

Clinical assessment of anatomical variation of flexor digitorum superficialis in the little finger

Quratulain Javaid, Loung Umedani

Abstract

Objective: To determine the frequency of anatomical variation of flexor digitorum superficialis in the little finger, prevalence of isolated presence of 5th digit flexor digitorum superficialis tendon and interconnected presence of 4th and 5th digit flexor digitorum superficialis tendon, and to assess the association of anatomical variations with ethnicity.

Method: The cross-sectional, descriptive study was conducted at the Bahria University of Health Sciences, Karachi, from August 2022 to May 2024, and comprised subjects of either gender aged 18-23 years belonging to five ethnic communities; Punjabi, Sindhi, Balochi, Pathan and Urdu-speaking. The presence of flexor digitorum superficialis was assessed using the Standard and Modified tests. Data was analysed using SPSS 27.

Results: Of the 234 subjects with mean age 20.03 ± 1.08 years, 146(62.4%) were females and 88(37.6%) were males. In terms of ethnicity, there were 163(69.65%) Punjabi subjects, 17(7.26%) Pathan, 13(5.55%) Sindhi, 12(5.12%) Balochi, and 29(12.40%) belonged to the Urdu-speaking community. Flexor digitorum superficialis was noted in 150(64.1%) of the subjects. Agenesis was observed in 84(35.9%) individuals, with bilateral agenesis in 38(16.2%) and unilateral agenesis in 46(19.7%). The prevalence of right flexor digitorum superficialis showed non-differences ($p > 0.05$) with respect to ethnicity, while the difference was significant on the left side ($p = 0.05$). Significant differences ($p = 0.032$) were observed on the left limb for the isolated presence of 5th digit flexor digitorum superficialis tendon and interconnected presence of 4th and 5th digit flexor digitorum superficialis tendon.

Conclusion: There existed anatomical variability in terms of prevalence of flexor digitorum superficialis in the little finger with respect to ethnicity. Unilateral agenesis was more than bilateral agenesis, and active tendon function was more prevalent than interconnected function.

Key Words: Anatomical variation, Flexor digitorum superficialis, Interconnected tendon.

(JPMA 75: 1878; 2025) DOI: <https://doi.org/10.47391/JPMA.25-22012>

Introduction

Flexor digitorum superficialis (FDS) is a large muscle that belongs to the flexor (anterior) compartment of the forearm, making it a flexor muscle of the forearm belonging to the intermediate layer.¹ The functional aspect of FDS is associated with the flexion of proximal interphalangeal joint. There exists anatomical variability in terms of anatomical structure of FDS belonging to the fifth digit. These variations include hypoplastic structural form, thinning of tendon, unilateral and bilateral absence along with tendinous connections of little finger to the fourth digit.²⁻⁴ Studies have also reported presence of accessory belly and tendon of FDS.^{5,6} The variance in structure can be attributed to the evolutionary changes that have been observed in primates.⁵ The variability in the anatomy of FDS could also be due to the adaptability

.....
 Department of Anatomy, Bahria University Health Sciences, Karachi, Pakistan.

Correspondence: Quratulain Javaid. Email:

quratulain.bumdc@bahria.edu.pk

ORCID ID: 0000-0002-2858-2896

Submission complete: 06-09-2024 **First Revision received:** 31-12-2024

Acceptance: 10-09-2025

Last Revision received: 09-09-2025

of the hand function rather than the phylogenetic agenesis. The distinctive pattern of FDS anatomy varies from region to region, and prevalence ranges from 0% to 47.8%.^{7,8} The variability in the agenesis also differs between the two limbs. Unilateral agenesis on the right side has been reported to be 8%, while on the left side the absence has been reported to be 12%.⁹ A study in North Carolina documented that FDS was found to be congenitally absent when an accident patient was observed for the muscle tendon in both the forearms.¹

FDS can be easily used for operative procedures, like tendon transfers and reconstructive surgeries, because of its superficial location and also because its resection does not result in any sort of functional loss. A study in Turkiye determined the effect of presence and absence of FDS muscle on hand gripping, and concluded that hand gripping strength was not dependent on agenesis or presence of FDS.¹⁰ FDS can be categorised among the muscles that present with distinctive anatomy, and, therefore, the unique and unusual pattern of FDS must be known to the anatomists, physiotherapists and surgeons as it may influence clinical examination of hands with

injuries. Also, the treating doctor should know about the variance in anatomy while checking for the functional activity of the muscle.¹ Tendon anatomical variability must be kept in mind while reconstructive surgeries are planned as the muscle framework varies from person to person. Comprehensive evaluation must be carried out before making differential diagnosis and performance of procedures, like tendon transfer and opponenplasty.²

Keeping in mind the importance of knowing the structural differences of FDS, the current study was planned to determine the frequency of anatomical variation of FDS in the little finger, prevalence of isolated (active) presence of 5th digit FDS tendon, and interconnected presence of 4th and 5th digit FDS tendon along with assessing the association of anatomical variation of FDS in the little finger with ethnicity.

