FOLIA MEDICA CRACOVIENSIA
Vol. LXII, 1, 2022: 5–17
PL ISSN 0015-5616
DOI: 10.24425/fmc.2022.141687

Typology of flexor carpi radialis muscle in human fetuses

Małgorzata Suchanecka[1], Katarzyna Siwek[1], Jacek Ciach[1],
Krzysztof Eicke[1], Victoria Tarkowski[2]

[1]Division of Anatomy, Department of Human Morphology and Embryology, Wroclaw Medical University
[2]Clinical and Dissecting Anatomy Students Scientific Club, Wroclaw Medical University

Corresponding author: Katarzyna Siwek, Ph.D.
Division of Anatomy, Wroclaw Medical University
wyb. Ludwika Pasteura 1, 50-367 Wrocław, Poland
Phone: +48 717 841 331; Fax: +48 717 840 079; E-mail: katarzyna.siwek@umw.edu.pl

Abstract: Introduction: The musculus flexor carpi radialis (FCR) is a muscle with an important function for the mechanics and physiology of the hand. Its isolation during intrauterine development occurs relatively late, which may result in the presence of high variability during the fetal period.
The aim of this study is to determine the detailed typology of FCR in the fetal period based on the available material.
Material and Methods: A total of 114 human fetuses (53 female, 61 male) aged between 117.0 and 197.0 days of fetal life were included in the study. The research material was derived from the collections of the Department of Anatomy, Medical University of Wrocław. Fetuses were stored in typical conservation solvents. The study incorporated the following methods: anthropological, preparational, and image acquisition, which was obtained using an innovative digital microscope. Statistical analysis was performed using R software.
Results: The typology of FCR was determined based on the characteristics of the distal attachment of the investigated muscle. The statistical analysis revealed a predominance of type I in the examined fetal material — the attachment located on metacarpal bone II (about 82% of cases). Type IV (attachment to the 4th metacarpal bone) occurs with a frequency of less than 10% and the remaining types II and III occur with a frequency of 4–6%.
The statistical analysis did not reveal bilateral or dimorphic differences in the prevalence of each FCR type. In respect of the collected anthropometric parameters, no statistically significant dimorphic differences were revealed. For a more complete description, the FCR proportionality index was introduced. The mean value of this index was 0.6 and was independent of the side or sex of the analyzed fetus.
Conclusions: FCR in the fetal period is characterized by a stable course in both the proximal and distal attachments.

Keywords: fetal anatomy, forearm, morphology, flexor compartment, flexor carpi radialis.

Submitted: 02-Dec-2021; **Accepted in the final form:** 10-Feb-2022; **Published:** 29-Jun-2022.

Introduction

The flexor carpi radialis (FCR) muscle is one of the significant muscles of the forearm [1]. It typically begins with a common proximal attachment with other forearm flexors within the medial epicondyle of the humerus. The belly is located on the lateral side of the forearm, initially between the bellies of the pronator teres and palmaris longus muscles [2]. In the distal part of the forearm, the FCR passes into the terminal tendon, which passes beyond the flexor retinaculum through the furrow of the trapezium bone and usually ends at the base of the 2nd metacarpal bone [3, 4]. The function of the muscle is to flex and abduct the wrist.

In man, as a result of multistage changes linked to evolution, the upper limb has changed its character from supportive to manipulative [5, 6]. The musculoskeletal system of the upper limb meets these requirements through the precise integration of many tissues. This coordination takes place at an early stage of development during the induction of differentiation and embryonic growth [7]. The available scientific data indicates that upper limb development is significantly different depending on its topography [8]. The proximal part of the limb develops faster and the distal part significantly slower [9]. At the point of separation of muscles such as biceps brachii or triceps brachii, the muscles of the forearm are still a common muscular mass. Subsequent separation of the forearm muscles can potentially be associated with their greater variability [10]. However, one of the first muscles to separate into this group is the FCR. Perhaps this underlies the relatively high stability of its course as demonstrated on material from *maturus/senilis* individuals [11]. The stability of the course and the proximal as well as distal attachment of the FCR is emphasised by many authors of historical scientific papers from the turn of the 20th century [12, 13]. It is likely that these data underlie the relatively few publications analysing the anatomy of the FCR.

