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Anthropometric values of the vincula tendinum; vincula longa in Nigerian male cadavers

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ABSTRACT

The vincula tendinum of the hands are synovial folds, which connect the tendons of the flexor digitorum profundus and superficialis muscles to the phalanges and interphalangeal articulations of the hand. The vincula system of the hand consists of the vincula brevia and longa. The aim of this study was to document and compare the anthropometric values of the vincula longa of the 2nd to 5th digits, in Nigerian cadavers. Thirty (30) formalin fixed adult male Nigerian cadavers, with no traumatic or surgical evidence in the hand were obtained and the hand dissected. The vincula longa was exposed following dissection procedures as provided by Cunningham's manual of practical anatomy volume 1, and measured with the aid of a digital vernier caliper (mm). Statistical Package for Social Sciences (SPSS) version 23.0 was used for descriptive statistics. Unpaired t-test was used for mean comparison of proximal and distal digit length, and test of symmetry was performed using paired t-test. P< 0.05 was considered statistically significant. The total mean±SD value of the vincula longa in the right index finger was 13.47±3.95mm and 14.52±3.24mm on the left. The value of the vincula longa in the right and left middle fingers were 13.34±3.05mm and 14.24±2.59mm, respectively. The total mean±SD value of the vincula longa in the right and left ring fingers were 11.38±2.49mm and 12.17±2.45mm, respectively. 9.57±2.49mm and 9.57±2.76mm were the mean±SD values of the vincula longa in the right and left little fingers, respectively. It was noted that the values of the proximal vincula longa were greater than those of the distal vincula longa of the same digit, their differences were statistically significant (P<0.05). No statistically significant difference (P>0.05) was observed between the proximal right and left vincula longa of the middle and little fingers, and the distal right and left vincula longa of the little finger. Additionally, statistically significant differences (P>0.05) were observed between the proximal right and left vincula longa of the index and ring fingers, and the distal right and left vincula longa of the index, middle, and ring fingers.

Keywords: *Anthropometry, Digits, Vincula longa, Flexor tendons.*

INTRODUCTION

The human hand is the manual and mechanical part of the upper limb, it consists of the thumb, four fingers and a palm. The hand is unique in being free of habitual locomotor duty and devoted entirely to functions of manipulation. In addition, it relays sensory information about the temperature, the shape and texture of objects to the brain (Moore *et al.,* 2006; Markze, 1971; Blair, 2002). The manipulative skills of the hand are depended upon the muscles of the hand, which include the flexor digitorum superficialis and profundus. The vincula (longa and brevia) are specialized mesotendinous structures containing arteries originating from four digital volar arterial arches which are formed by the anastomoses of the two proper palmar digital arteries on each digit. They connect the tendons of the flexor digitorum profundus and flexor digitorum superficialis (FDP and FDS) muscles to the phalanges and interphalangeal articulations of the hand. They also provide support and transmit vessels to the flexor tendons. In addition, the vincula longa, are more variable in arrangement, they are filiform slips that extend to the dorsal aspect of the tendons. The vincula brevia, are a more constant feature, they arise as triangular bands and join near the insertions of each flexor tendon (Stewart *et al.,* 2007; Naredo *et al.,* 2023; Guler and McGrouther, 1992; Bachoura *et al.,* 2017; Shao *et al.,* 1995; Armenta and Lehrman, 1980; Flindall and McGrouther, 1991). Stewart *et al.,* (2007) suggested that the vincula can in some circumstances affect the mechanics of digital flexion of the hand.

Clinically, the intact vincula can minimize tendon retraction after flexor tendon injuries (Stewart *et al*., 2007). Previous study done by Naredo *et al.*, (2023) suggested that, the vincula system and other anatomical structures located between the flexor tendons and the phalanges could be potentially inflamed in Psoriatic Arthritis (PsA) dactylitis producing an ultrasound image of tissue inflammation similar to that of tenosynovitis (Naredo *et al*., 2023). Previous studies analyzing the anatomical structures and imaging details designated the digital flexor tendons vincula system as an entity connecting the palmar and articular/digital arterial vascular system with a transitional synovium layer and with the flexor tendon sheath (Armenta and Lehrman, 1980; Cohen and Kaplan, 1987; Micu and García-de-Pereda-Notario, 2023).

