11. Přílohy

11.1. Příloha 1 - Arterial Supply of the Thumb: Systemic Review, Miletín et al., 2017

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REVIEW

Arterial Supply of the Thumb: Systemic Review

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We offer a complete systemic review of the anatomy of arteries of the thumb, including their sources in the first web space. Eleven studies were selected from the PubMed, Medline, Embase, Scopus and Ovid databases. Data about each artery of the thumb were obtained; in particular, the incidence and dominance of each of these arteries were calculated. The ulnopalmar digital artery of the thumb (UPDAT) was found in 99.63%, the radiopalmar digital artery of the thumb (RPDAT) in 99.26%, the ulnodorsal digital artery of the thumb (UDDAT) in 83.39%, and the radiodorsal digital artery of the thumb (RDDAT) in 70.38%. The sources for the thumb arteries are the first palmar metacarpal artery (for UPDAT in 63.15%, for RPDAT in 78.88%, for UDDAT in 56.95% and for RDDAT in 41.48%), the first dorsal metacarpal artery (for UPDAT in 20.54%, for RPDAT 2.53%, for UDDAT in 20.62%, and for RDDAT in 4.81%) and the superficial palmar arch, either complete or incomplete (for UPDAT in 25.57%, for RPDAT in 23.04%, for UDDAT in 0%, and for RDDAT in 5.19%). The dominant source could be identified in 88.2% of cases: the first palmar metacarpal artery (66.2%), the first dorsal metacarpal artery (15.5%) and the superficial palmar arch, complete or incomplete (8.2%). Four arteries usually supply the thumb. Any artery in the first web space can be a source for the thumb arteries. We propose a new classification of the arteries of the hand, dividing them into three systems (superficial palmar, deep palmar and dorsal system), and suggest that the term "princeps pollicis artery" be reconsidered and systemic anatomical terms of the thumb arteries preferred. Clin. Anat. 30:963–973, 2017. ©2017 Wiley-Liss, Inc.

Key words: princeps pollicis artery; arteria princeps pollicis; arterial supply; vascularization; thumb; thumb arteries; systematic review

INTRODUCTION

The thumb contributes to about 40% of hand function (Strickland et al., 1998) and a hand is considerably disabled without sufficient thumb function. Therefore, preservation or reconstruction of the thumb is one of the most important topics in hand surgery.

Detailed anatomical knowledge of the thumb vasculature is required for restorative and reconstructive surgery. Surgeons need to be provided with unified and detailed descriptions of the arterial blood supply to the thumb. To make it as easy as possible to acquire this important knowledge, a clear and understandable terminology is necessary. However, currently available sources do not provide such description and terminology.

In this article, we aim to provide a thorough description of the anatomy of the thumb arteries along with an account of their variability, including

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their incidence, diameter and anastomoses. Moreover, we describe the first web space arteries according to their potential as source vessels for the thumb arteries and their potential dominance, both described by incidence. In addition, we reconsider the commonly-used anatomical terminology, especially the term "princeps pollicis artery", as we believe it can mislead.

HISTORY (LITERATURE REVIEW)

Detailed descriptions of the hand arteries long failed to engage the interest of the great anatomists. The first author to dedicate a whole monograph to hand anatomy was Charles Bell (Bell, 1833). After the end of 19th and the beginning of the 20th century, interest in anatomical variations of the hand arteries, including the thumb, began to rise. From this period we recall the outstanding (and then exceptional) anatomical and surgical papers focusing on the hand arteries such as those of Tandler (1897) and Jaschtschinski (1897), and major studies focusing on variant anatomy such as "Handbuch der Systematischen Anatomie des Menschen" (Henle, 1868), "Variations des artères du membre superior" (Dubreuil-Chambardel, 1926) and "Das Arteriensystem der Japaner" (Adachi, 1928), in which the thumb arteries are described in the chapters covering the upper limbs.

Between 1930 and 1980 new studies focusing on the hand arteries were published; some of them focused on the anatomy of the thumb arteries (Parks et al., 1978; Earley, 1986; Ames et al., 1993). They met the requirements of rapidly developing reconstructive surgery and sought to fulfill the surgeon's demands. Their description of small vessels focuses on the importance of each vessel as a source of the thumb blood supply, and the authors tried to unify the nomenclature. Two of the most remarkable publications from that era are by Murakami and colleagues (Murakami et al., 1969) and Coleman and Anson (Coleman and Anson, 1961). These two studies provided large sample sizes and detailed descriptions of their results.

At the end of the 20th and at the beginning of 21st century, significantly fewer articles dealing with the clinical anatomy of hand vessels, including thumb vessels, were produced annually. Thereafter, the interest of most researchers switched to the embryology of the forehand and hand arteries and related variant anatomy of the forehand. Studies of the clinical anatomy of the hand vessels were often based on only a few samples, such as the study by Brunelli and Gilbert (2001). An interesting study by Ikeda et al. (1988) used modern radiological methods to visualize the arteries in 220 cadaver hands.

Recent books covering surgical anatomy and written mainly by hand surgeons could also contribute usefully to the understanding of topographic anatomy (Kaplan and Spinner, 1984; Doyle, 2003; Schmidt and Lana, 2004).

The Use of the Term "Princeps Pollicis Artery"

The term "princeps pollicis artery", present in the official anatomical nomenclature from BNA in 1895 (His, 1895), dates back to the beginning of the 19th century (Meckel, 1815). Although the synonym "magna pollicis artery" was also used (Bell, 1811; Tiedemann, 1822; Smith, 1835; Burns, 1838; Richmond, 1880), most 19th-century authors gave both terms ("princeps pollicis artery" and "magna pollicis artery") (Wilson and Goddard, 1813; Harrison, 1824; Von Bierkowski, 1825; Berres, 1828; Flood, 1839; Bock, 1840; Von Behr 1847; Von Luschka, 1865); "ramus princeps pollicis" was rarely applied (Quain, 1828).

The usage of some terms differs between the authors' original text and its translation into English; for example, the French original by Cruveilhier does not mention this artery (Cruveilhier, 1834) but the English translation by Pattison contains both synonyms, stating that the "magna vel princeps pollicis" is a frequent but not constant vessel (Cruveilhier, 1844). The Latin-German original by Tiedemann uses both terms (Tiedemann, 1822) but the English translation by Knox gives only "arteria magna pollicis" (Tiedemann, 1835).

It is mentioned in the latest anatomical nomenclature "Terminologia Anatomica" (FCAT, 1998) and in official nomenclature for hand anatomy published by the International Federation of Societies for Surgery of the Hand (IFSSH, 2001). However, the authors whose studies have focused on the blood supply to the thumb are not united in identifying the artery that should be called the "princeps pollicis artery". Adachi and Hasebe (1928) claim that the term "princeps pollicis artery" is more likely to be a synonym for the first palmar metacarpal artery (Adachi and Hasebe, 1928). This view has been adopted and reflected in many modern anatomical textbooks.

Nevertheless, other authors consider it necessary to justify the word "princeps" in the name of the artery ('princeps' meaning 'principal'). According to Murakami et al. (1969), the princeps pollicis artery is the artery with the greatest diameter supplying the palmar arteries that is not a branch of the superficial palmar arch (Murakami et al., 1969). In this case, the large first dorsal metacarpal artery could be the princeps pollicis artery. Parks et al. (1978) argue that "princeps pollicis artery" is the artery with greatest diameter supplying the thumb arteries that is a branch of the deep palmar arch only (Parks et al., 1978), so it could be a large second palmar metacarpal artery.

Some authors refuse to use this term. Tandler (1897) rejects the term "princeps pollicis artery", arguing that the first palmar metacarpal artery is not a major source of the blood supply for thumb arteries and therefore the term is not justified (Tandler, 1897). Earley (1986) suggests abandoning it completely and Ames et al. (1993) consider it a misnomer (Ames et al., 1993).

METHODS

In order to survey the blood supply to the thumb completely, we performed a deep systemic review of the available literature. We conducted a systemic search of the OVID, MEDLINE, SCOPUS, and EMBASE databases. After the keywords "princeps pollicis artery", "arteria princeps pollicis", "arterial supply",

TABLE 1. Incidence of the Thumb Arteries

	Brunelli, Gilbert	Coleman, Anson	Earley	Ikeda et al.	Ramirez, Gonzales	Sample size of each artery	Positive	Results
Sample size of each study	25	100	20	220	30	-	-	-
UPDAT	-	-	20	219	30	270	269	**99.63%**
RPDAT	-	-	20	218	30	270	268	**99.26%**
UDDAT	25	-	14	177	30	295	246	**83.39%**
RDDAT	13	83	14	140	28	395	278	**70.38%**

Legend: RDDAT, radiodorsal digital artery of the thumb; UDDAT, ulnodorsal digital artery of the thumb; RPDAT, radiopalmar digital artery of the thumb; UPDAT, ulnopalmar digital artery of the thumb.

"vascularization", "thumb", and "arterial patterns in the hand" were added, 4,876 articles were obtained. After case reports, letters to the editors and short communications were excluded, 84 papers remained. From PUBMED, 379 articles were obtained after adding the keywords. Some of these articles were found in both searches. We then carefully researched the abstracts and excluded all the articles that did not address the topic. The remaining nine papers were included in our systematic review. We also searched for works published before 1926 that were not included in the databases originally searched. As a result, the article by Julius Tandler (Zur Anatomie der Arterien der Hand, 1897) was added to our review. To increase our number of samples, we searched for the key work in vascular anatomy, "Das Arteriensystem der Japaner" by Adachi and Hasebe (1928). This book gave us two additional sources. Finally, therefore, 11 study materials were included in our systemic review.

To conduct the first part of the review we selected original studies only, based on anatomical dissection on cadaveric hands and featuring consistent use of terminology (Adachi and Hasabe, 1928; Coleman and Anson, 1961; Parks et al., 1978; Foucher and Braun, 1979; Earley, 1986; Brunelli and Gilbert, 2001; Ramirez and Gonzalez, 2012); only one study used arteriography instead of dissection (Ikeda et al., 1988). The main reason for excluding studies from the first part of our systemic review was a confusing description of the samples (Jaschtschinski, 1897; Murakami et al., 1969; Ames et al., 1993). Moreover, case reports were not included, as we focused mainly on common variants of arterial anatomy.

From the studies included in our review we extracted data concerning the incidence of each artery and its sources in the first web space. We summarized these data in a synoptic table (see Tables). The data for each artery of the thumb are presented in rows according to the authors of the original studies.

First, we counted the total sample, composed from particular sample sizes for every single artery. After we obtained the resultant sample for each individual artery, we inferred the percentage probability that each artery of the first web space was a source of the thumb blood supply.

None of the studies included all of the arteries we describe. In order to maintain both sample size and statistical significance we decided to assemble each individual artery's sample (each row in Tables 1 and 2 represents one specific sample).

The incidence and percentage of each artery in the first web space being a source of the thumb blood supply was then calculated. Owing to the specificity of each individual sample, each row of the table was analyzed separately. Therefore, the total percentage does not necessarily equal 100%. Furthermore, each individual artery could have more than one source.

The second part of our systemic review focuses only on the original studies, and the dominance of the sources of blood supply to the thumb was calculated. Selected studies provided anatomical dissection of the structures in cadaveric hands; the terminology used to describe the results was fully understandable and it was clear which source was dominant (Tandler, 1897; Murakami et al., 1969; Parks et al., 1978; Ames et al., 1993). The results of this part of the review are presented in Table 3. As before, the percentage probability for the dominance of each artery was calculated. We also conducted a thorough search of the description of the blood supply of the thumb and available visual documentation. After synthesizing the data, we propose a unified description of the thumb arterial circulation anatomy, along with the variations and anastomoses between arteries. Our findings are accompanied by relevant illustrations, along with photographs of dissections obtained by the authors specifically for this study.