However, recent clinical data indicate the importance of pathologies associated with FCR dysfunction [14, 15]. Furthermore, the terminal tendon of the muscle is recognised as an important component in stabilising the intercarpal joints — especially on the radial side. It may therefore have a role in hand physiology [1]. In the light of the presented scientific data, an attempt was made to assess the anatomical variability of FCR. Due to very limited access to cadavers of mature individuals, it was decided to conduct such an analysis on the basis of foetal material.

An important reason for choosing such a material is the fact that FCR develops much later, which may result in the presence of greater variability in muscle anatomy [10].

The aim of the study is to determine the typology and morphometry of the flexor carpi radialis muscle in human fetuses.

Material and Methods

A total of 114 human fetuses (53 female, 61 male) aged 117.0 to 197.0 days of fetal life were recruited for the study. All specimens were obtained from the collection of human fetuses stored in the prenatal laboratory of the local Department of Anatomy. Basic metric data describing the study population are included in Table 1. The whole material was acquired from local university clinics between 1960 and 1996. The fetuses were derived from unexpected preterm births or miscarriages. The course of delivery as well as the decision to stop fetal resuscitation was made by a study-independent medical team. A suitable preservation fluid containing ethyl alcohol, glycerol, and formaldehyde was used to store the fetuses in fixed proportions. The material was stored in a dedicated blacked-out room at a constant temperature. The methodology for storage and preservation of the material did not change throughout the period from the acquisition of the material to its use for scientific purposes [16–22].

Table 1. Basic metric characteristics of the study material (v-pl — Vertex plantare; v-tub — Vertex tuberale, total x — analysis of whole material, p — probability value, F — female, M — male).

	Total X	Total X CI 95%	Male X	Male X CI 95%	Female X	Female X CI 95%	p (M vs F)
Morphological age [days]	177.8	(175.58; 180.28)	177	173–182	179	176–181	0.879
Calendar age [days]	166.63	(159.90; 173.35)	158	147–168	175	167–183	0.596
Body mass [g]	537.18	(501.22; 573.15)	536	488–585	538	482–593	0.782
v-pl [mm]	288.00	(280.04; 295.96)	287	276–299	288	276–300	0.636
v-tub [mm]	204.02	(197.54; 210.50)	206	195–217	202	195–209	0.924

The study was conducted between October 2020 and July 2021. Dissections were carried out using classical anatomical techniques. After stabilizing the upper limb, the skin and subcutaneous tissue were removed in the first step (Fig. 1a, 1b). The fascia was visualized and followed by opening of the flexor compartment of the forearm (Fig. 1c). In the next step, available metric relevant anthropometric points were observed. This was followed by a detailed dissection of FCR (Fig. 1d). In the next stage, metric measurements were taken and the location of the initial and final attachment of the muscle was assessed (Fig. 1e, 1f).

The individual phases of dissection were documented with schematic drawings and photographs. Photographs were taken using a digital system from Tagarno Prestige (Tagarno Innovision A/S, Denmark) and a Sony Alfa 7II digital camera (Minato, Tokyo, Japan) stabilised on a Manfrotto tripod (Vitec Group, Richmond, UK). Metric

Fig. 1. Stages of preparative access to the flexor carpi radialis muscle (FCR) in human fetuses **a** — fetal upper limb; **b** — fetal upper limb — state after removal of skin and subcutaneous tissue; **c** — fetal upper limb — opened anterior compartment of the forearm; **d** — fetal upper limb — visible musculus flexor carpi radialis; **e** — fetal upper limb — visible initial attachment of FCR; **f** — fetal upper limb — visible terminal attachment of FCR.

measurements were taken using a Mitutoyo Absolute Digimatic digital caliper (Mitutoyo Corporation, Kanagawa, Japan). Each metric measurement was taken three times by two independent observers (KS, KE) and then an overall mean was calculated, which was the basis for further analysis. Statistical analysis was conducted using R-Project software (The R Foundation for Statistical Computing, Vienna, Austria).