There are previous documentations that gives clear description of the anatomy of the vincula system and its Biomechanical significant on digital motion (Stewart *et al.*, 2007; Chaurasia, 2020; Micu and García-de-Pereda-Notario, 2023; Guler and McGrouther, 1992). However, there are few documentations on the anthropometric values of the vincula longa. This study aims at documenting and comparing the anthropometric values of the vincula longa of the 2^{nd} to 5^{th} digits, in Nigerian cadavers.

MATERIALS AND METHODS

For the purpose of this study, thirty (30) formalin fixed adult male cadavers of undetermined age were dissected. The dissected specimens were procured from the Departments of Anatomy of the University of Port Harcourt, Rivers State University and Bayelsa Medical University, all located in South Southern Nigeria. Only adult cadavers with no traumatic or surgical evidence in the hands, particularly the fingers, were used for this study.

The following dissection procedures were followed to expose the vincula longa: Make a vertical incision from the tip of the finger to the midpoint of the bottom crease; strip the skin and superficial fascia from the deep fascia by blunt dissection; identify and follow the proper palmar digital arteries which accompany the nerves; divide the fibrous flexor sheath longitudinally. Note it is thick at the level of the bodies of the phalanges and relatively thin opposite the joints. Examine the extent of the digital synovial sheath; lift the tendons of the flexor digitorum superficialis and profundus within the digital sheath, to expose the vinculae passing between them and the outer layer of the synovial sheath on the phalanges (Koshi, 2017).

The superficial or proximal and deep or distal vincula longa were exposed and measured. All measurements were taken in millimeters (mm) with the aid of a digital vernier caliper. The measurements were carefully done to ensure accuracy and reliability of data. The data obtained was subjected to Statistical Package for Social Sciences (SPSS) version 23.0 for descriptive statistics. Inferentially, unpaired t-test was used for mean comparison of proximal and distal digit length, and test of symmetry was performed using paired t-test. $P< 0.05$ was considered statistically significant.

RESULTS

The data obtained from the anthropometric lengths of the vincula longa were analyzed statistically and the resultant observations were presented in table 1-6.

Table 1: Descriptive statistics of vincula longa of right hand in Nigerian cadavers

Right Digit Length	Digit Type	N	Minimum	Maximum	Mean±SD (mm)
Index	Proximal	30	10.60	20.33	15.23±3.62
	Distal	30	6.94	18.28	11.72±3.51
	Total	60	6.94	20.33	13.47±3.95
middle	Proximal	28	12.00	18.10	14.88±2.15
	Distal	28	6.00	17.81	11.80±3.06
	Total	56	6.00	18.10	13.34±3.05
Ring	Proximal	30	5.36	15.83	12.74±2.16
	Distal	30	5.20	13.13	10.02±2.04
	Total	60	5.20	15.83	11.38±2.49
Little	Proximal	30	4.82	18.45	10.58±2.48
	Distal	29	4.72	16.20	8.53±2.07
	Total	59	4.72	18.45	9.57±2.49

N*= Number of subjects,* ***SD****= Standard deviation,* ***mm****= millimeters*

Table 2: Descriptive statistics of vincula longa of left hand in Nigerian cadavers

Left Digit Length	Digit Type	N	Minimum	Maximum	Mean±SD (mm)
Index	Proximal	29	10.13	20.30	15.53±3.15
	Distal	29	9.34	18.51	13.52±3.05
	Total	58	9.34	20.30	14.52±3.24
middle	Proximal	29	11.99	18.12	15.27±1.85
	Distal	28	9.15	17.85	13.17±2.84
	Total	57	9.15	18.12	14.24±2.59
Ring	Proximal	29	10.22	15.11	13.11±2.79
	Distal	29	8.21	13.90	11.23±1.63
	Total	58	8.21	15.11	12.17±2.45
Litte	Proximal	29	8.00	15.78	10.46±2.62
	Distal	29	5.78	14.74	8.67±2.65
	Total	58	5.78	15.78	9.57±2.76

N*= Number of subjects,* ***SD****= Standard deviation,* ***mm****= millimeters*

Table 3: Test of comparison for right proximal and distal vincula longa in Nigerian cadavers using unpaired t-test.