The authors kindly thank all of the body donors (with written consent for experimentation with human subjects) for their gift. The work was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

RESULTS

In order to make our results easy to understand, we present them together with a short recapitulation of the anatomy of each part of arterial system of the hand.

Thumb Arteries

The thumb, like the three-phalangeal fingers, is supplied by four arteries, two palmar and two dorsal

TABLE 2. Sources of UPDAT

	Adachi, Hasebe	Brunelli, Gilbert	Coleman, Anson	Earley	Foucher, Braun	Ikeda et al.	Parks et al.	Ramirez, Gonzalez	Sample size of each artery	Positive	Results
Sample size of each study	100	25	100	20	30	220	50	30	-	-	-
FPMA	31	16	-	11	-	158	40	25	445	281	**63.15%**
Superficial system	27	6	-	7	-	31	-	30	395	101	**25.57%**
UA	10	-	-	3	-	-	-	-	120	13	**10.83%**
SPA	9	-	-	3	-	-	-	-	120	12	**10.00%**
MA	1	-	-	0	-	-	-	-	120	1	**0.83%**
SPBRA	7	-	-	1	-	-	-	-	120	8	**6.67%**
FDMA	42	-	-	1	-	30	-	3	370	76	**20.54%**
UDDAT	0	-	-	1	-	0	-	0	370	1	**0.27%**
Absence	-	-	-	0	-	1	-	0	270	1	**0.37%**

Legend: UDDAT, ulnodorsal digital artery of the thumb; FDMA, first dorsal metacarpal artery; FPMA, first palmar metacarpal artery; MA, median artery; UPDAT, ulnopalmar digital artery of the thumb; SPA, superficial palmar arch; SPBRA, superficial palmar branch of radial artery; UA, ulnar artery.

(Figs. 1 and 2). These arteries run alongside the nerves (branches of the median nerve) in neurovascular bundles. The palmar arteries are larger and are almost invariably present, whereas the dorsal arteries are small and their presence is not constant. The source vessels of all the arteries mentioned above are the arteries of the palm and the first web space. It is common for one artery of the thumb to have more than one source (Table 1).

Ulnopalmar digital artery of the thumb. The ulnopalmar digital artery of the thumb (UPDAT) (*arteria digitalis ulnopalmaris pollicis*) was found in 99.63% of autopsies and appeared to have the largest diameter of all the arteries, on average 1.1 mm (range 0.7–1.9 mm) (Ramirez and Gonzalez, 2012). In most cases, UPDAT was a branch of the first palmar metacarpal artery (63.15%). Other frequent sources were the first dorsal metacarpal artery (20.54%), the ulnar artery (10.83%), and the complete superficial palmar arch (10%). In cases of incomplete superficial palmar arch the superficial branch of the radial artery could also be a source, as we observed in a few cases (6.67%). Other hand arteries provided sufficient sources for UPDAT, although this was very rare (Fig. 3 and Table 2).

Radiopalmar digital artery of the thumb. The radiopalmar digital artery of the thumb (RPDAT) (*arteria digitalis radiopalmaris pollicis*) was only slightly more variable than UPDAT. The prevalence of RPDAT was 99.26%. Its diameter appeared narrower than UPDAT; the average was 0.81 mm (range 0.4–1.8 mm) (Ramirez and Gonzalez, 2012). According to our findings, the most frequent source for RPDAT was the first palmar metacarpal artery (77.88%). There were also other sources such as the ulnar artery (14.29%) and the superficial branch of the radial artery (10.86%). The complete superficial palmar arch was a source of RPDAT in 4.41% of cases. In

TABLE 3. Sources of RPDAT

	Adachi, Hasebe	Brunelli, Gilbert	Coleman, Anson	Earley	Fouhcer, Braun	Ikeda et al.	Parks et al.	Ramirez, Gonzalez	Sample size of each artery	Positive	Results
Sample size of each study	100	25	100	20	30	220	50	30	-	-	-
FPMA	75	25	-	18	-	167	40	26	445	351	**78.88%**
Superficial system	23	0	-	0	-	41	-	27	395	91	**23.04%**
UA	5	0	-	0	-	-	-	20	175	25	**14.29%**
SPA	6	0	-	0	-	-	-	-	145	6	**4.14%**
MA	1	0	-	0	-	-	-	0	175	1	**0.57%**
SPBRA	10	0	-	2	-	-	-	7	175	19	**10.86%**
FDMA	0	0	-	0	-	10	-	0	395	10	**2.53%**
Absence	-	-	-	0	-	2	-	0	280	2	**0.71%**

Legend: FDMA, first dorsal metacarpal artery; FPMA, first palmar metacarpal artery; MA, median artery; SPA, superficial palmar arch; SPBRA, superficial palmar branch of radial artery; UA, ulnar artery.

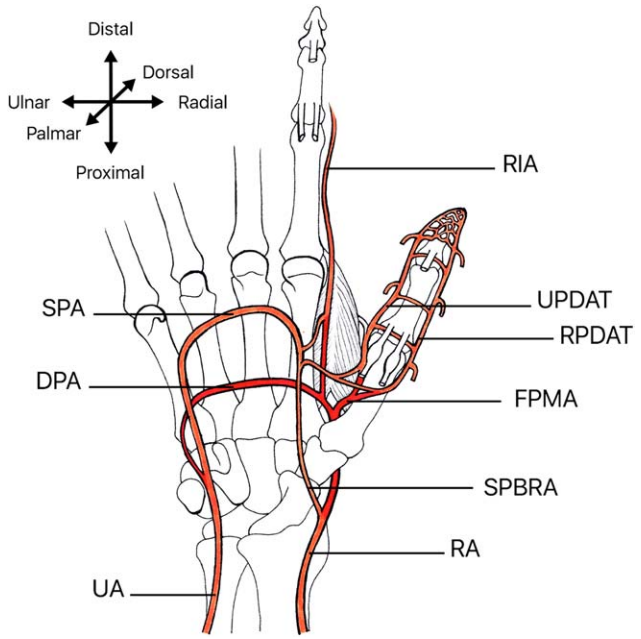

Fig. 1. Arteries of the thumb and their sources—palmar view. Legend: DPA, deep palmar arch; FPMA, first palmar metacarpal artery; RPDAT, radiopalmar digital artery of the thumb; UPDAT, ulnopalmar digital artery of the thumb; RA, radial artery; RIA, radialis indicis artery; SPA, superficial palmar arch; SPBRA, superficial palmar branch of radial artery; UA, ulnar artery. Source: Based on Gray's anatomy (41st Ed., 2016), modified according to our results. [Color figure can be viewed at wileyonlinelibrary.com]

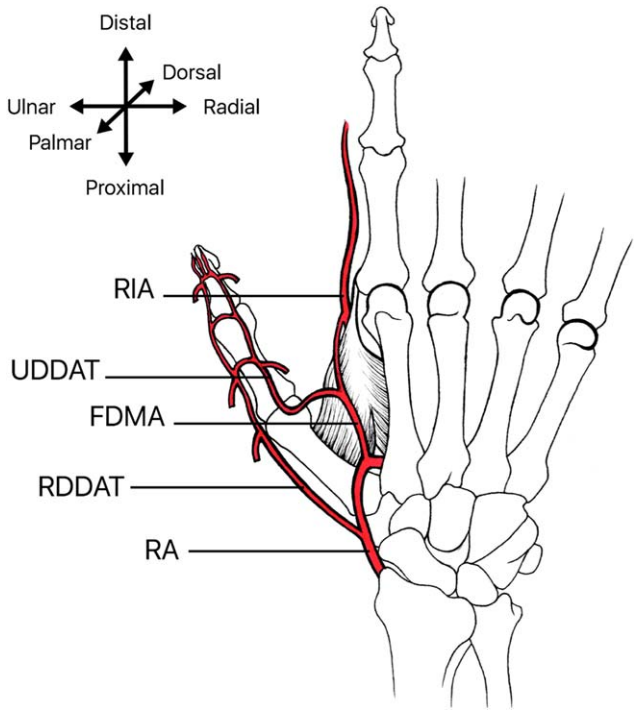

Fig. 2. Arteries of the thumb and their sources—dorsal view. Legend: RDDAT, radiodorsal digital artery of the thumb; UDDAT, ulnodorsal digital artery of the thumb; FDMA, first dorsal metacarpal artery; RA, radial artery; RIA, radialis indicis artery. Source: Based on Gray's Anatomy (41st Ed., 2016), modified according to our results. [Color figure can be viewed at wileyonlinelibrary.com]

2.53%, RPDAT was also a branch of the first dorsal metacarpal artery (Table 3).

***Ulnodorsal digital artery of the thumb*.** The ulnodorsal digital artery of the thumb (UDDAT) (*arteria digitalis ulnodorsalis pollicis*) is a small artery with average diameter 0.61 mm (range 0.2–1.2 mm) (Ramirez and Gonzalez, 2012). It was found in 83.39% of subjects. The most probable source of this artery could be the first palmar metacarpal artery (56.95%), first dorsal metacarpal artery (20.62%), and a stem of the radial artery (4.75%). Exceptionally, we found one case in which a strong UDDAT was the only source of the UPDAT (Earley, 1986) (Table 4).

***Radiodorsal digital artery of the thumb*.** The radiodorsal digital artery of the thumb (RDDAT) (*arteria digitalis radiodorsalis pollicis*) is the weakest of the thumb arteries with average diameter 0.4 mm (range 0.1–0.9 mm) (Ramirez and Gonzalez, 2012). It was found in 70.38% of cases. Usually, it is considered to be a direct branch of the radial artery. However, our findings confirmed this statement in only 15.19% of cases; in most cases the source of RDDAT was the first palmar metacarpal artery (41.48%). RDDAT can be also a branch of the superficial branch of the radial artery, of the superficial palmar arch (5.19% in total) or of the RPDAT (2.96%). In contrast to the other arteries mentioned above, RDDAT commonly had only one source (Table 5).

Source Vessels of Thumb Arteries

The thumb arteries are branches of the hand arteries. After thorough research of the material, we propose a new classification of the arterial pattern of the

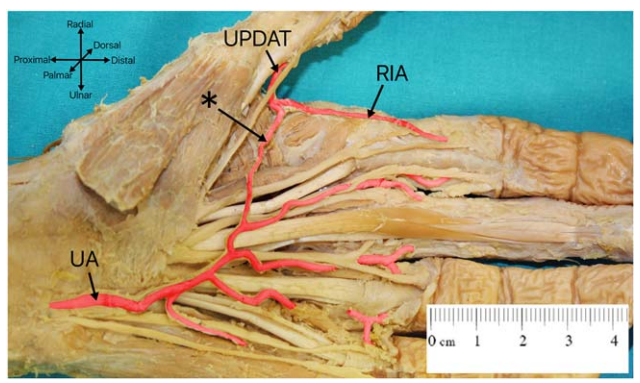

Fig. 3. Branches of the ulnar artery to the thumb arteries in incomplete superficial palmar arch (dominant in 8.22%). Legend: UPDAT, ulnopalmar digital artery of the thumb; RIA, radialis indicis artery; UA, ulnar artery; *, branches from ulnar artery to the thumb arteries. Source: Author's own dissections. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 4. Sources of UDDAT

	Adachi, Hasebe	Brunelli, Gilbert	Coleman, Anson	Earley	Foucher, Braun	Ikeda et al.	Parks et al.	Ramirez, Gonzalez	Sample size of each artery	Positive	Results
Sample size of each study	100	25	100	20	30	220	50	30		-	-
FPMA	-	25	-	2	-	119	-	22	295	168	**56.95%**
SPA	-	0	-	0	-	0	-	0	295	0	**0.00%**
FDMA	-	0	-	6	3	58	-	0	325	67	**20.62%**
RA	-	0	-	6	-	0	-	8	295	14	**4.75%**
Absence	-	0	-	6	-	43	-	0	295	49	**16.61%**

Legend: FDMA, first dorsal metacarpal artery; FPMA, first palmar metacarpal artery; RA, radial artery; SPA, superficial palmar arch.

hand. Considering their topographic anatomy we distinguish three arterial systems: superficial palmar, deep palmar and dorsal systems (Fig. 4).