The entire study protocol was approved by the local bioethics committee (KB167/21).

Statistical methods

Data source

Data of each fetus was obtained from two sources:

- numerical variables (27): information from a fetus' record card: morphological age, calendar age, body mass, total body length (v-pl), crown-rump length (v-tub) and direct measurements with a certified and validated caliper (Fig. 2),
- categorical variables (3): sex and a type of insertion of FCR on left and right upper limb

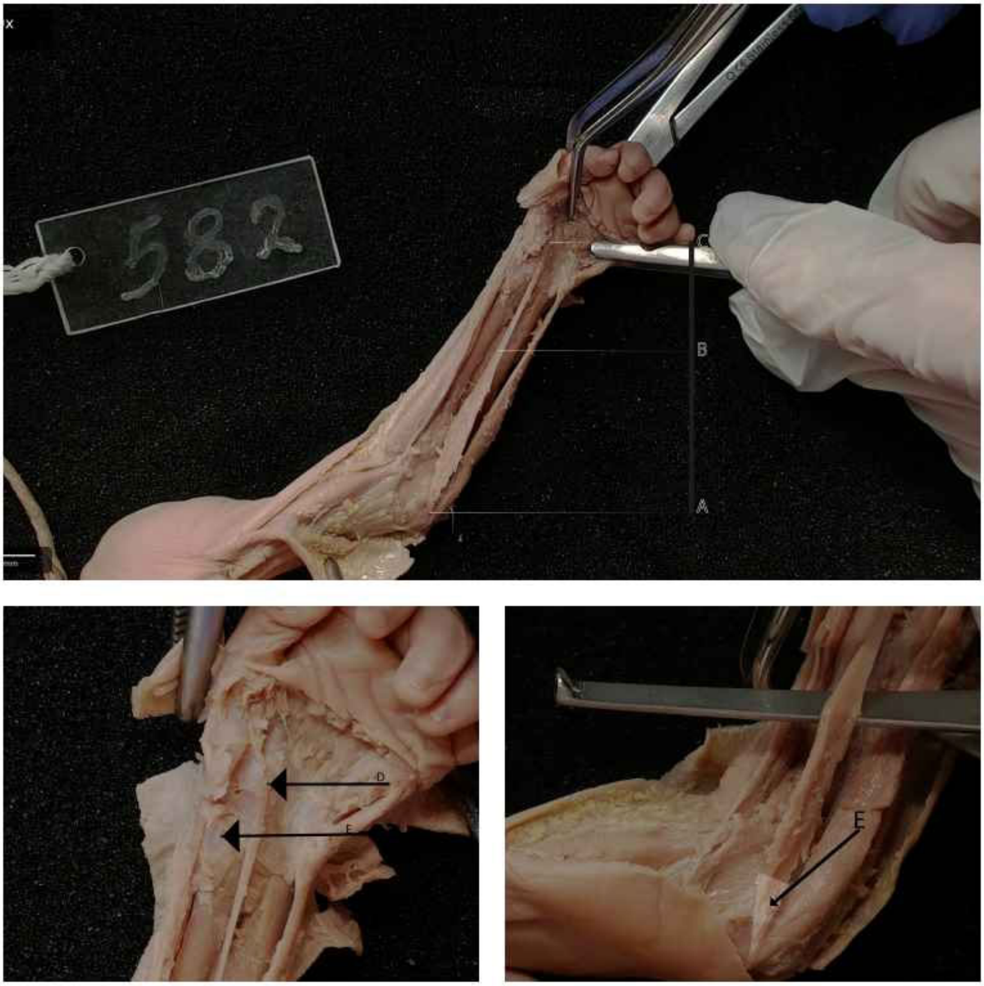

Fig. 2. Measuring points related to the study. Top photo (A — measuring point of the initial attachment; B — measuring point of the border between the FCR belly and the tendon; C — measuring point of the terminal attachment); bottom left photo (D — FCR attachment on metacarpal bone II; E — anthropometric point of radiale); bottom right photo (E — FCR initial attachment area).