Subjects and Methods

The cross-sectional, prospective, descriptive study was conducted at the Bahria University of Health Sciences (BUHS), Karachi, from August 2022 to May 2024, and comprised subjects of either gender aged 18-23 years belonging to Punjabi, Sindhi, Balochi, Pathan and Urdu-speaking ethnic communities. The sample size was calculated using OpenEpi version 3, based on an

with abnormalities, fractures or past surgical history of hand and forearm were excluded. Informed consent was obtained from all the participants.

FDS presence was tested using Standard and Modified tests. The Standard test involved asking the subject to fully extend all the fingers with the help of the other hand; extension of all proximal interphalangeal (PIP) joints and distal interphalangeal joints (DIP) joints was done except for the little finger. The presence of flexion at the PIP joint of the little finger indicate FDS positivity. The Modified test involved asking the subject to fully extend all the fingers (extension of PIP and DIP joints) except for the ring and the little fingers. The presence of flexion at the PIP of the little finger indicated FDS positivity in connection with the fourth finger.^{7,11} In case of negative Standard test, the Modified test was used to rule out common tendinous attachment of the ring finger and the little finger (Figure 1).

Data was analysed using SPSS 27. Kolmogorov-Smirnov test was used to check data normality. Data was reported as frequencies and percentages, or as mean \pm standard deviation, as appropriate. Chi-square or Fisher's exact test was used, as appropriate. $P \leq 0.05$ was considered significant.

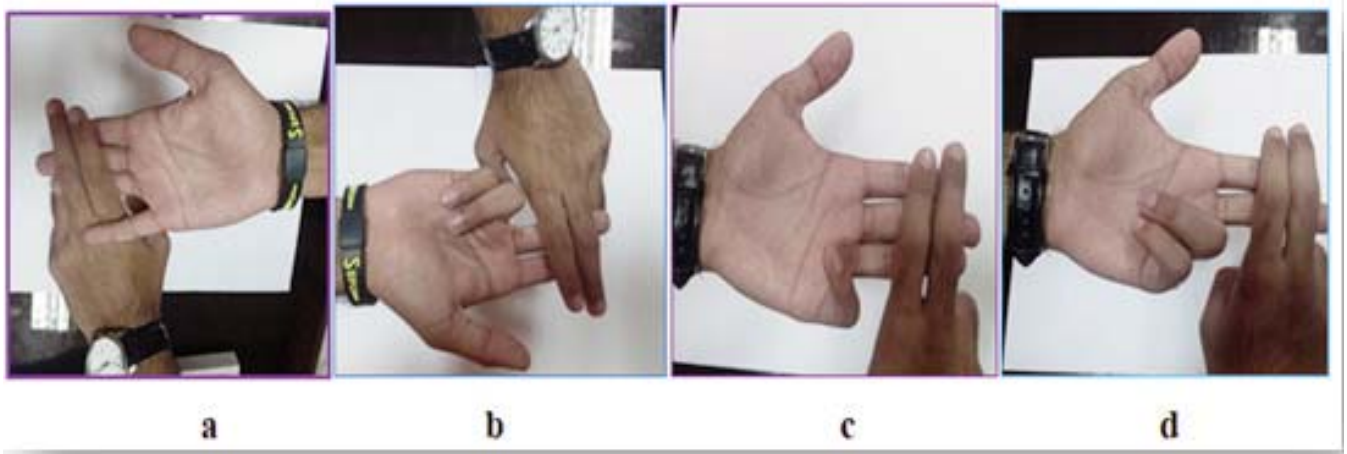


Figure-1: Clinical testing for flexor digitorum superficialis (FDS).

a: Absence of right FDS by Standard Test; b: Presence of right FDS interconnectivity evident by Modified Test; c: Presence of left FDS by Standard Test; d: Presence of left FDS evident by Modified Test.