Superficial palmar system. The superficial palmar system is mainly constituted from the ulnar artery, which diverges radially after its passage through the ulnar canal, which is located approximately at the level of the midpalmar crease. It then gives off common digital arteries supplying the web spaces between the three-phalangeal fingers (Standring, 2016). In most cases the ulnar artery ends up in the first web space, where it gives off tiny terminal branches to supply the radial portion of the index finger and the thumb (Walter, 1789; Lauth, 1835; Meyer, 1861; Luschka, 1865). Furthermore, the terminal branch for the thumb splits into two branches that merge with UPDAT and RPDAT. Sometimes, three terminal branches of the ulnar artery can be found, one supplying the radial side of the index finger and two supplying the thumb (Murakami et al., 1969). These two arteries are thin and in some cases are not present at all. According to our systemic review, they never constitute the dominant source for the thumb.

The superficial branch of the radial artery can also be part of the superficial palmar system. It arises from the radial artery proximally to the styloid process of the radius and proceeds distally toward the thenar muscles (Standring, 2016). Although this artery mostly terminates in the thenar muscles it can be a source for other arteries; according to our systemic review it is a source for the UPDAT in 6.67% of cases, for the RPDAT in 10.86%, and for the RDDAT in 5.19%. Of the three papers that describe the source vessels of the dorsal arteries of the thumb, only Ikeda et al. designate the superficial palmar system as a possible source of the dorsal arteries of the thumb (Earley, 1986; Ikeda et al., 1988; Ramirez and Gonzalez, 2012). Unlike other authors, Ikeda and his team used angiography to confirm these findings (Ikeda et al., 1988). However, they did not subdivide the superficial palmar system into individual arteries. They used the global term "superficial palmar arch" as a source for these arteries, regardless of its completeness. The superficial branch of the radial artery can be a dominant source of the thumb blood supply. According to our findings, this is true in 7.69% of cases.

The ulnar artery and the superficial branch of the radial artery can anastomose and thus constitute the superficial palmar arch. Although it is described as a constant textbook pattern, it is absent in about 32% of cases (Jaschtschinski, 1897). If constituted, it gives off branches into the first web space, which supply the radial side of the index finger and the thumb (Walter, 1789; Lauth, 1835; Meyer, 1861; Luschka, 1865).

TABLE 5. Sources of RDDAT

	Adachi, Hasebe	Brunelli, Gilbert	Coleman, Anson	Earley	Foucher, Braun	Ikeda et al.	Parks et al.	Ramirez, Gonzalez	Sample size of each artery	Positive	Results
Sample size of each study	100	25	100	20	30	220	50	30	-	-	-
FPMA	-	-	-	0	-	112	-	0	270	112	**41.48%**
SPA	-	-	-	0	-	14	-	0	270	14	**5.19%**
FDMA	-	-	-	0	-	13	-	0	270	13	**4.81%**
RA	-	-	-	14	-	7	-	20	270	41	**15.19%**
RPDAT	-	-	-	0	-	0	-	8	270	8	**2.96%**
Absence	-	12	17	6	-	80	-	2	395	117	**29.62%**

Legend: FDMA, first dorsal metacarpal artery; FPMA, first palmar metacarpal artery; RPDAT, radiopalmar digital artery of the thumb; RA, radial artery; SPA, superficial palmar arch.

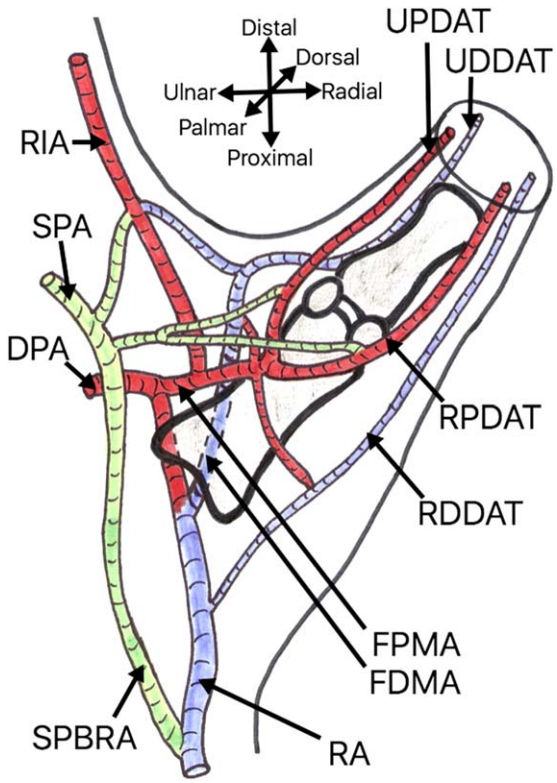

Fig. 4. Sources of the thumb arteries divided by systems: green, superficial palmar system (dominant in 8.22%); red, deep palmar system (dominant in 66.21%); blue, dorsal system (dominant in 15.53%). Legend: DPA, deep palmar arch; RDDAT, radiodorsal digital artery of the thumb; UDDAT, ulnodorsal digital artery of the thumb; FDMA, first dorsal metacarpal artery; FPMA, first palmar metacarpal artery; RPDAT, radiopalmar digital artery of the thumb; UPDAT, ulnopalmar digital artery of the thumb; RA, radial artery; RIA, radialis indicis artery; SPA, superficial palmar arch; SPBRA, superficial palmar branch of radial artery. Source: Original drawing. [Color figure can be viewed at wileyonlinelibrary.com]

However, the branching pattern of the thumb branches varies. One artery can split into two separate branches, similarly to the pattern mentioned earlier in the case of the ulnar artery (Murakami et al., 1969). These branches can be quite large so they might be understood as the dominant source vessels for the thumb blood supply. According to our systemic review, this occurred in 13.89% of cases. We propose that the term 'superficial palmar system' be used as a general signifier for the ulnar artery, the superficial branch of the radial artery and the superficial palmar arch regardless of whether the superficial palmar arch is actually constituted.

Not only the arteries mentioned above, but also the median artery, can be a source for the thumb blood supply (Adachi and Hasebe, 1928). Although its presence varies (in different studies it was observed in 3–20% of cases) it can be a source for the thumb arteries (Rodriguez-Niedenführ et al., 1999; Kachlik et al., 2016). According to our systemic review, the median artery is a source vessel for the UPDAT in 0.83% and for the RPDAT in 0.57% of cases. Moreover, the median artery is never a dominant artery of the thumb (Fig. 5).

Deep palmar system. The deep palmar system is constituted mainly from the radial artery, which passes over the styloid process of the radius and the base of the first metacarpal bone (Standring, 2016). It then runs between two portions of the first dorsal interosseous muscle, enters the space between the first dorsal interosseous muscle and the transverse head of the adductor pollicis muscle, and proceeds further to the ulnar side. Then it continues between the flexor tendons and metacarpal bones at about 1 cm proximal to the midpalmar crease. Finally, it forms an anastomosis with the deep branch of the ulnar artery, which arises from the ulnar artery inside the ulnar canal and constitutes the deep palmar arch. In contrast to the superficial palmar arch, the deep palmar arch is almost always complete (Jaschtschinski, 1897). It generates four metacarpal arteries that run distally. Of these four metacarpal arteries, the first is the greatest in diameter and arises from the radial artery in the space between the first dorsal interosseous muscle and the transverse head of the adductor pollicis muscle (Standring, 2016). It tends to be the source of both palmar arteries supplying the thumb. Our findings suggest that it is a source for the UPDAT in 63.15% and for the RPDAT in 78.88% of cases. Mostly, it is the dominant source of the blood supply to the thumb (64.84%).

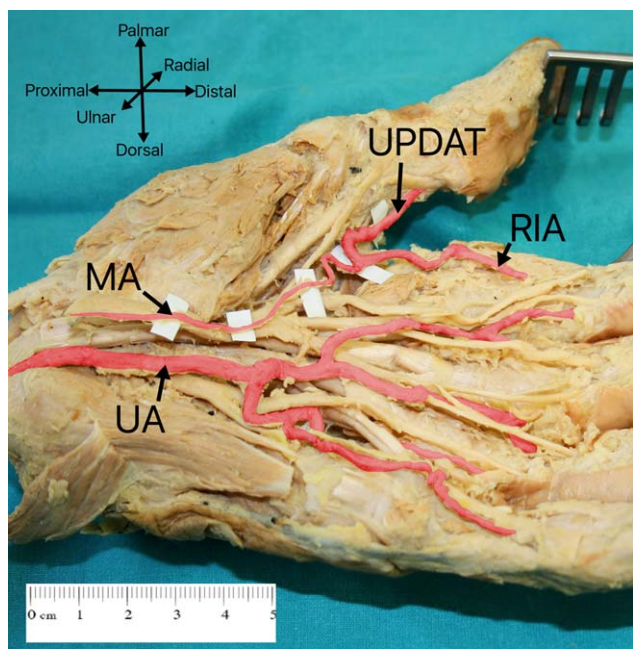

Fig. 5. Median artery supplying the thumb (<1%). Legend: MA, median artery; UPDAT, ulnopalmar digital artery of the thumb; RIA, radialis indicis artery; UA, ulnar artery. Source: Author's own dissections. [Color figure can be viewed at wileyonlinelibrary.com]

The radialis indicis artery is a branch of the first palmar metacarpal artery. It tends to be stronger than corresponding branches of the superficial palmar system (Standring, 2016).

The second palmar metacarpal artery was described as a potential source for the thumb, supplying arteries in two studies (Parks et al., 1978; Ames et al., 1993). These studies claim this artery to be a dominant source for the thumb blood supply in a few cases (the overall probability of the dominance was, according to our systemic review, about 1.37%). However, a second palmar metacarpal artery is not described in any of the studies analyzed to map potential sources for the thumb blood supply regardless of dominance, as was part of our systemic review.

***Dorsal system*.** The dorsal system is constituted by the radial artery and the dorsal metacarpal arteries. The radial artery is often the source for the RDDAT (15.19%) and can also be the source for the UDDAT (4.75%). Among all the dorsal metacarpal arteries, only the constantly present first dorsal metacarpal artery participates in the thumb blood supply (De Rezende et al., 2004; Omokowa et al., 2005). This artery can also be a source of every thumb artery of the four mentioned. Most commonly, it is a source for the UDDAT (20.63%) and the UPDAT (20.54%). The RDDAT branches from the first dorsal metacarpal artery in 4.81%. It can be the RPDAT branching from the first dorsal metacarpal artery in 2.53% of cases.

Dominance of Sources of the Thumb Blood Supply

According to our systemic review, one artery had a distinctly larger diameter than the others in 85.84% of cases. We call this the dominant source vessel (in agreement with the original authors). The results of our systemic review indicate that the most common dominant source vessel for the thumb arteries is the first palmar metacarpal artery (64.84%) and the second is the first dorsal metacarpal artery (15.53%). The superficial palmar system is a dominant source in only 8.22% of cases. In some of the studies mentioned earlier, it is not clearly specified whether the superficial palmar arch was complete or incomplete (Parks et al., 1978; Ames et al., 1993). Nevertheless, it can be inferred from the results that if the superficial palmar arch is incomplete, the superficial branch of the radial artery can be the dominant source vessel of the thumb blood supply (according to Ames et al. (1993), this is the case in 7.69%), whereas the ulnar artery cannot. In 11.87% of cases the diameters of the observed arteries were similar so no artery was designated as the dominant one (Figs. 6 and 7 and Table 6).