Mathematical methods

A significance level of $\alpha = 0.05$ was assumed. All collected numerical values were summarized using: mean, median, min, max and 95% CI for mean. A Shapiro–Wilk test was performed for each variable in order to check if it's normally distributed. The same calculations were performed after dividing the data into two groups: females and males. A comparison between sexes was done with a Mann–Whitney test (because most of the variables was not distributed normally). Measurements of the left upper limb were compared against measurements of the right upper limb using Wilcoxon signed rank test. Linear regression coefficients between respective variables of left and right side was also calculated. We didn't assume a priori any correlations in each pair of 27 numeric variables: our aim was to find such. For each unique pair of collected variables a scatter plot with a linear regression line was generated. The number of created plots was large: $\binom{27}{7} = 351$, so we decided to take into account only these with a significant Pearson's correlation test and the correlation coefficient $|r| \geq 0.85$ (a threshold chosen arbitrary).

For every computation of linear regresssion coefficients, values outside an interval $(x - 3s; x + 3s)$, where x and s are, respectively, a sample mean and standard deviation, were discarded in order to reduce the influence of measurement errors.

A distribution of FCR insertion types was calculated and tested with a chi-square goodness of fit test against a null hypothesis that each type is equally possible. Then chi-square homogeneity tests for FCR insertion types were performed in order to compare counts of types: left versus right upper limb, female versus male fetuses for separately left and right upper limb.

Results

Results

The basic statistics of the examined group indicate the absence of gender differences in the analyzed material (Table 1).

A new typology of the muscle was proposed based on its characteristic distal attachment:

Type 1 — typical attachment to the 2nd metacarpal bone (Fig. 3a)
Type 2 — attachment to the trapezium bone (Fig. 3b)
Type 3 — attachment to the III metacarpal bone (Fig. 3c)
3a – lateral adhesion to III metacarpal bone
3b – medial adhesion to III metacarpal bone
Type 4 — attachment to the IV metacarpal bone (Fig. 3d)
4a – lateral adhesion to the IV metacarpal bone
4b – medial adhesion to IV metacarpal bone

It has been shown that type 1 is predominant in the majority of cases. The other types occur with a statistically significantly lower frequency than type 1 (Fig. 4).

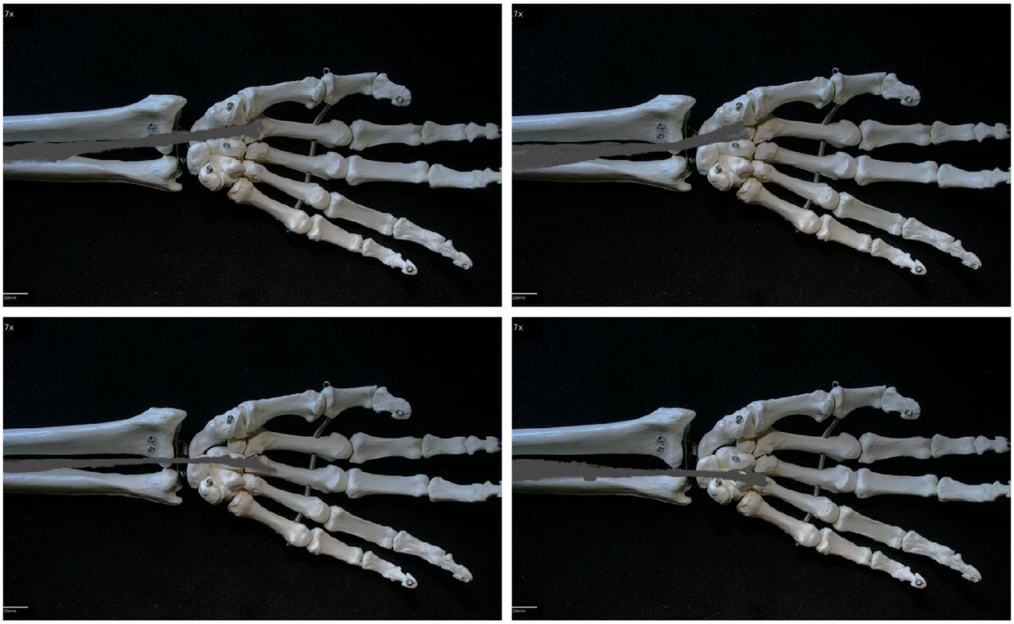

Fig. 3. Flexor carpi radialis types.

