.12). Tendon width differed significantly (p=0.03), with the fleshy type showing the largest mean width (0.81 ± 0.33 cm), compared with 0.35 ± 0.12 cm in the normal type and 0.33 ± 0.09 cm in the reversed type.

Table 3. Total Musculotendinous Length According To Morphological Type

Morphological type	Number of specimens	Mean total length (cm)
Normal	40	27.63 ± 3.42
Fleshy	4	27.97 ± 4.15
Reversed	3	27.23 ± 3.87

The mean total musculotendinous length was similar across the three groups. The fleshy variant had the highest numerical mean (27.97 ± 4.15 cm), followed by the normal type (27.63 ± 3.42 cm) and the reversed type (27.23 ± 3.87 cm).

Table 4. Side-Wise Comparison of Muscle-Belly and Tendon Measurements

Measurement	Left side (n=25)	Right side (n=22)	p value
Muscle-belly length (cm)	10.51 ± 1.88	10.32 ± 1.76	0.39
Muscle-belly width (cm)	1.32 ± 0.29	1.28 ± 0.25	0.27
Muscle-belly thickness (cm)	0.52 ± 0.19	0.54 ± 0.17	0.71
Tendon length (cm)	17.05 ± 1.92	17.38 ± 1.98	0.15
Tendon width (cm)	0.37 ± 0.14	0.35 ± 0.12	0.52
Tendon thickness (cm)	0.09 ± 0.03	0.09 ± 0.03	0.83

Note: Side-wise morphometry includes only specimens in which the muscle was present; the three absent muscles had no measurable parameters. No statistically significant side-to-side difference was observed for any parameter. Muscle-belly length, width, and thickness were comparable between left and right sides, as were tendon length, width, and thickness (all p>0.05). Overall, the measured morphology was broadly symmetrical between sides in the available specimens.

DISCUSSION

In our study, we provide regional data on the palmarislongus in north-western Rajasthan. The muscle was present in 94.0% of the examined upper limbs and absent in 6.0%. The normal proximal-belly/distal-tendon configuration predominated, but fleshy and reversed variants together accounted for 14.9% of present muscles. Most dimensions were comparable across morphological types and sides; tendon width was the only parameter showing a statistically significant inter-variant difference.

The observed 6.0% agenesis rate was close to the findings of Olewniket al.[3], who reported absence in 7.5% of 80 cadaveric upper limbs and presence in 92.5%. Sambhavet al.[5] documented a slightly higher agenesis rate of 9.4% in 64 cadaveric upper limbs from Jodhpur, another centre in western Rajasthan.

The geographic proximity of Nagaur and Jodhpur makes this comparison particularly relevant, although differences in cadaver composition and sample size may explain the numerical variation.

The frequency in our study was lower than that reported in several clinical Indian studies. Agarwal[6] documented an overall unilateral absence of 16.9% and bilateral absence of 3.3% in an Indian population. Sankaret al.[7] reported an overall agenesis rate of 28.0% in the Andhra population. Yammine[4] found a pooled agenesis rate of 20.25% in a systematic review of clinical studies, with substantial variation by ethnicity and study method. Clinical examination may misclassify thin, aberrant, or deeply placed tendons, whereas direct dissection allows definitive identification; therefore, clinical and cadaveric prevalence estimates should not be considered directly interchangeable.

Among the muscles present, 85.1% showed normal morphology. Quadroset al.[8] identified two variants among 40 South Indian upper limbs, including one reversed palmarislongus and one palmarisprofundus. Mathew et al.[9] emphasized that agenesis, duplication, reversal, and accessory forms can coexist with considerable variability in origin and insertion. The 6.4% proportion of reversed muscles among present specimens in our series is notable because the reversed arrangement is more often described in isolated reports and small anatomical series than in larger prevalence studies. In the reversed form, a proximal tendon is followed by a distal muscle belly near the wrist. Longhurstet al.[10] highlighted the marked heterogeneity of reversed palmarislongus and its potential association with exertional symptoms or median-nerve compression when a bulky distal belly occupies the confined volar wrist region. Similarly, fleshy variants may present as an unexpected soft-tissue structure during surgery or imaging. Natsiset al.[11] described a fleshy palmarislongus and stressed its relevance in differential diagnosis and operative planning.