Anastomoses of Thumb Arteries

All of the thumb arteries are interconnected by a system of anastomoses (Earley, 1986; Ramirez and Gonzalez, 2012). These anastomoses provide a collateral blood supply and can be found between the palmar arteries, the dorsal arteries, and also between both palmar and dorsal arteries.

According to Ramirez and Gonzalez (2012), UPDAT and RPDAT form an anastomosis at the base of the proximal phalanx of the thumb, located distally to the sesamoid bones, in the middle of the proximal phalanx length, and at the base of the distal phalanx proximal to the flexor pollicis longus muscle tendon insertion. Small branches rise from the most distal anastomosis and enter the vinculum breve of the flexor pollicis longus muscle tendon. These anastomoses are located

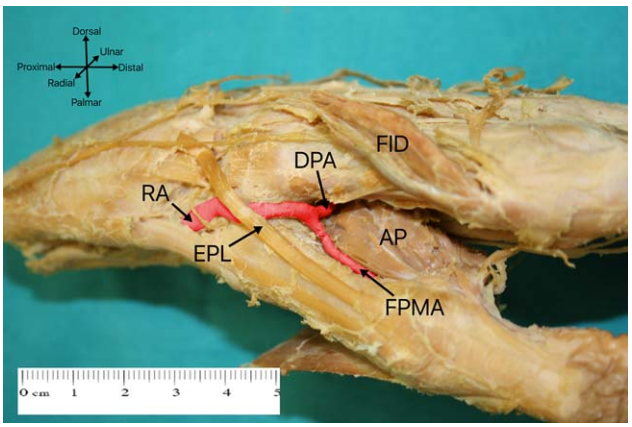

Fig. 6. Radial artery branching to the first metacarpal artery and deep palmar arch inside the space between the first dorsal interosseous muscle and the transverse head of the adductor pollicis muscle. Legend: APM, adductor pollicis muscle; DPA, deep palmar arch; EPLM, extensor pollicis longus muscle tendon; FDIM, first dorsal interosseus muscle; FPMA, first palmar metacarpal artery; RA, radial artery. Source: Author's own dissections. [Color figure can be viewed at wileyonlinelibrary.com]

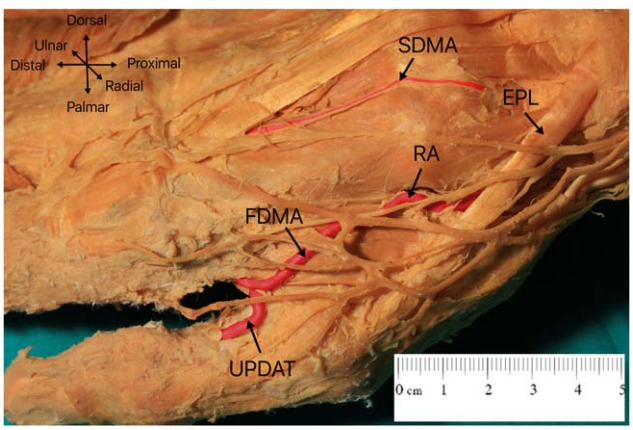

Fig. 7. First dorsal metacarpal artery as a dominant source of the thumb arterial supply (15.53%). Legend: EPLM, extensor pollicis longus muscle tendon; FDMA, first dorsal metacarpal artery; UPDAT, ulnopalmar digital artery of the thumb RA, radial artery; SDMA, second dorsal metacarpal artery. Source: Author's own dissections. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 6. Dominance of the Sources

	Ames et al.	Murakami et al.	Parks et al.	Tandler	SAMPLE SIZE OF EACH ARTERY	POSITIVE	RESULT
Sample size of each study	39	90	50	130	-	-	-
Deep palmar system	7	-	43	95	219	145	**66.21%**
FPMA	7	-	40	95	219	142	**64.84%**
SPMA	0	-	3	0	219	3	**1.37%**
Superficial palmar system	3	-	0	15	219	18	**8.22%**
SPA	-	-	0	15	180	15	**8.33%**
UA	0	-	-	-	39	0	**0.00%**
SPBRA	3	-	-	-	39	3	**7.69%**
Dorsal system	3	18	7	20	309	48	**15.53%**
FDMA	3	18	7	20	309	48	**15.53%**
No dominance	26	-	0	0	219	26	**11.87%**

FPMA, first palmar metacarpal artery; FDMA, first dorsal metacarpal artery; MA, median artery; SPA, superficial palmar arch; SPBRA, superficial palmar branch of radial artery; SPMA, second palmar metacarpal artery; UA, ulnar artery.

underneath the tendon sheath on the palmar surface of the phalanges. The arteries terminate on the tip of the thumb where they form an affluent net located in the pulp of the thumb. In this net, a stronger anastomosis located in the middle of the phalanx distal to the flexor pollicis longus muscle insertion can be identified, along with the further distally located terminal arterial branches, merging together in a V-shape.

The anastomoses of UDDAT and RDDAT can be found in about half the length of the proximal phalanx and over the interphalangeal joint. They are located underneath the dorsal aponeurosis on the dorsal phalangeal surface. The terminal branches of the dorsal arteries merge together in about half the length of the distal phalanx, located distally to the dorsal aponeurosis insertion and proximally to the fingernail matrix. The branches supplying the fingernail matrix rise from the distal part of the anastomosis described earlier.

The palmar and dorsal arteries are also interconnected by anastomoses. The proximal couple of anastomoses is at the level of the metacarpophalangeal joint and corresponds to the distal set of perforators interconnecting the palmar and dorsal hand arterial networks. Other anastomoses are located in the central regions of both the proximal and distal phalanges (Fig. 8).

In some cases, a very well developed anastomosis can even substitute for the proximal stem of one of the arteries of the thumb. In most cases it is an anastomosis between RPDAT and RDDAT. RPDAT was in such cases the major source, occurring in 2.96% of cases (Ramirez and Gonzalez, 2012).

DISCUSSION

We performed a thorough literature research and systemic review of the available data. Although reports concerning the distribution of particular sources of the arteries vary, all of the selected studies met our inclusion criteria.

Our results confirm that the thumb is supplied by two pairs of arteries, palmar, and dorsal, which are interconnected by many anastomoses. Thumb arteries are branches of the arteries of the first web space. According to their topography, we classify the arteries of the hand into three systems: superficial palmar, deep palmar and dorsal. By applying this proposed classification we can evade the question of the completeness of the superficial palmar arch.

On the basis of our systemic review, we confirm a key role of the first palmar metacarpal artery in the arterial blood supply to the thumb. It is the most common source of not only the palmar but also the dorsal

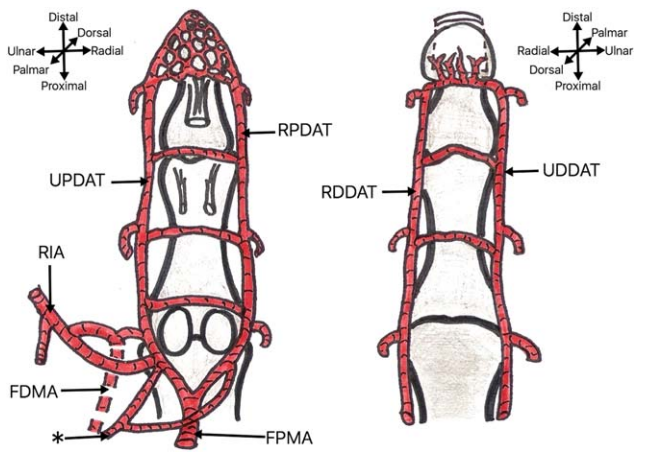

Fig. 8. Anastomoses of the thumb arteries. Legend: UPDAT, ulnopalmar digital artery of the thumb; RPDAT, radiopalmar digital artery of the thumb; UDDAT, ulnodorsal digital artery of the thumb; RDDAT, radiodorsal digital artery of the thumb; FPMA, first palmar metacarpal artery; FDMA, first dorsal metacarpal artery; RIA, radialis indicis artery; *, branches from the superficial palmar system. Source: Original drawing based on the paper by Ramirez and Gonzalez (2012). [Color figure can be viewed at wileyonlinelibrary.com]

thumb arteries. However, the thumb has additional blood supplies from the superficial palmar and dorsal systems and the arteries from these two systems can be the dominant sources for the thumb. Thus, it could be inferred that thumb blood supply relies on more than one artery. If there is a dominant source other than the first palmar metacarpal artery, which is incorrectly considered the princeps pollicis artery (Murakami et al., 1969; Parks et al., 1978), the interpretation could confuse even an experienced reader. The current terminology (princeps pollicis artery) is not specific enough to support the most common variants, so a more spatially descriptive terminology should be adopted in preference to the existing anatomical terms. The main source of the thumb blood supply is usually the first dorsal metacarpal artery, but if the situation differs, the pure systemic anatomy approach can contribute to avoiding potential confusion. Such ambiguities were mentioned in our previous article, which focused on terminology (Kachlik et al., 2015).

The remaining scientific question is a proper anatomical terminology for the branches of the superficial palmar system of the hand arteries supplying the thumb and the radial side of the index finger, which correspond to the common digital artery for the first web space. These arteries still lack appropriate anatomical terms.

The limitations of our work were mainly related to missing quantitative data about arterial diameters. Ramirez and Gonzalez (2012) describe the diameters of four arteries supplying the thumb, but other studies included in our systemic review do not describe any. Tandler distinguishes weak, middle and strong arteries (Tandler, 1897). Mentioning the arterial diameters would be useful mainly in the sources specifically discussing the dominance of the arteries of the thumb. This could be a suggestion for further research, as this particular knowledge is required in hand surgery. Furthermore, it would be interesting to consider the potential benefit of modern imaging (CT angiography, MRI) for further studies of the anatomy of the hand arteries.

CONCLUSION

We have presented detailed material describing the arterial supply to the thumb, focusing on the clinically useful aspects of the topic such as the presence, strength, and dominance of the arteries, and we propose a simplification and clarification of the nomenclature. Our work could be useful for surgeons as it could help them to understand the anatomy of the thumb blood supply fully, which could be further used in preservation, replantation and reconstructive surgery of the hand. We propose that the anatomical nomenclature be revisited and suggest that the term "princeps pollicis artery", which we find misleading, be reconsidered.

DECLARATION OF INTEREST

The authors declare that they have no conflicts of interest.

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11.2. Příloha 2 - Innominate variant artery in the first web space, Miletín et al., 2020

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Research Article

Innominate variant artery in the first web space

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ABSTRACT

Introduction: Numerous variations are characteristic for hand anatomy. Although a lot of work has been done in the field, a detailed description of the branches of the radial artery is still missing. The aim of this study is to determine the incidence and diameter of the accessory artery, which can be found running on the dorsal surface of the interosseus dorsalis primus muscle, to deliver the detailed description of this arterial variation and based on that to suggest a systematic name of the artery which would be in line with Terminologia Anatomica.
Methods: We used 133 complete donor bodies and 237 cadaverous hands in our study, giving us a total sample size of 503 samples. When possible, we determined the age of the donors which was between 62 and 90 years. We performed detailed anatomical dissection to determine the individual branching. We also measured the diameter of selected arteries. When relevant we performed statistical comparisons. To do that we first applied *Shapiro–Wilk test* to determine the normality of distribution and after that we used *Mann–Whitney U test* and *One-way ANOVA*.
Results: The variation of interest was found in 11.93% of cases. Based on the anatomical differences we determined four types of branching, type 1–3 forming the anastomosis with superficial palmar arch (being considered as positive findings) and type 4 which did not form this anastomosis (thus considered to be a negative finding).
Discussion: We successfully determined the incidence of this arterial variation on a sufficient sample size. We also described the anatomy of this branching in detail and were able to determine four types of this branching. After careful consideration of these findings we proposed the new name for this artery and suggest to use the name superficial dorsal branch of radial artery. This could contribute to a better understanding of this branching and potential use in clinical practice.