Right Digit Length	MD	SE	95% C.I of the difference		df	t-value	P-value
			Lower	Upper			
Index	3.51	0.92	1.67	5.35	58.00	3.81	**0.00***
Middle	3.08	0.71	1.66	4.50	54.00	4.36	**0.00***
Ring	2.72	0.54	1.63	3.80	58.00	5.00	**0.00***
Little	2.04	0.60	0.85	3.24	57.00	3.43	**0.00***

= Significant at P<0.05,* ***MD* *= Mean difference,* ***C.I****= Confidence interval,* ***df****= Degree of freedom,* ***SE****= Standard error*

Table 4: Test of comparison for left proximal and distal vincula longa in Nigerian cadavers using unpaired t-test

Right Digit Length	MD	SE	95% C.I of the difference		df	t-value	P-value
			Lower	Upper			
Index	2.02	0.81	0.38	3.65	56.00	2.48	**0.02***
Middle	2.10	0.64	0.81	3.38	46.15	3.29	**0.00***
Ring	2.33	0.38	1.58	3.08	56.00	6.21	**0.00***
Little	1.80	0.69	0.41	3.18	56.00	2.60	**0.01***

= Significant at P<0.05, **MD = Mean difference, **C.I**= Confidence interval, **df**= Degree of freedom, **SE**= Standard error*

Table 5: Test of symmetry for proximal right and left vincula longa in Nigerian cadavers using paired t-test

Proximal digit comparison	Paired differences			95% C.I of the differences		Paired t-test		
	MD	SD	SE	Lower	Upper	df	t-value	P-value
Right vs left index finger	-0.48	1.17	0.22	-0.92	-0.03	28.00	-2.19	**0.04***
Right vs left middle finger	-0.48	1.30	0.25	-0.99	0.03	26.00	-1.92	0.07
Right vs left ring finger	-0.91	2.34	0.44	-1.81	-0.02	28.00	-2.10	**0.04***
Right vs left little finger	0.18	3.02	0.56	-0.97	1.33	28.00	0.32	0.75

= Significant at P<0.05, **MD = Mean difference, **C.I**= Confidence interval, **df**= Degree of freedom, **SD**= Standard deviation, **SE**= Standard error*

Table 6: Test of symmetry for distal right and left vincula longa in Nigerian cadavers using paired t-test

Proximal digit comparison	Paired differences			95% C.I of the differences		Paired t-test		
	MD	SD	SE	Lower	Upper	df	t-value	P-value
Right vs left index finger	-1.76	2.50	0.46	-2.71	-0.81	28.00	-3.79	**0.00***
Right vs left middle finger	-1.37	1.88	0.35	-2.10	-0.65	27.00	-3.87	**0.00***
Right vs left ring finger	-1.32	2.28	0.42	-2.18	-0.45	28.00	-3.11	**0.00***
Right vs left little finger	-0.07	3.02	0.57	-1.25	1.10	27.00	-0.13	0.90

= Significant at P<0.05, **MD = Mean difference, **C.I**= Confidence interval, **df**= Degree of freedom, **SD**= Standard deviation, **SE**= Standard error*

DISCUSSION

This study statistically analyzed and compared the vincula longa anthropometric values of the 2nd to 5th digits of the hand. In the results of the present study, the descriptive characteristics of the right and left parameters are showed in table 1 and 2 respectively. The mean±SD value of the proximal vincula longa of the index finger was 15.23±3.62mm on the right and 15.53±3.15mm on the left (Table 1-2), with the left having a greater value. The test of symmetry for the proximal vincula longa of the right and left index fingers, showed a negative t-value (-2.19) and it was statistically significant (P<0.05) (Table 5). Additionally, the mean±SD value of the distal vincula longa of the index finger was 11.72±3.51mm on the right and 13.52±3.05mm on the left (Table 1-2), the left is significantly larger. The test of symmetry for the distal vincula longa of the right and left index fingers, showed a negative t-value (-3.79) and it was statistically significant (P<0.05) (Table 6). The test of comparison for right proximal and distal vincula longa (Table 3), and left proximal and distal vincula longa lengths (Table 4) of the index fingers, both showed statistically significant differences (P<0.05). Additionally, in the present study the total mean±SD of the vincula longa of the index finger was 13.47±3.95mm on the right, and 14.52±3.24mm on the left. Yalin et al., (1994) reported the average length of the vinculae longum for the index fingers to be 9.6mm (0.96 cm), which is significantly lesser than the result of the present study. In the present study, the vincula longa of the index finger was also observed to have greater values on the left than the right.