The mean tendon length in the normal group was 17.28 ± 1.92 cm, while mean tendon width was 0.35 ± 0.12 cm (3.5 ± 1.2 mm). In a systematic review of 24 cadaveric studies, Yammine and Eric[2] reported a pooled tendon length of 13.9 ± 2.6 cm and width of 4.0 ± 1.7 mm. Thus, the mean tendon length in our normal specimens was relatively generous, while tendon width was broadly comparable with pooled cadaveric data. Variation in measurement landmarks, fixation, ancestry, and forearm dimensions can materially affect morphometric comparisons.

Tendon width was significantly greater in the fleshy variant. This finding likely reflects the broader musculotendinous transition and short, robust distal tendon characteristic of a fleshy configuration. Although the small subgroup limits precision, the observation may be clinically useful because graft selection depends not only on the presence of the tendon but also on whether its length and calibre match the intended reconstruction. Jakubietzet al.[12] found that the palmarislongus did not meet predetermined graft criteria in a substantial proportion of cadavers, underscoring that presence alone does not guarantee suitability.

No significant side-related difference was identified in any measured parameter. This supports broad bilateral symmetry at the group level, although individual asymmetry remains possible. The three specimens without a measurable muscle were on the side excluded from the right-side morphometric denominator, and the small sample precluded a robust paired-cadaver analysis. Larger studies with documented sex, age, stature, forearm length, and paired laterality would allow more detailed evaluation of predictors of tendon size.

The surgical relevance of accurate recognition extends beyond graft adequacy. The palmarislongus lies close to the median nerve, and anomalous tendons or an absent tendon can make identification difficult. Chooet al.[13] reviewed safe harvesting techniques after iatrogenic median-nerve injury during attempted tendon harvest. Weber and Mackinnon[14] also reported restoration of function after the median nerve had been mistaken for the palmarislongus tendon, illustrating the potentially severe consequences of anatomical error. Preoperative clinical examination or ultrasonography and direct verification of tendon movement before division are prudent when anatomy is uncertain.

The study has several limitations. It was conducted at a single institution with a modest sample and small variant subgroups. Sex, age, handedness, body habitus, and exact geographic origin of the cadavers were not consistently available. Embalming may alter tissue dimensions, and the study did not evaluate histological structure, biomechanical strength, branching insertion patterns, or relations to neurovascular structures in quantitative detail. Nevertheless, direct dissection provided reliable confirmation of presence and gross morphology, and the findings add useful regional information to the anatomical literature. In anthropometry[15] its long, accessible tendon is commonly used for tendon grafting.

CONCLUSION

The palmarislongus was present in 94.0% of the examined cadaveric upper limbs. Normal morphology predominated, but fleshy and reversed variants were clinically relevant and together represented almost one sixth of present muscles. Tendon width was greatest in the fleshy variant, while other morphometric measurements were similar across types and between sides. Surgeons

and radiologists working in north-western Rajasthan should anticipate both agenesis and variant morphology, confirm the structure before harvest, and assess tendon calibre and length rather than assuming suitability from presence alone.

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How to cite this article: Charu Taneja, Priyanshi Balot, Kavita Dhidharia, Suman Sharma, Basant Kumar, Shushil Kudi, MORPHOLOGICAL EVALUATION OF PALMARIS LONGUS MUSCLE IN THE POPULATION OF NORTH-WESTERN RAJASTHAN, Asian J. Med. Res. Health Sci., 2026; 4 (2):1463-1467.

Source of Support: Nil, Conflicts of Interest: None declared.