1. Introduction

Numerous vessel variations are characteristic for the hand anatomy. Thorough knowledge of these variations is crucial for clinical surgeons who use them during replantations and as pedicles for local flaps or as a recipient vessel for free flaps. Although detailed anatomy of hand vessels has already been discussed, some of these variations are still unclear or only superficially described and deserve further research. In relation to the first web space, located distally from the extensor pollicis longus tendon, the radial artery emits the ulnodorsal digital artery of the thumb and a branch for the second metacarpal bone and digit named first dorsal metacarpal artery (second, third and fourth metacarpal arteries arise from dorsal carpal network). After that, the radial artery plunges in between heads of the interosseus dorsalis primus muscle and continues into the deep layer of the palm.

Just before the radial artery enters the space between the heads of interosseus dorsalis primus muscle, a strong branch can arise from the radial artery. This strong branch then continues distally on the dorsal surface of the interosseus dorsalis primus muscle. At the very end of the first web space it rewinds back to the palm in order to form the anastomosis with the superficial palmar arch. Until today this artery lacks its anatomical name (FCAT, 1998) (Fig. 1).

Both classic anatomical textbooks (Lippert and Pabst, 1985; Moore et al., 2013; Lanz and Wachsmuth, 2004; Standring, 2016) and variations anatomy literature (Dubreuil-Chambardel, 1926; Bergman et al., 1996; Tubbs et al., 2016) lack detailed description of this artery. Moreover, this cannot be found either in hand

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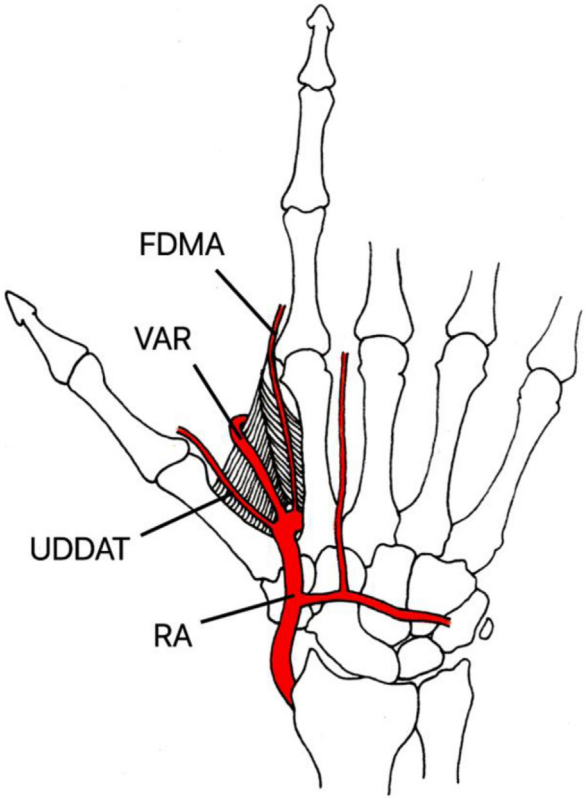

Fig. 1. Vascular anatomy of the dorsum of the first web space (author's drawing). Legend: FDMA – first dorsal metacarpal artery, UDDAT – ulnodorsal digital artery of the thumb, RA – radial artery, VAR – observed variation.

surgery textbooks which are focused on anatomy (Green et al., 2005; Mathes, 2005). In some textbooks, the variation can be visible in drawings or dissection images, but is not mentioned in the text (Hafferl, 1953; Jenkins and Hollinshead, 1991). Adachi describes a similar artery only as a continuation of the variable "arteria antebrachialis dorsalis superficialis" and he omits its unique existence (Adachi and Hasebe, 1928). Thiel and Telger mention this artery as an anastomosis between the superficial palmar arch and the princeps pollicis artery (Thiel and Telger, 1997). Schmidt and Lanz describe a strong variation of the ulnodorsal digital artery of the thumb (in their nomenclature dorsoulnar artery), but they do not cover its anastomosis with superficial palmar arch (Schmidt and Lanz, 2004). The first in-depth description of this artery is delivered by Murakami, who describes it as an intermediate branch of the first dorsal metacarpal artery, which was found on 14 extremities out of 62 and which forms terminal anastomosis with palmar arteries of the thumb and index finger (Murakami et al., 1969). Sherif accepts Murakami's classification and on the sample of 21 extremities mentions the incidence of 27%. The anastomosis with superficial palmar arch is not described by him (Sherif, 1994a). Pistre found this artery in five extremities out of 29 and describes the anastomosis with palmar arteries (Pistre et al., 2001). Bianchi also accepts Murakami's description of the branching but names the artery as central branch of first dorsal metacarpal artery (Bianchi, 2001). Murakami, Sherif and Bianchi all agree that branches of the first dorsal metacarpal artery mainly rise from the radial artery separately and the finding of a common trunk is an exception. Muyldermans mentions that this might only be an aberrant course of the first dorsal metacarpal artery, which could be found in about 10% of individuals (Muyldermans and Hierner, 2009). Browning argues that this might be the princeps pollicis artery and he does not cover the incidence of the artery (Browning and Morton, 1955).

The main aim of this paper is to determine the incidence of the above mentioned arterial variation by using the sufficient sample size and deliver the detailed description of this arterial variation and based on that to suggest a systematic name of the artery which would be in line with Terminologia anatomica (FCAT, 1998).

2. Materials and methods

2.1. Materials

We used 503 cadaver hands for our project which were borrowed from the depository of the Department of Anatomy of the Third Faculty of Medicine and the 1st Faculty of medicine, Charles University, Prague, from the Department of Anatomy, Faculty of Medicine in Hradec Kralove, Charles University, and from the Department of Anatomy, Faculty of Medicine, Palacky University in Olomouc.

The material was conserved by using formaldehyde method and the extremities were kept in alcohol stream or alcohol solution. Vascular injections or other methods leading to increased visibility of the vessels have not been used.

Our sample constituted of 133 complete donor bodies (266 cadaver hands; 80 female bodies, 53 male bodies). The age of the donors at the time of death was between 62 and 90 years. The remaining 237 hands had been separated from the trunk before the autopsy was done and hence gender and age identification of the donor body was no longer possible.

2.2. Methods

We performed a detailed anatomical dissection of the studied hands with special focus on the arteries of the first web space. We made an S-shaped incision over the first web space and retracted the skin flaps with clamps. Then we dissected the superficial venous network, branches of the superficial branch of the radial nerve and finally the radial artery and its branches lying on the interosseus dorsalis primus muscle. We always explored the plane underneath the muscle fascia for eventual arterial branches. For every sample, we kept the data about the side (right or left hand), and gender if possible. Furthermore, we distinguished positive findings and negative findings.

In order to be classified as positive findings, the accessory artery had to meet following criteria:

- The artery had to branch from radial artery (RA) branching or before RA entered the space between heads of the interosseus dorsalis primus muscle.
- The artery had to go through the middle part of the dorsal surface of the interosseus dorsalis primus muscle without being related to the first or second metacarpal bone, as other arteries could be found there (ulnodorsal digital artery of the thumb runs along the first metacarpal bone and first dorsal metacarpal artery runs along the second metacarpal bone).
- In its distal part the artery had to form an anasotomosis with the superficial palmar arch.

When positive findings were concluded, we kept a note about the source of branching (either from RA stem or from its branches); about its course (whether it runs on the surface of interosseus dorsalis primus muscle fascia or between the muscle and fascia); and whether or not the artery gave branches for the thumb or index finger. Furthermore, we measured the diameter of the artery precisely 1 cm from the branching. The digital sliding scale was used to measure it (Figs. 2 and 3).

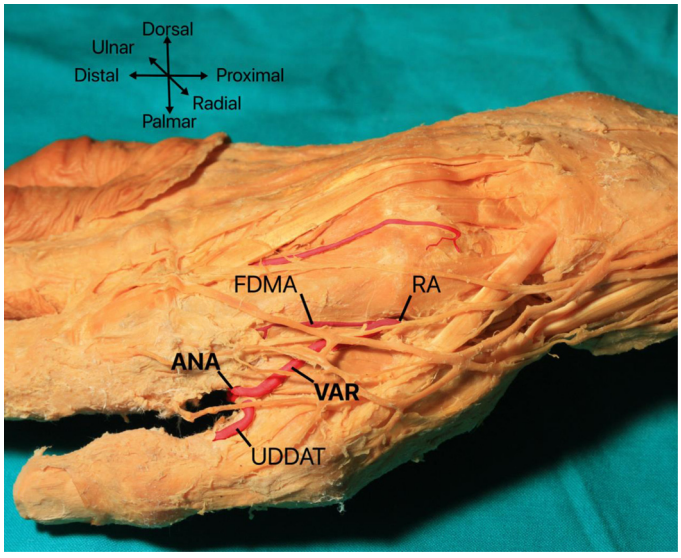

Fig. 2. Dissection of the vascular variation, right hand (author's archive). Legend: FDMA – first dorsal metacarpal artery, UDDAT – ulnodorsal digital artery of the thumb, RA – radial artery, VAR – observed variation, ANA – anastomosis with superficial palmar arch.

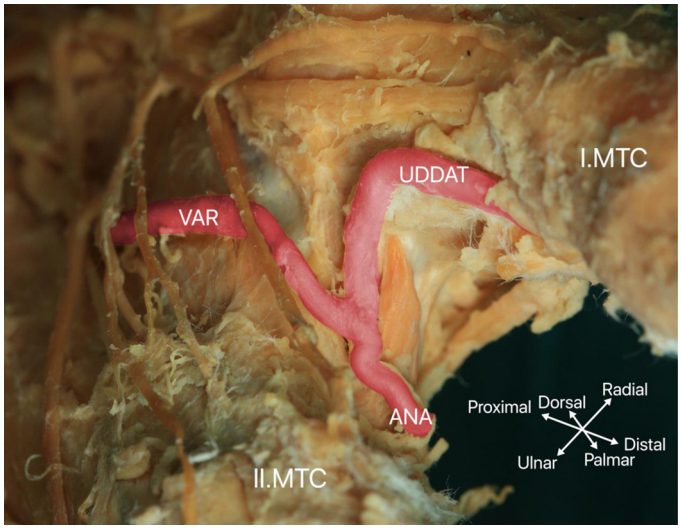

Fig. 3. Dissection of the vascular variation – axial view of the first web space, right hand (author's archive). Legend: UDDAT – ulnodorsal digital artery of the thumb, I.MTC – first metacarpal bone, II.MTC – second metacarpal bone, VAR – observed variation, ANA – anastomosis with superficial palmar arch.

2.3. Statistical tests

In order to provide a statistical description of the sample, frequencies of cadaver hands counts, the number of right and left hands in the sample and gender were counted. Specific branching patterns were counted in percent. The odds ratio was calculated to determine the predictive value of right versus left hand for the positive findings. The mean diameter of the arteries, their means in particular branching patterns and in gender were calculated. Statistical tests were done when needed by using SPSS program. When relevant, we tested the distribution of the data by using *Shapiro–Wilk test* and after that the non-parametric *Mann–Whitney U* test or *ANOVA* test was used.