estimated prevalence of 18% for the functional absence of FDS in the little finger, as reported in previous studies. A margin of error of 5% and a 95% confidence interval were used.⁴ The sample size was slightly inflated. The sample was raised using non-randomised convenience sampling technique from among BUHS students. Those included were subjects of either gender aged 18-23 years who had normal anatomy of the hand and forearm. Those

Results

Of the 234 subjects with mean age 20.03 ± 1.08 years, 146(62.4%) were females and 88(37.6%) were males. There were a total of 468 hands; 234(50%) left and 234(50%) right. In terms of ethnicity, there were 163(69.65%) Punjabi subjects, 17(7.26%) Pathan, 13(5.55%) Sindhi, 12(5.12%) Balochi, and 29(12.40%)

Table-1: Prevalence of Right and Left flexor digitorum superficialis (FDS) among ethnic groups (n=234).

Ethnicity	Number of right hands	Right FDS		P value
		Present	Absent	
Punjabi	163	124/163 (76.1%)	39/163 (23.9%)	0.367
Pathan	17	14/17 (82.4%)	3/17 (17.6%)	
Sindhi	13	11/13 (84.6%)	2/13 (15.1%)	
Balochi	12	11/12 (91.7%)	01/12 (8.3%)	
Karachi origin	29	19/29 (65.5%)	10/29 (34.5%)	
Total	234	179/234 (76.4%)	55/234 (23.5%)	

Ethnicity	Number of left hands	Left FDS		P value
		Present	Absent	
Punjabi	163	125/163 (76.7%)	38/163 (23.3%)	0.05*
Pathan	17	16/17 (94.1%)	01/17 (5.9%)	
Sindhi	13	12/13 (92.3%)	01/13 (7.7%)	
Balochi	12	12/12 (100%)	0/12 (0%)	
Karachi origin	29	20/29 (69%)	09/29 (31%)	
Total	234	185/234 (79%)	49/234 (21%)	

belonged to the Urdu-speaking community. FDS was noted in 150(64.1%) subjects. Agenesis was observed in 84(35.9%) individuals, with bilateral agenesis in 38(16.2%) and unilateral agenesis in 46(19.7%). Specifically, absence on the right side was noted in 18(7.7%) subjects, while absence on the left side was documented in 13(5.6%).

Among the 468 hands, the FDS muscle was present in 179(76.5%) right hands and 185(79.1%) left hands. On the right side, no significant differences were observed among the ethnic groups (p=0.367), while, on the left side, significant differences were noted (p=0.05), with the Balochi group exhibiting the highest prevalence of FDS presence (Table 1).

Among the right hands, isolated 5th digit FDS tendon was present in 112(47.9%), and shared tendons between the 4th and 5th digits were observed in 67(28.6%) hands. Regarding the left hand, isolated 5th digit FDS tendon was present in 117(50%) hands, while shared tendons were found in 68(29.1%) hands. Significant differences were observed on the left hand when comparing isolated (active) presence of the 5th digit FDS tendon to interconnected presence of the 4th and 5th digit FDS tendons (p=0.032). On the right side, the differences were

Table-2: Prevalence of isolated and interconnected flexor digitorum superficialis (FDS) tendon.

Ethnicity	Right sided FDS			P value	Left sided FDS		
	Isolated FDS Tendon	Interconnected FDS Tendon			Isolated FDS Tendon	Interconnected FDS Tendon	P value
Punjabi	73/163 (44.8%)	51/163 (31.3%)	0.316	75/163 (46.0%)	50/163 (30.7%)	0.032*	
Pathan	11/17 (64.7%)	3/17 (17.6%)		14/17 (82.4%)	2/17 (11.8%)		
Sindhi	6/13 (46.2%)	5/13 (38.5%)		6/13 (46.2%)	6/13 (46.2%)		
Balochi	9/12 (75.0%)	2/12 (16.7%)		7/12 (58.3%)	5/12 (41.7%)		
Karachi origin	13/29 (44.8%)	6/29 (20.7%)		15/29 (51.7%)	5/29 (17.2%)		
Total	112/234 (47.9%)	67/234 (28.6%)		117/234 (50.0%)	68/234 (29.1%)		