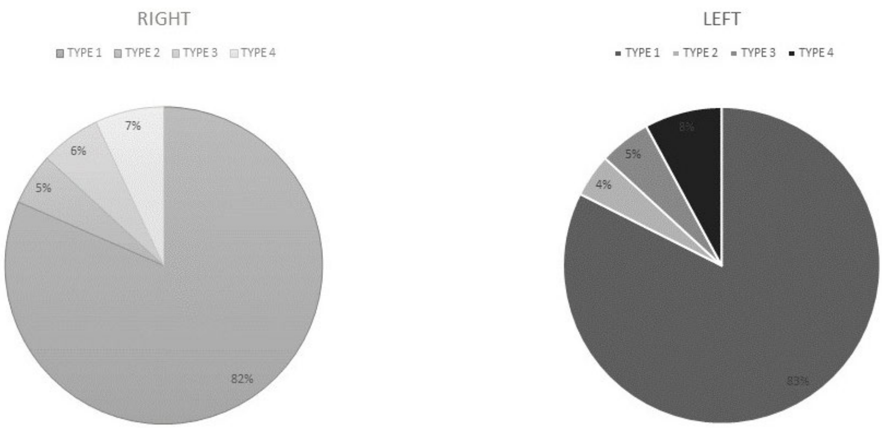

Fig. 4. Prevalence of different types of flexor carpi radialis muscle.

Categorical variables

A detailed statistical analysis of all categorical variables was carried out based on the established typology. The chi-square tests, demonstrating infinitesimal p-values, rejected that types of FCR insertions are equally distributed, both in left and right upper limb.

A comparison of FCR insertion types between left and right upper limb showed no significant difference between counts of each type. This statement holds as well if the comparison is performed separately for males or females.

Numerical variables

For the most of numerical variables, Shapiro–Wilk tests rejected the null hypothesis that the variables are normally distributed. However, interestingly, this does not apply to females fetuses, in which for approximately half of the variables the normality test failed to reject the null hypothesis.

Further statistical tests rejected the hypothesis assuming a difference between females and males for each of 27 numerical variables. Notably, most of the calculated p-values were very close or even equal to 1.0 (Table 2).

Table 2. Metric characteristics of the study group (FCR — flexor carpi radialis, p — probability value, F — female, M — male, L — left, R — right).

	Body side	**X [mm]**	**p (F vs M) (Mann–Whitney test)**	**p (L vs R) (Wilcoxon signed rank test)**
Total lenght FCR	**right**	48.08	1.000	0.007
	left	48.60	1.000	
Length of FCR belly	**right**	26.39	1.000	0.048
	left	26.76	1.000	
Length of FCR tendon	**right**	21.78	1.000	0.781
	left	22.35	1.000	
Arm length	**right**	54.97	1.000	0.48
	left	54.82	1.000	
Forearm length	**right**	43.87	1.000	0.013
	left	44.27	1.000	
Upper extremity length	**right**	115.43	1.000	0.057
	left	115.08	1.000	
Elbow width	**right**	11.8	1.000	0.06
	left	11.7	1.000	
Wrist width	**right**	10.31	1.000	0.85
	left	10.27	1.000	

Comparisons of left upper limb versus right upper limb measurements demonstrated significant differences in a few numerical variables (Table 2). For each measurement pair of analogous quantities in left and right upper limb, a scatter plot with an added linear regression line was created. All 11 plots showed a strong (r >0.85) positive linear relationship.

Our attempt to find meaningful relationships between other quantities was successful. From 351 of analyzed variable pairs we found 26 pairs which showed a statistically significant strong positive linear relationship. For example, a statistically significant strong correlation was found between: total muscle length and wrist width (r = 0.85), total muscle length and hand length (r = 0.86), total muscle length and arm length (r = 0.89) and total muscle length and forearm length (r = 0.86).