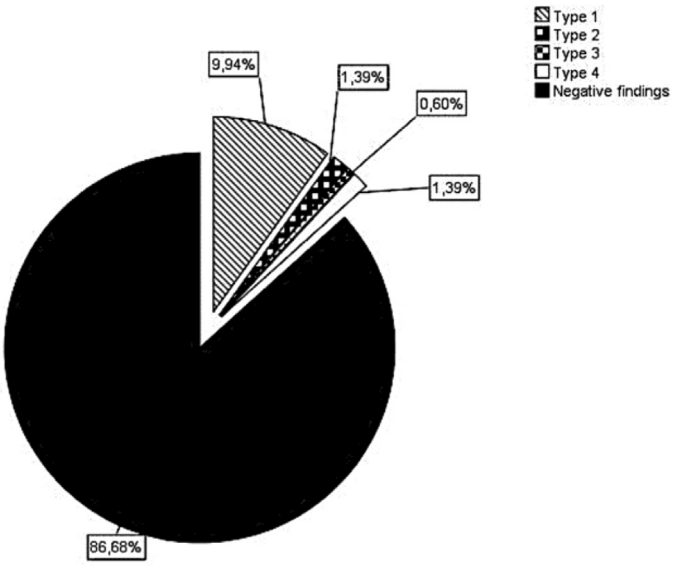

Fig. 4. The distribution of positive and negative findings according to (A) gender and (B) side.

3. Results

Out of all 503 hands, positive findings of accessory artery were found in 60 out of 503 cadaver hands (11.93%). In case of complete donor bodies, the bilateral positive findings were found in two cases out of 133 complete bodies (1.50%). Similar proportion of occurrence of the accessory artery was found in both left and right hands (30 positive findings out of 250 cases in left hands; 30 positive findings out of 253 cases in right hands). No predictive value of the side of hand was found, the odds ratio for positive findings in right hand was 1.01 (OR = 1.01) (Fig. 4).

Our findings did not suggest the higher incidence of positive findings in relation to gender. The odds for positive findings to be found in male were not significant (OR = 0.96). Among male samples we found 13 positive occurrences of the accessory artery compared to 93 negative findings. Similarly in female samples we found 19 positive findings compared to 141 negative findings (Fig. 5).

Out of all the cases (503 hands in total), the majority were negative findings (436 hands, 86.7%). The accessory artery was found to branch directly from the radial artery in 57 cases (11.3%). In three cases (0.6%) the accessory artery branched from the first dorsal metacarpal artery. In seven cases (1.4%) the artery produced a strong branch for a thumb (ulnopalmar digital artery of the thumb) and thus the artery became a dominant source of the arterial blood supply for the thumb. In all of the cases mentioned above, the artery was found to be passing superficially from the fascia of the interosseus dorsalis primus muscle. No artery was found to run between the fascia and muscle belly.

Taking in account the systematic anatomy we have determined following types of the accessory artery:

- **Type 1:** The artery branches from the radial artery before it dives between heads of the interosseus dorsalis primus muscle and in its distal part it turns over the edge of the interosseus dorsalis primus muscle and produces the anastomosis with the superficial palmar arch on the palmar site of the hand (Fig. 6).
- **Type 2:** The artery branches from the radial artery before it dives between heads of the interosseus dorsalis primus muscle and in its distal part it turns over the edge of the interosseus dorsalis primus muscle and produces the anastomosis with the superficial

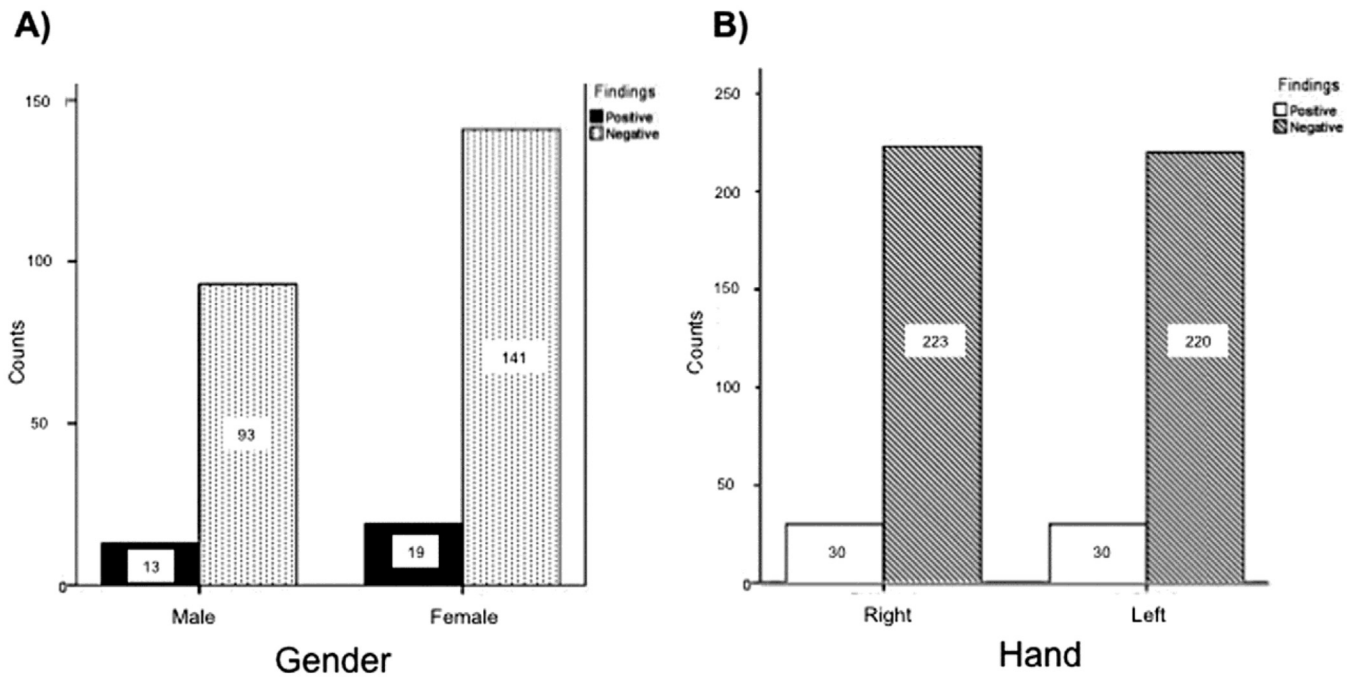

Fig. 5. Distribution of particular types and negative findings.

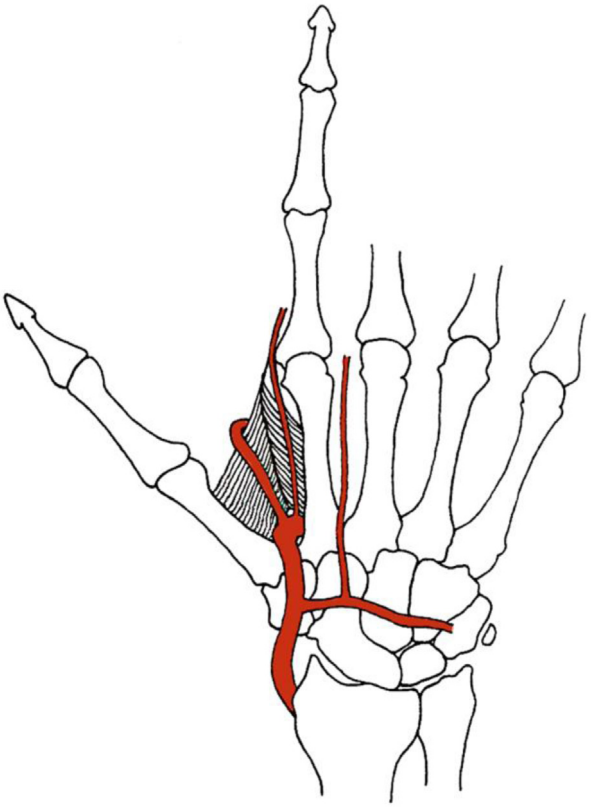

Fig. 6. Type 1.

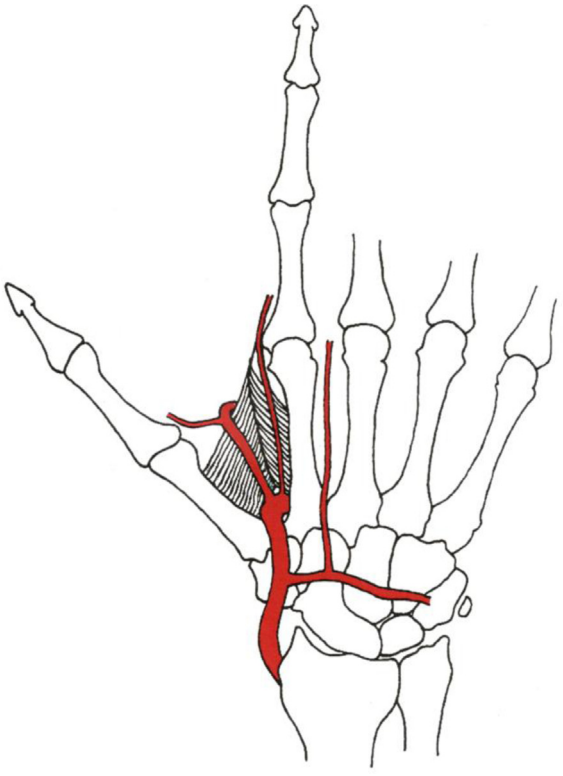

Fig. 7. Type 2.

palmar arch and emits ulnopalmar digital artery of the thumb (Fig. 7).

- **Type 3:** The artery arises from the first dorsal metacarpal artery, passes on the surface of the interosseus dorsalis primus muscle and in its distal part it turns over the edge of the interosseus dorsalis primus muscle and anastomose with the superficial palmar arch on the palmar site of the hand (Fig. 8).
- **Type 4:** The artery arises from the first dorsal metacarpal artery, passes on the surface of interosseus dorsalis primus muscle where it terminates and produces no further anastomosis with the superficial palmar arch. For the purpose of the study, Type 4 was considered to be a negative finding (Fig. 9).

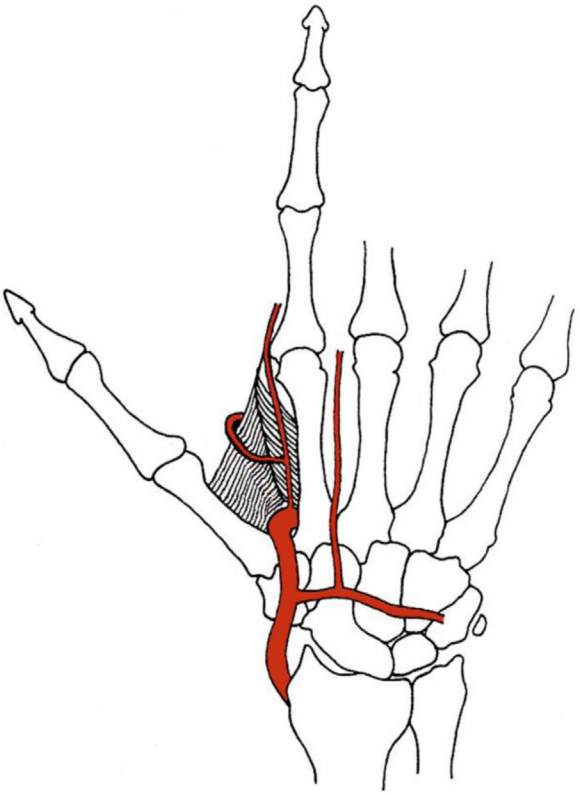

Fig. 8. Type 3.