From this study, it can be noted that the mean±SD value of the proximal vincula longa of the middle finger was 14.88±2.15mm on the right and 15.27±1.85mm on the left (Table 1-2), the value on the left is significantly larger than the right. In addition, the test of symmetry for the proximal vincula longa of the right and left middle fingers, showed a negative t-value (-1.92) and there was not statistically significant difference observed (P>0.05) (Table 5). The mean±SD value of the distal vincula longa of the middle finger was 11.80±3.06mm on the right and 13.17±2.84mm on the left (Table 1-2). It was noted that the value of the left distal vincula longa of the middle finger was significantly larger than the right. The test of symmetry for the distal vincula longa of the right and left middle fingers, showed a negative t-value (-3.87) and it was statistically significant (P<0.05) (Table 6). The test of comparison for right proximal and distal vincula longa (Table 3), and left proximal and distal vincula longa lengths (Table 4) of the middle fingers, using unpaired t-test, both showed statistically significant differences (P<0.05).

It was reported in the study done by Yalin et al., (1994) that the average length of the vinculae longum for the ring fingers were 9.7mm (0.97 cm). However, in the present study the mean±SD value of the proximal vincula longa of the ring finger was observed to be 12.74±2.16mm on the right and 13.11±2.79mm on the left (Table 1-2), with the left having a greater value. The test of symmetry for the proximal vincula longa of the right and left ring fingers, were observed to have a negative t-value (-2.10) and there was a statistically significant difference observed ($P<0.05$) (Table 5). The mean±SD value of the distal vincula longa of the ring finger was 10.02±2.04mm on the right and 11.23±1.63mm on the left (Table 1-2), the value on the left is significantly larger than the right. The test of symmetry for the distal vincula longa of the right and left ring fingers, showed a negative t-value (-3.11) and it was statistically significant ($P<0.05$) (Table 6). The test of comparison for right proximal and distal vincula longa (Table 3), and left proximal and distal vincula longa lengths (Table 4) of the ring fingers, using unpaired t-test, both showed statistically significant differences ($P<0.05$).

In the present study, the right proximal vincula longa of the little finger had a mean±SD reading of 10.58±2.48mm (Table 1), while the left proximal vincula longa was 10.46±2.62mm (Table 2), having no analytical gap in significance ($p>0.05$) and a positive t-value (0.32) (Table 5). It was observed that the value of the right distal vincula longa of the little finger was significantly larger than the left. The mean±SD value of the distal vincula longa of the little finger was 8.53±2.07mm on the right and 8.67±2.65mm on the left (Table 1-2), the value on the left is significantly larger than the right. The test of symmetry for the distal vincula longa of the right and left little fingers had a negative t-value (-0.13) and there was no statistically significant difference observed ($P<0.05$) (Table 6). The test of comparison for right proximal and distal vincula longa (Table 3), and left proximal and distal vincula longa lengths (Table 4) of the little fingers, using unpaired t-test, both showed statistically significant differences ($P<0.05$).

In all measured parameters, the anthropometric values on the left hand were greater than those on right hand, except for the right proximal vincula longa of the little finger which was greater than the left. In addition, it was only in the little finger where no statistically significant differences ($P>0.05$) were observed in all its test of symmetry (Table 5-6). The results of this study can serve as a great tool to surgeons and clinicians in carrying out reconstructive surgeries in the digits of the hand, that are related to the flexor digitorum tendon and vincula. In addition, the findings of

this study can also serve as a basis for future research into the functional and biomechanical properties of the vincula brevia, and their role in hand movements and dexterity.

CONCLUSION

From the results of this study, a major conclusion is that the anthropometric values of the vincula longa of the digits on the left hand are greater than those on the right hand, and the values of the proximal vincula longa are greater than those of the distal vincula longa of the same digit. Additionally, there are statistically significant differences ($P<0.05$) between the proximal and distal vincula longa of the same digit by lateralization.

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CONFLICT OF INTEREST**:** There is no conflict of interest.

AUTHOR'S CONTRIBUTION**:** All the authors contributed to the various components of the study such as study design, work, statistical analysis and manuscript writing.

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