*p<0.05, **p<0.001

Laterality of FDS among the ethnic groups

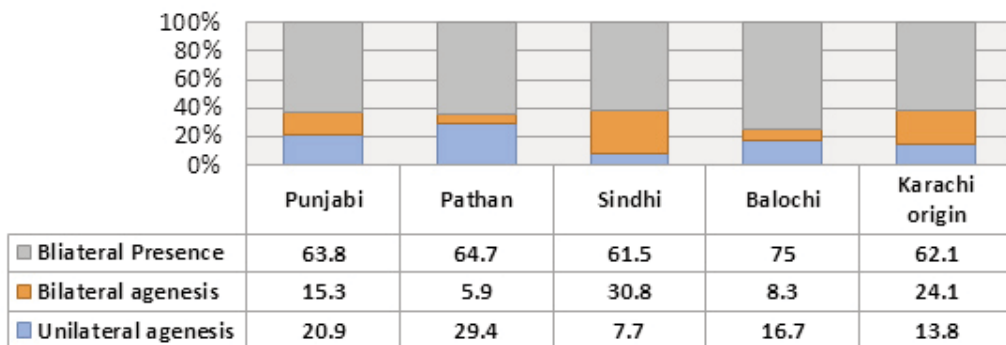


Figure-2: Ethnic groups and laterality of flexor digitorum superficialis (FDS) within them.

not significant (Table 2). Laterality of FDS presence also differed among the ethnic groups (Figure 2).

Discussion

There exists a natural variability in the presence of FDS in the forearm.^{12,13} In the current study,

the overall absence of FDS tendon was observed in 35.8%. A study in Riyadh mentioned analogous total agenesis 36.6%.¹⁴ In comparison to the current results, higher prevalence of agenesis 49.3% was reported by a study conducted in Islamabad and Rawalpindi.¹¹

Across the world, there are variances among the prevalence of agenesis among different ethnicities. The current study also showed a similar trend. A study in Mumbai showed higher prevalence (47.8%) of FDS agenesis, while a Karnataka study found no case of agenesis.^{8,3} Similarly, a research in Antalya reported FDS absence to be 18.5% compared to 23.7% in Istanbul.^{15,16}

In the current study, higher active tendon presence was observed compared to shared tendon. The prevalence of isolated 5th digit FDS tendon presence was 50% and 47.9% on the left and right sides, respectively. Similar to these observations, low frequency of interconnected tendon between the two fingers has been reported, with a study in Japan reporting independent function in 67.5% and another Japan-based study on baseball players documenting 36.2% isolated function in the throwing hand compared to 47.8% in the non-throwing hand.^{17,18}

The current study showed variable frequency for connecting function between the 4th and the 5th fingers FDS, ranging from 11.8% to 46.2% among the different ethnic groups. Tejaswi et al. mentioned lesser level of dependence (5.2%) between the two tendons of ring finger and *digiti minimi*.³ Rafique et al. mentioned the connecting function to be in 22.5% of the study population.¹¹ A European research on FDS reported parallel results with interconnectivity between the two finger tendons (29.9%).¹⁹ Yammine et al. documented 37.5% study subjects to have shared tendons functionality.⁷ A Japan-based research stated the interconnected tendon function to be 32.5%.¹⁷ This clearly depicts the variance in interconnected functionality across the world. An isolated FDS tendon permits for independent flexion at the PIP joint, enhancing dexterity and fine motor skills essential for performing daily activities, like typing or playing musical instruments. Contrarily, interconnected FDS tendons assists in coupled finger movements, possibly restraining precise finger control. These anatomical differences can have an impact on individual's ability to perform tasks needing independent finger movements.

Bilateral agenesis in the current study was 16.2% and unilateral agenesis was witnessed in 19.7%. A study in Saudi Arabia reported comparable results;^{14,8} and 19.9%, respectively.¹⁴ Rafique et al. reported a higher prevalence of bilateral agenesis (23.6%) with a lower unilateral

prevalence (0.96%).¹¹ A study in Mumbai documented higher bilateral absence of FDS (42%).⁸

In the present study, right-sided agenesis (7.7%) was observed to be more than the left-sided (5.6%). Comparable to the current results, Alzharani et al. reported higher prevalence for right (12.1%) than left agenesis (9.7%) in Saudi population.¹⁴ Similarly, a study in Brazil reported analogous prevalence but with higher values with agenesis to be 34.53% and 30.06% on the right and left sides, respectively.²⁰ Other studies across the world have documented more left-sided agenesis.^{11,8,9} A study in Punjab, Pakistan reported a lower prevalence of agenesis 0.9% and 1.1% for right and left forearms, respectively¹¹ while a study in India reported right-sided and left-sided agenesis to be 6.1% and 8.6%, respectively.⁸ A study in Bulgaria documented 24% and 16% left-sided and right-sided FDS agenesis, respectively.⁹