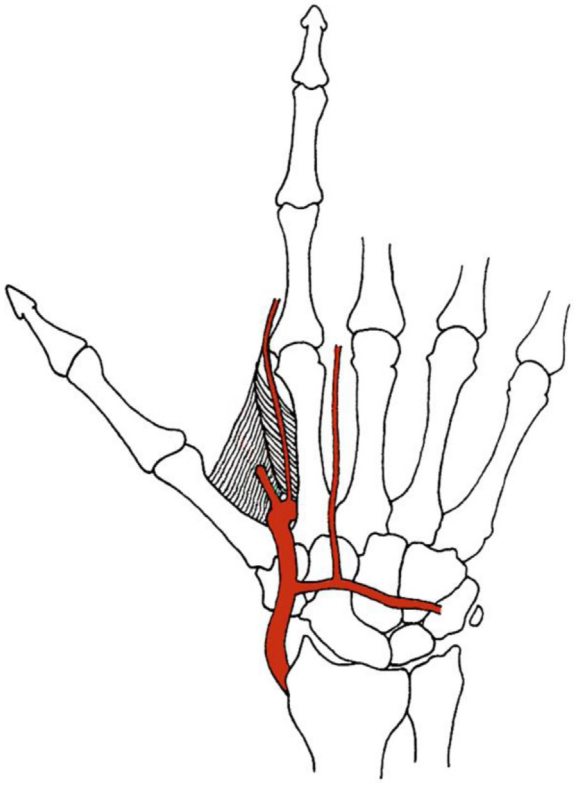

Fig. 9. Type 4.

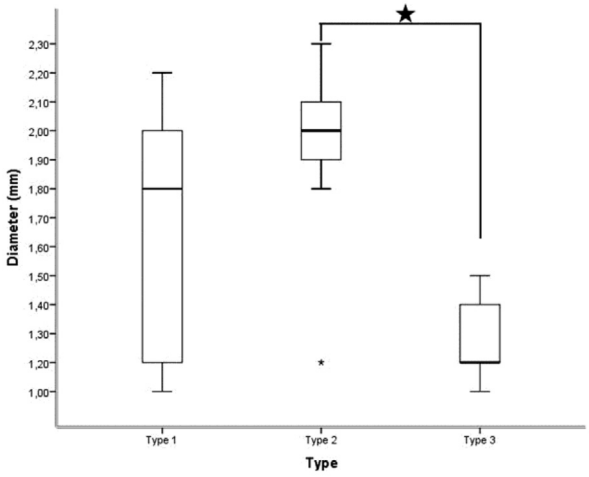

Fig. 10. Comparison of mean diameter in particular types.

In the positive findings (Types 1–3) we also measured the diameter of the artery. The normality of distribution was tested by *Shapiro–Wilk test* and the distribution was skewed (df = 60, $p < 0.001$). The resulting diameter ranched between 1 and 2.3 mm (median = 1.8 mm, IQR = 0.8).

Moreover, we measured the diameter with respect to a particular type (Types 1–3, as defined above). We found the diameter of the accessory artery to be the greatest in Type 2 (mean = 1.9 mm, SE = 0.66, CI = 1.59–2.26), followed by Type 1 (mean = 1.6 mm, SE = 0.13, CI = 1.48–1.72), and type 3 respectively (mean = 1.23 mm, SE = 0.14, CI = 0.6–1.85). We found a significant difference between the groups ($F(2) = 3.219$, $p = 0.047$). Turkey post hoc test revealed that the diameter differed significantly between type 2 and type 3 (mean difference = 0.69, SE = 0.28, $p = 0.05$). The detailed figure could be found in Fig. 10.

We also looked at the possible difference in diameter in gender. We did not find any significant differences in the diameters between male (median = 1.25 mm, IQR = 0.42) and female (median = 1.5, IQR = 1.0); (p = 0.36).

4. Discussion

In this paper we describe in detail the inconsistently appearing artery which can be found subcutaneously in the first web space with special focus given to its incidence, topography and branching. Until now, such a description has been missing in both anatomical and surgical literature.

According to our result this artery occurs in almost 12% of cases. It does not correlate with gender.

Moreover, it does not show any side differences. We described four types of artery with respect to its branching. Type 1 was the most common one, being found in almost 10% of cases. The artery rises from the radial artery, and forms the anastomosis with the superficial palmar arch. Type 2 is much less common, being found in only 1.4% of our cases. In this type, the artery rises from the radial artery, forms the anastomosis with the superficial palmar arch and continues as a strong ulnopalmar digital artery of the thumb. This variation also has the largest diameter. Type 3 is even less common than Type 2 (0.6%) and rises from the first dorsal metacarpal artery. It forms the anastomosis with the superficial palmar arch. Unlike all the types above, type 4 does not form the anastomosis with the superficial palmar arch and thus was considered as negative finding. It was rising from the radial artery as found in all the other types. Average diameter of the artery as analyzed in positive findings ranged between 1.0 and 2.3 mm and did not show any

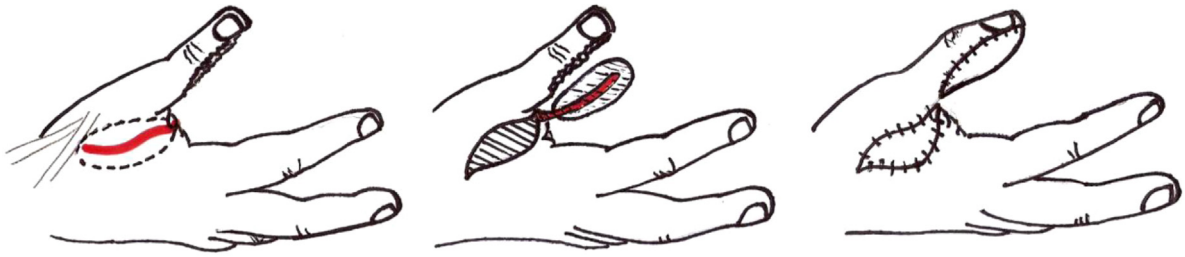

Fig. 11. Possible use of the artery as the pedicle vessel of reverse island flap for thumb reconstruction (author's drawing).

correlation with gender or side. As mentioned above, we found a statistically significant difference between the diameters of Type 2 and Type 3. The reason for the larger diameter found in Type 2 could be that it is a major source of arterial blood supply of the thumb. In contrast, Type 3 was found to be smaller probably due to its branching from a weak first dorsal metacarpal artery.

The name of the artery however still remains in question. We do not agree with the description of the first dorsal metacarpal artery branching into radial, intermediate (central) and ulnar branches as proposed by Murakami (Murakami et al., 1969) and after him also by Sherif, Bianchi and Pistre (Sherif, 1994a,b; Bianchi, 2001; Pistre et al., 2001). With respect to the fact that arteries branch from the radial artery separately, we consider them to be separate arteries. The radial branch of the first dorsal metacarpal artery is, according to our opinion, the ulnodorsal digital artery of the thumb and the ulnar branch is the first dorsal metacarpal artery itself (Miletin et al., 2017). The artery that resembles the intermediate branch, however, still lacks its systemic name. With respect to its origin from radial artery, its superficial course and terminal anastomosis with the superficial palmar arch we suggest the term superficial dorsal branch of radial artery (*ramusdorsalissuperficialisarteriae radialis*). The term also paraphrases the anatomical term superficial palmar branch of radial artery.

We also believe, that the above mentioned superficial dorsal branch of the radial artery might be successfully used in plastic and reconstructive surgery, similar to other already used arteries. These arteries include the first dorsal metacarpal artery, the ulnodorsal digital artery of the thumb and the second dorsal metacarpal artery that are routinely used as pedicle arteries of local axial flaps (Holevich, 1963; Foucher and Braun, 1979; Cavadas, 2003; Zhang et al., 2009). Furthermore, due to its strong diameter and terminal anastomosis with the superficial palmar arch, this arterial variation seems to be a favorable pedicle for cutaneous and fasciocutaneous flaps. Tezcan already described the use of such flap in five cases (Tezcan et al., 1997). Moreover, this artery could be also used as a recipient vessel for free flaps, such as toe to thumb transfer. This, however, remains to be examined. Furthermore, knowledge of this variation could be also beneficial during venous cannulation, as the variation can be mistaken for a vein (Tibbetts, 2002) (Fig. 11).

This study has some limitations. Such a limitation could be the sample size. Although our sample size is the largest one that covers this topic, it still could be too small to distinguish in detail the rare cases, mainly in variations in Types 2, 3 and 4. For a faster preparation the intravascular injection could have been used, however, we do not consider this to have a major effect on our results. As we were not able to determine the precise age of our donors, we were not able to correlate the age and diameter of the observed vessels that might also play a role.

Further research needs to be done in the field. This research should include visual methods such as sonography or angiography and apply them on healthy volunteers together with clinical palpation examination and obtaining basic clinical data such as age and gender. Furthermore, we would like to describe the reliability of simple clinical examination compared to imaging methods, as we presume, that the pulse of the artery, if it is present, can be always easily palpated. This could eventually contribute to better determination of future clinical use of the vessel.

5. Conclusion

Based on the large anatomical study we describe an inconstant branch of the radial artery in the dorsum of the hand and define its four subtypes. These findings can be further used in surgical reconstruction of the thumb.

Authors' contribution

Jakub Miletin – project development, dissection and acquisition of data, drafting of the manuscript.

Andrej Sukop – critical revision of the manuscript.

Vaclav Baca – data analysis/interpretation.

David Kachlik – dissection and acquisition of data, drafting of the manuscript.

Ethical statement

The authors kindly thank all of the body donors (with written consent for experimentation with human subjects) for their gift.

The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

Conflict of interest

The authors state that they have no conflict of interests.

Acknowledgements

We express our major gratitude to all the donors, whose gift allows anatomical science to continue in revealing secrets of human body. All the parts of donated bodies were treated with major respect and in agreement with ethical principles. We are also grateful to Barbora Vyhnánková, the author of Figs. 1, 6–9 and 11.

The protocol for the research project has been approved by the Ethics Commission of the Faculty of Medicine, Charles University and it conforms to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000). All human subjects gave informed consent and donors' anonymity has been preserved.

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11.3. Příloha 3 - A plea for extension of the anatomical nomenclature: Vessels, Kachlík et al, 2021

A plea for extension of the anatomical nomenclature: Vessels

David Kachlik[1,2], Vladimir Musil[3*], Alzbeta Blankova[1], Zuzana Marvanova[1], Jakub Miletin[1], Daniela Trachtova[1], Vlasta Dvorakova[2], Vaclav Baca[2]

ABSTRACT

This article is the fourth and last part of a series aimed at extending and correcting the anatomical nomenclature. Because of the rapid development of internet and the use of electronic formats in communication in anatomy, embryology, histology, medical education, and clinical medicine, an appropriate, precise, and concise anatomical nomenclature is required. Such tool enables to avoid any potential confusion and possible scientific/medical mistakes. The up-to-date official anatomical terminology, Terminologia Anatomica, is available longer than 20 years and needs to be refined and extended. The authors have collected and listed 210 terms and completed them with definitions and/or explanations. We aimed to start a discussion about their potential incorporation into the new revised version of the Terminologia Anatomica. This article is primarily focused on the vessels of the human body (arteries, veins, and lymphatic system).

KEYWORDS: Anatomical terminology; anatomical nomenclature; Terminologia Anatomica; vessels; artery; vein

INTRODUCTION

This article is the fourth and last part of a series aimed at extending and correcting the anatomical nomenclature. It closes a set of contributions to extent and revise the technical norm for naming morphological structures of the human body in relation to the anatomical nomenclature of the nervous system and senses [1], locomotor system [2], and organs [3]. All the general statements and discussions concerning the history, grammar, and clinical relevance of the anatomical nomenclature and terminology are parts of our previous set of articles. We have also repetitively stressed the importance of anatomical nomenclature in enabling clear, unanimous, and unambiguous communication among specialists. All revised or newly proposed terms to be potentially incorporated into the only official valid version of the anatomical nomenclature called Terminologia Anatomica (TA) are summarized in these articles [1-15].