Interestingly, among these 26 relationships there is only one in which a fetus mass is present—the correlation between v-tub (vertex-tuberale diameter) and fetal weight (r = 0.86).

Additionally, the relationship between the metric parameters of muscle and bone dimensions was analyzed. For a more complete description based on Loth's work [11, 12], the FCR proportionality index (I) was introduced according to the formula:

$$I = \frac{M \times 100}{FR}$$

Where M is the muscle belly length and FR is the forearm length (radial-stylion). The value of this index was 0.6 and was not correlated with body side ($p = 0.7$) or gender ($p = 0.65$).

Discussion

In recent years, due to limited access to anatomical specimens of maturus/senilis individuals, there has been an increased demand to search for alternative resources of anatomical specimens [23, 24]. Fetal collections accumulated in many anatomical laboratories in the 19th and 20th centuries are one such source [22, 25, 26].

Fetal material, due to its much smaller size, is easier to store. Therefore, it is possible to collect a large number of fetuses, which increases the chances of conducting a reliable statistical analysis of the obtained results.

In the case of the present study, anatomical analyses were performed based on 114 fetuses from the local anatomical collection.

Our analyses demonstrated a stable course of the musculus flexor carpi radialis, which follows the standard textbook description. The initial attachment in all cases is typical, and the terminal tendon attaches standardly to the 2nd metacarpal bone in about 80% of cases. Similar observations are shown by Loth and Wood who evaluate FCR on adult material [11, 13].

Loth states in one of his publications that the FCR does not anthropologically represent anything interesting. In modern scientific language, this can be restated as the FCR being a muscle with a stable course and attachments [12]. In the case of modern authors, a similar statement to Loth is made by Potu *et al.* who analyzed 37 limbs and found no significant differences in FCR attachments [2]. It should be noted, however, that the current publication demonstrates the presence of variability in the terminal attachment of the FCR. It has been shown that in a few percent of cases, the FCR attaches to one of the carpal bones or independently to the 3rd or 4th metacarpal bone.

Our observations are indirectly confirmed by European and American authors.

Lantieri *et al.* [27] have shown in a morphological analysis of 25 limbs of *maturus* specimens that the FCR attaches jointly to the 2nd and 3rd metacarpal bones, with the dominant attachment on the 2nd metacarpal bone and only single fibers penetrating to the 3rd metacarpal bone. They also showed that in 48% of samples there is an additional or independent attachment on the trapezium bone.

However, it should be noted that when analyzing the fetal material we did not show a common attachment to both metacarpal bones. In addition, an attachment to the trapezium was present in a minority of cases.

On the other hand, Bishop showed that FCR attaches in 77% to the 2nd metacarpal bone and in the remaining cases to 3rd metacarpal bone. He also described isolated cases of attachment to the trapezial crest [28].

Thus, there are descriptions in the world literature attesting to the presence of independent terminal attachments of FCR to the 2nd or 3rd metacarpal bone.

The stable course of FCR demonstrated and confirmed in adult-based work is clinically important when surgical intervention is required in the distal part of the upper limb.

The available literature explains that the muscle's stable position is related to its important role in the proper function of the wrist joints [29].

It is difficult to determine the reason for the demonstrated asymmetry. In the past, several studies have also shown this kind of variability [30, 31]. However, these studies considered that the indicated asymmetry was due to measurement error. In the case of this study, it is important to note that the measurements were made by two independent researchers and the average of all acquired data was taken for analysis. In addition, statistical tests were used, which are characterized by resistance to large measurement errors. Therefore, it can be indirectly concluded that the measurement error is not the primary cause of the demonstrated asymmetry. This study demonstrated that the right limb is the longer one in selected parameters.

Perhaps this indicates the beginning of lateralisation of the brain and greater activity of the right upper limb in utero (e.g., more frequent thumb sucking) [32, 33]. In our opinion, the reason is much more trivial, and is due to the positioning of the limbs in limited uterine volume, or the influence of pathological factors that triggered the premature termination of pregnancy.