FDS used for operative procedures does not only add biochemical strength, but also improves hand locomotion after the procedure.²¹ The FDS tendon as a graft also works well for extensor muscles injuries involving the radial nerve.²² Clinically, knowledge of prevalence of agenesis of FDS is empirical for the physiotherapists and plastic surgeons.²³ As FDS absence does not affect pinch and grip strength, therefore it is considered an ideal tendon for resection, keeping in mind its superficial anatomical location.²⁴ FDS absence can limit the surgeons' choice to use it for reconstructive operative procedures.^{10,24,25}

The current study has limitations as it was conducted at a single centre, and it did not take into account the genetic linkage of FDS agenesis. Multicentre extensive studies exploring the association of genetic linkage of anatomical variability are needed to validate the current findings.

Conclusion

There existed anatomical variability in terms of prevalence of FDS in the little finger among the ethnic races. Unilateral agenesis was more than bilateral agenesis. Active tendon function was more prevalent than interconnected function.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References

1. Carter JT, Polmear M, Herrera F, Gonzalez G. Bilateral Congenital Absence of Small Finger Flexor *Digitorum Superficialis* Tendons in a Trauma Patient. *Cureus* 2020;12:e6948. doi:

- 10.7759/cureus.6948.
2. Shah S, Verma R, Singh K, Mittal RK, Garg R. Absent palmaris longus with hypoplastic flexor digitorum superficialis of the little finger: A rare case report. *Indian J Case Reports* 2021;7:263-5. DOI: 10.32677/IJCR.2021.v07.i06.014
 3. Tejaswi HL, Anupama MP, Ajay N. Clinical assessment of agenesis of Palmaris Longus and Flexor Digitorum Superficialis in Indian population. *Indian J Forensic Med Toxicol* 2015;9:6-8. DOI : 10.5958/0973-9130.2015.00003.1
 4. Sullivan KM, Dean A, Soe MM. OpenEpi: a web-based epidemiologic and statistical calculator for public health. *Public Health Rep* 2009;124:471-4. doi: 10.1177/003335490912400320.
 5. Emura K, Hirasaki E, Arakawa T. Muscle-tendon arrangement and intramuscular nerve distribution of flexor digitorum superficialis in the siamang (*Symphalangus syndactylus*), western lowland gorilla (*Gorilla gorilla gorilla*), western chimpanzee (*Pan troglodytes verus*), and Japanese macaque (*Macaca fuscata*). *Anat Sci Int* 2023;98:493-505. doi: 10.1007/s12565-023-00713-x.
 6. Maniglio M, Chalmers CE, Thürig G, Passaplan C, Müller C, McGarry MH, et al. The anatomy and function of a bilateral accessory flexor digitorum superficialis muscle: A case report and review of literature. *Morphologie* 2020;104:287-92. doi: 10.1016/j.morpho.2020.06.002.
 7. Yamine K, Erić M. Agenesis, functional deficiency and the common type of the flexor digitorum superficialis of the little finger: A meta-analysis. *Hand Surg Rehabil* 2018;37:77-85. doi: 10.1016/j.hansur.2017.11.007.
 8. Mugalur A, Shahane SM, Samant A, Pathak AC, Patil A, Reddy R. Anatomic variation of palmaris longus and flexor digitorum superficialis of little finger in Indian population. *SICOT J* 2015;1:5. doi: 10.1051/sicotj/2015006.
 9. Popnikolov M, Barzev M, Iliev A, Landzhov B, Georgiev GP. Absence of Palmaris Longus Muscle and Flexor Digitorum Superficialis Muscle Tendon to the Little Finger—Incidence in the Bulgarian Population. *Acta Morphol. Anthropol* 2020;27:73-9.
 10. Erdağı K. The effects of the presence or the absence of flexor digitorum superficialis tendon of the little finger on the handgrip strength of athletes. *Isokinet Exerc Sci* 2020;28:191-7. Doi:10.3233/IES-202103.
 11. Rafique N, Rafique A, Bint Bilal H, Nawaz I, Ali M. Frequency of the agenesis of palmaris longus and flexor digitorum superficialis tendons among individuals. *J Med Sci* 2023;31:132-6. Doi: 10.52764/jms.23.31.2.9.