However, recent publications suggest that the reason may lie in the fact that all the changes caused by different physical factors during development can cause developmental defects [34]. In conclusion, however, it must be emphasized, following Żytkowski *et al.* [35] that a clear distinction must be made between anatomical variation which, despite being outside the norm, is still a valid although atypical structure and clinical anomalies, behind which lie organ or limb dysfunction or disease.

Due to the demonstrated significant statistical bilateral differences in selected parameters, the authors of this study focused on the evaluation of the newly developed FCR typology. The aspect of demonstrated asymmetry will be further investigated using the widest possible fetal material.

Limitations

1. Limited access to material. It was not possible to undertake an anatomical analysis linking the proposed typology to the age classes of the fetuses due to limited access to good quality anatomical specimens at ages younger than 117 days of fetal life.
2. The method of preservation of the material, which adversely affects selected parameters of the fetuses.

Acknowledgements

The authors would like to thank Mrs Alina Proniewicz for her help in the project. According to the new recommendations [36] all authors sincerely thank those who donated their bodies to the science so that anatomical research could be perfomed. Results from such research can potentially increase mankind/s overall knowledge that can then improve patient care. Therefore these donors and their families deserve our highest gratitude.

The study was supported by the statutory grant SUB.A350.21.070 under the supervision of Katarzyna Siwek.

Conflict of interest

None declared.

References

1. *Salvà-Coll G., Garcia-Elias M., Llusá-Pérez M., et al.*: The role of the flexor carpi radialis muscle in scapholunate instability. J Hand Surg Am. 2011; 36: 31–36.
2. *Potu B.K., Kumar V., Annam S., et al.*: A morphometric study on flexor carpi radialis muscle of the forearm: A cadaveric study. Morphologie. 2016; 100: 12–16.
3. *Reimann A.F., Daseler E.H., Anson B.J., et al.*: The palmaris longus muscle and tendon. A study of 1600 extremities. Anat Rec. 1944; 89: 495–505.
4. *Olewnik Ł., Wysiadecki G., Polguj M., et al.*: Anatomical variations of the palmaris longus muscle including its relation to the median nerve — A proposal for a new classification. BMC Musculoskelet Disord. 2017; 18.
5. *Skinner M.M., Stephens N.B., Tsegai Z.J., et al.*: Human evolution. Human-like hand use in Australopithecus africanus. Science. 2015; 347: 395–399.
6. *Marzke M.W.*: Precision grips, hand morphology, and tools. Am J Phys Anthropol. 1997; 102: 91–110.
7. *Huang A.H., Riordan T.J., Pryce B., et al.*: Musculoskeletal integration at the wrist underlies the modular development of limb tendons. Dev. 2015; 142: 2431–2441.
8. *Piccari Scarpa G.G., Marchini M., Nicoletti P.*: Osservazioni Sullo Sviluppo Dell'articolazione Scapoloomerale Nell'uomo, Con Particolare Riferimento Ai Suoi Rapporti Con Il Tendine Del Capo Lungo Del Muscolo Bicipite Del Braccio. Arch Ital di Anat e di Embriol. 1977; 82: 85–98.
9. *Bobzin L., Roberts R.R., Chen H.J., et al.*: Development and maintenance of tendons and ligaments. Dev. 2021.
10. *Guéro S.*: Developmental biology of the upper limb. Hand Surg Rehabil. 2018; 37: 265–274.
11. *Loth E.* Anthropologie des parties molles. Masson et Cie; 1931.
12. *Loth E.* Beiträge zur Anthropologie der Negerweichteile (Muskelsystem). Strecker & Schröder; 1912.
13. *Wood J.*: IX. Variations in human myology observed during the Winter session of 1865–66 at King's College, London. Proc R Soc London. 1867; 15: 229–244.
14. *Patrick N.C., Hammert W.C.*: Hand and Wrist Tendinopathies. Clin Sports Med. 2020; 39: 247–258.
15. *De Maeseneer M., Brigido M.K., Antic M., et al.*: Ultrasound of the elbow with emphasis on detailed assessment of ligaments, tendons, and nerves. Eur J Radiol. 2015; 84: 671–681.
16. *Kędzia A., Andrzejak R., Dudek K., et al.*: Analysis of Human Scapula Morphometry in the Fetal Period. Adv Clin Exp Med. 2009; 18: 197–204.
17. *Dudek K., Kędzia W., Kędzia E., et al.*: Mathematical modelling of the growth of human fetus anatomical structures. Anat Sci Int. 2017; 92: 521–529.
18. *Dudek K., Nowakowska-Kotas M., Kędzia A.*: Mathematical models of human cerebellar development in the fetal period. J Anat. 2018; 232: 596–603.
19. *Karykowska A., Rohan-Fugiel A., Mączka G., et al.*: Topography of muscular branches of the superficial fibular nerve based on anatomical preparation of human foetuses. Ann Anat — Anat Anzeiger. 2021; 237.
20. *Karykowska A., Domagała Z.A., Gworys B.*: Musculus peroneus longus in fetal period. Folia Morphol (Warsz). 2022; 81: 124–133.
21. *Wozniak S., Florjanski J., Kordecki H., et al.*: Fetal sigmoid colon mesentery — In relevance in fetal ultrasound application. A pilot study. Ann Anat. 2018; 216: 152–158.
22. *Rohan A., Domagala Z., Abu Faraj S., et al.*: Branching patterns of the foetal popliteal artery. Folia Morphol. 2019; 78: 71–78.
23. *McCumber T.L., Latacha K.S., Lomneth C.S.*: The state of anatomical donation programs amidst the SARS-CoV-2 (Covid-19) pandemic. Clin Anat. 2021; 34: 961–965.
24. *Ghosh S.K.*: Paying respect to human cadavers: We owe this to the first teacher in anatomy. Ann Anat. 2017; 211: 129–134.
25. *Elvan Ö., Bobuş A., Erdoğan S., et al.*: Fetal anatomy of the facial nerve trunk and its relationship with posterior auricular artery. Surg Radiol Anat. 2019; 41: 153–159.

26. *Wiśniewski M., Baumgart M., Grzonkowska M., et al.*: Quantitative anatomy of the ulna's shaft primary ossification center in the human fetus. Surg Radiol Anat. 2019; 41: 431–439.
27. *Lantieri L., Hennebert H., Le Viet D., et al.*: A study of the orientation of the fibers of the flexor carpi radialis tendon: Anatomy and clinical applications. Surg Radiol Anat. 1993; 15: 85–89.
28. *Bishop A.T., Gabel G., Carmichael S.W.*: Flexor carpi radialis tendinitis. Part I: Operative anatomy. J Bone Jt Surg — Ser A. 1994; 76: 1009–1014.
29. *Rotman M.B., Donovan J.P.*: Practical anatomy of the carpal tunnel. Hand Clin. 2002; 18: 219–230.
30. *K dzia A., Janeczko M., Miśkiewicz K., et al.*: Morphometry of human musculus gluteus maximus in foetal period. Adv Clin Exp Med. 2014; 23: 9–16.
31. *Czyż M., Kędzia A.*: Preliminary metrological study of the lumbar vertebral column during the foetal period. Folia Morphol (Warsz). 2003; 62: 259–262.
32. *Hepper P.G., Shahidullah S., White R.*: Handedness in the human fetus. Neuropsychologia. 1991; 29: 1107–1111.
33. *Hepper P.G.*: The developmental origins of laterality: Fetal handedness. Dev Psychobiol. 2013; 55: 588–595.
34. *Simet S.M., Cassidy K.M.*: Dissection and analysis of a complex cadaveric hand dysmorphology. Transl Res Anat. 2021; 25: 100141.
35. *Żytkowski A., Tubbs R.S., Iwanaga J., et al.*: Anatomical normality and variability: Historical perspective and methodological considerations. Transl Res Anat. 2021; 23: 100105.
36. *Iwanaga J., Singh V., Ohtsuka A., et al.*: Acknowledging the use of human cadaveric tissues in research papers: Recommendations from anatomical journal editors. Clin Anat. 2021; 34: 2–4.