 12. Belbl M, Kunc V, Kachlik D. Absence of flexor digitorum profundus muscle and variation of flexor digitorum superficialis muscle in a little finger: two case reports. *Surg Radiol Anat* 2020;42:945-9. doi: 10.1007/s00276-020-02420-y.
 13. Zielinska N, Borowski A, Drobniowski M, Olewnik Ł. Coexistence of rare variations of palmaris profundus and flexor superficialis muscle. *Folia Morphol* 2024;83:482-8. doi: 10.5603/FM.a2023.0043.
 14. Alzahrani MT, Almalki MA, Al-Thunayan TA, Almohawis AH, Al Turki AT, Umedani L. Clinical Assessment of the Congenital Absence of Palmaris Longus and Flexor Digitorum Superficialis Muscles in Young Saudi Population. *Anat Res Int* 2017;2017:5342497. doi: 10.1155/2017/5342497.
 15. Guler F, Kose O, Turan A, Baz AB, Akalin S. The prevalence of functional absence of flexor digitorum superficialis to the little finger: a study in a Turkish population. *J Plast Surg Hand Surg* 2013;47:224-7. doi: 10.3109/2000656X.2012.742019.
 16. Irmak F, Yesilada AK, Sirvan SS, Sevim KZ. Prevalence of muscular and tendinous variations of flexor digitorum superficialis and absence of palmaris longus muscle in Turkey: a population study. *Şişli Etfal Hastanesi Tip Bülteni* 2017;51:303-8. DOI: 10.5350/SEMB.20170725042122.
 17. Watanabe Y, Shirato R, Wada T, Iba K, Sonoda T, Yamashita T. Quantitative examination of isolated finger flexion associated with function of the flexor digitorum superficialis. *J Phys Ther Sci* 2020;32:748-53. doi: 10.1589/jpts.32.748.
 18. Masuma H, Kenmoku T, Saito K, Kawabata M, Watanabe H, Miida K, et al. Evaluation of flexor digitorum superficialis function in adolescent baseball players. *JSES Int* 2022;7:143-6. doi: 10.1016/j.jseint.2022.09.009.
 19. Pękala JR, Zarzecki MP, Pękala PA, Ochał M, Walocha JA, Tomaszewski KA. Tendon Variations of the Flexor Digitorum Superficialis of the Little Finger in Cadaveric and Physical Examination Evaluations. *Faseb J* 2019;33:767-26. Doi: 10.1096/fasebj.2019.33.1_supplement.767.26.
 20. Oliveira BM, Fernandes CH, Nakachima LR, Dos Santos JBG, Hirakawa CK, Faloppa F. Prevalence of Absence of Function of the Flexor Digitorum Superficialis Muscle Tendons in the Fourth and Fifth Fingers of the Hand in the Brazilian Population. *Rev Bras Ortop* 2020;55:448-54. doi: 10.1055/s-0039-3402458.
 21. Maslow JI, Posey SL, Habet N, Duemmler M, Odum S, Gaston RG. Central Slip Reconstruction With a Distally Based Flexor Digitorum Superficialis Slip: A Biomechanical Study. *J Hand Surg Am* 2022;47:145-50. doi: 10.1016/j.jhsa.2021.09.010.
 22. Rondon AJ, Aversano MW, Kluemper CT, Pino PA, Kozin SH, Zlotolow DA. Flexor Digitorum Superficialis Tendon Transfer for Wrist Extension. *JBSJ Essent Surg Tech* 2021;11:e21.00011. doi: 10.2106/JBSJ.ST.21.00011.
 23. Lee YK. Anomaly originated flexor digitorum superficialis muscle of the small finger: A case report. *Medicine (Baltimore)* 2023;102:e34566. doi: 10.1097/MD.00000000000034566.
 24. Saied MD, Heshmaty MD, Sadeghifar MD, Ghiassi S, Okati MD. Assessment of the Effect of Variations of Palmaris Longus Tendon and Fifth Superficial Flexor Digitorum on Pinch and Grip Strength. *Iran J Orthop Surg* 2020;13:121-7. Doi: 10.22034/ijos.2020.121300.
 25. Sadeghifar AR, Karbalaiekhani A, Saied AR. An assessment of the effects of variations in the Palmaris longus tendon and the fifth superficial flexor digitorum on pinch and grip strength. *J Back Musculoskelet Rehabil* 2020;33:743-7. doi: 10.3233/BMR-170916.

AUTHOR'S CONTRIBUTION:

QJ: Design, data acquisition, interpretation, drafting, revision, final approval and agreement to be accountable for all aspects of the work.

LU: Drafting, revision, final approval and agreement to be accountable for all aspects of the work.