International Federation of Associations of Anatomists (IFAA) is the only organ responsible for worldwide valid official terminology in human anatomy, histology, and embryology. Concerning the anatomical nomenclature, its last version is quite old-fashioned as it was issued already 22 years ago, in 1998 [16], by not anymore existing Federative Committee on Anatomical Terminology (FCAT), which was in 2005 renamed to Federative International Committee on Anatomical Terminology (FICAT) and in 2009 replaced by Federative International Programme on Anatomical Terminology (FIPAT). Now, FIPAT prepares a new edition called Terminologia Anatomica 2, which is already available online as a draft not yet approved by IFAA and thus not official [17]. The anatomical terminology of vessels is also part of the Terminologia Histologica, published in 2008 [18], Terminologia Embryologica in 2013 [19] and its revision Terminologia Embryologica 2, issued in 2017 [20], and concerning the brain and sensory organs as a part of the Terminologia Neuroanatomica, published in 2017 [21].

The authors have gathered anatomical terms of vascular system absent in the Terminologia Anatomica that they have encountered during their scientific and educational work. Some terms listed here are mentioned and explained in classical textbooks and familiar to all anatomist and thus they are not completed with references. Other terms have been reviewed, refined, or proposed *de novo* for anatomical structures which were previously not well described and/or defined.

Terms presented ***in bold italics*** are newly created terms proposed for incorporation into the Terminologia Anatomica, terms presented in *plain italics* are already listed in the Terminologia Anatomica, terms within quotation marks are non-recommended or obsolete, terms in parentheses are eponyms, synonyms, or explanations, and terms marked with

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asterisks have been already stated in some of our previous works. In total, 210 terms are suggested for incorporation into the TA: 22 concerning general terms in *Systema cardiovasculare*, 47 items in heart, 56 arteries, 51 veins, and 34 structures in *Systema lymphaticum*. The list of Latin terms compared to their English equivalents is presented in Table 1.

TABLE 1. List of Latin terms with their English equivalents

Latin term	English term
1. Anatomia generalis	
Fasciculus vasonervosus	Neurovascular bundle
Angiosoma	Angiosome
Arteriosoma	Arteriosome
Venosoma	Venosome
Phlebosoma	Phlebosome
Lymphosoma	Lymphosome
Vasa private	Nutritive vessels
Vasa publica	Functional vessels
Vincula arteriarum	Vincula of arteries
Valva venosa	Venous valve
Margo affixus (margo parietalis)	Fixed margin (parietal margin)
Margo liber	Free margin
Facies luminalis valvulae	Luminal surface of valvule
Facies parietalis valvulae	Parietal surface of valvule
Sinus valvulae	Sinus of valvule
Commissurae valvae	Commissures of valve
Cuspis valvulae	Cusp of valvule
Agger valvulae	Agger of valvule
Vasa gonadalia	Gonadal vessels
Vasa cruralia	Crural vessels
2. Cor	
Crux cordis	Crux cordis
Vestibulum atrii	Vestibule of atrium
Corpus atrii	Body of atrium
Cuspis valvae mitralis/tricuspidalis	
Apex	Apex
Margo	Margin
Basis	Base
Valva mitralis/tricuspidalis	
Commissura anterolateralis	Anterolateral commissure
Commissura posteromedialis	Posteromedial commissure
Commissura anteroposterior	Anteroposterior commissure
Commissura posteroseptalis	Posteroseptal commissure
Commissura anteroseptalis	Anteroseptal commissure
Trigonum nodi atrioventricularis	Triangle of atrioventricular node
Crus sinistrum fasciculi atrioventricularis	
Crus anterosinistrum	Anterior left arm
Crus posterosinistrum	Posterior left arm
Skeleton cordis	Skeleton of heart
Anulus aorticus	Aortic anulus
Anulus trunci pulmonalis	Pulmonary anulus
Fila coronaria	Coronary cords
Continuum aortomitrale	Aortomitral continuity
Trigona subcommissuralia	Subcommissural triangles
Tendo coni	Conus tendon
Tendo infundibuli	Infundibular tendon
Valva aortae	
Commissura sinistrodextra	Left-right commissure
Commissura posterosinistra	Left-posterior commissure
Commissura posterodextra	Right-posterior commissure
Valva trunci pulmonalis	
Commissura sinistrodextra	Left-right commissure
Commissura anterosinistra	Left-anterior commissure
Commissura anterodextra	Right-anterior commissure
Isthmus cavotricuspidalis	Cavotricuspidal isthmus
Plica ventriculoinfundibularis	Ventriculoinfundibular fold
Junctio sinutubularis	Sinutubular junction
Nodus sinuatrialis	
Caput	Head
Cauda	Tail
Ostia venarum (cardiacarum) minimarum	Openings of smallest cardiac veins
Ostia venarum ventriculi dextri anteriorum	Openings of anterior veins of the right ventricle
Ostium arteriae coronariae	Opening of coronary artery
Ramus diagonalis	Diagonal branch
Ramus diagonalis primus, secundus et tertius	First, second, and third diagonal branch
Ramus posterolateralis sinister	Left posterolateral branch
Valva terminalis venae cardiacae magnae	Terminal valve of great cardiac vein
Cavitas pericardiaca	Pericardial cavity
Porta arteriarum	Arterial porta
Porta venarum	Venous porta
3. Arteriae	
Arteria ciliaris posterior longa nasalis et temporalis	Nasal and temporal long posterior ciliary artery
Rami trabeculares (rami anterioris arteriae hypophysialis superioris)	Trabecular branches (of anterior branch of superior hypophysial artery)
Arcus labiorum superior	Superior labial arch
Arcus labiorum inferior	Inferior labial arch
Arteria subclavia dextra aberrans	Aberrant right subclavian artery
(Arteria pyramidalis)	(Pyramidal artery)
Arteria supraclavicularis	Supraclavicular artery
(Arteria brachialis accessoria)	(Accessory brachial artery)
(Arteria brachioradialis superficialis)	(Superficial brachioradial artery)
(Arteria brachioulnaris superficialis)	(Superficial brachioulnar artery)
(Arteria brachioulnoradialis superficialis)	(Superficial brachioulnoradial artery)
(Arteria brachiomediana superficialis)	(Superficial brachiomedian artery)
(Arteria comitans nervi mediani antebrachii et manus)	(Artery accompanying median nerve in forearm and hand)
Arteria cubitalis inferior	Inferior cubital artery
Ramus palmaris et dorsalis arteriae interosseae anterioris	Palmar and dorsal branch of anterior interosseous artery
Ramus ascendens et descendens rami carpalis dorsalis arteriae ulnaris	Ascending and descending branch of dorsal carpal branch of ulnar artery

(Contd...)

ANATOMIA GENERALIS

- ***Fasciculus vasonervosus**** (neurovascular bundle) is a bundle of a nerve and one or more vessels. The peripheral or cranial nerve is accompanied by an artery and one or two veins, or, if located in a superficial compartment, a

TABLE 1. *(Continued)*

Latin term	English term
Rete carpale palmare	Palmar carpal arch
Arteria digitalis ulnopalmaris pollicis et arteria digitalis radiopalmaris pollicis	Ulnopalmar and radiopalmar digital artery of thumb
Arteria digitalis ulnodorsalis pollicis et arteria digitalis radiodorsalis pollicis	Ulnodorsal and radiodorsal digital artery of thumb
(Ramus superficialis dorsalis arteriae radialis)	(Superficial dorsal branch of radial artery)
Ramus vertebrospinalis dexter et sinister	Right and left vertebrospinal branch
Arteria radiculospinalis	Radiculospinal artery
Arteria radiculopialis	Radiculopial artery
Vasocoronae	Vasocoronae
Rami perforantes (vasocoronarum)	Perforating branches (of vasocoronae)
Arteria sulcocommissuralis	Sulcocommissural artery
Ramus spinalis magnus (arteriae intercostalis posterioris)	Great spinal branch of posterior intercostal artery
(Truncus gastrosplenicus)	(Gastrosplenic trunk)
(Truncus hepatosplenicus)	(Hepatosplenic trunk)
(Truncus hepatogastricus)	(Hepatogastric trunk)
Ramus anterior et posterior arteriae splenicae	Anterior and posterior branch of splenic artery
Arteriae et venae intestinales rectae	Straight intestinal arteries and veins
Plexus vasculosus myentericus	Myenteric vascular plexus
Plexus vasculosus submucosus	Submucous vascular plexus
Rami retroperitoneales anteriores (aortae)	Anterior retroperitoneal branches of aorta
Venae retroperitoneales anteriores	Anterior retroperitoneal veins
Arteria sacralis lateralis superior et inferior	Superior and inferior lateral sacral artery
Arteria et vena obturatoria aberrans	Aberrant obturator artery and vein
Arteria et vena obturatoria accessoria aberrans	Aberrant accessory obturator artery and vein
Arteria femoralis communis	Common femoral artery
Arteria perforans prima, secunda et tertia	First, second, and third perforating artery
Truncus tibiofibularis	Tibiofibular trunk
Arteria tarsalis medialis proximalis et distalis	Proximal and distal medial tarsal artery
Arteria tarsalis lateralis proximalis et distalis	Proximal and distal lateral tarsal artery
Arteria sinus tarsi medialis	Medial artery of tarsal sinus
Arteria sinus tarsi lateralis	Lateral artery of tarsal sinus
4. Venae	
Ramus anterior et posterior (venae retromandibularis)	Anterior and posterior branch of retromandibular vein
Vena facialis communis	Common facial vein
Vena sphenopalatina	Sphenopalatine vein
Venae palatinae	Palatine veins
Vena infraorbitalis	Infraorbital vein
Plexus cavernosi concharum	Cavernous plexuses of conchae
Genu vasculosum (disci articularis temporomandibularis)	Vascular knee (of tempomandibular articular disc)
Arcus venosus xiphoideus	Xiphoid venous arch
(Vena incisurae scapulae)	(Suprascapular notch vein)
Vena perforans cubitalis	Cubital perforating vein
Arcus venae azygoi	Arch of azygos vein
Truncus splenomesentericus	Splenomesenteric trunk
Truncus gastropancreatocolicus	Gastropancreatosplenic trunk
Vena azygos lumbalis dextra	Right lumbar azygos vein

(Contd...)

TABLE 1. *(Continued)*

Latin term	English term
Vena azygos lumbalis sinistra	Left lumbar azygos vein
Vena communicans lumbalis	Lumbar communicating vein
Vena cremasterica	Cremasteric vein
Vena ligamenti teretis uteri	Vein of round ligament of uterus
Plexus pudendus	Pudendal plexus
Vena portae	Portal vein
Anastomoses portocavales	Portocaval anastomoses
Anastomosis portocavalis gastrooesophagea submucosa et adventitialis	Submucous and adventitial gastroesophageal portocaval anastomosis
Anastomosis portocavalis rectalis submucosa et adventitialis	Submucous and adventitial rectal portocaval anastomosis
Anastomosis portocavalis subcutanea	Subcutaneous portocaval anastomosis
Anastomosis portocavalis muscularis	Muscular portocaval anastomosis
Anastomosis portocavalis preperitonealis	Preperitoneal portocaval anastomosis
Anastomosis portocavalis retroperitonealis	Retroperitoneal portocaval anastomosis
Anastomosis portocavalis hepatica	Hepatic portocaval anastomosis
Anastomoses cavocavales	Cavocaval anastomoses
Anastomosis cavocavalis subcutanea	Subcutaneous cavocaval anastomosis
Anastomosis cavocavalis muscularis	Muscular cavocaval anastomosis
Anastomosis cavocavalis retroperitonealis	Retroperitoneal cavocaval anastomosis
Anastomosis cavocavalis vertebralis	Vertebral cavocaval anastomosis
Vena femoralis communis	Common femoral vein
Venae comitantes arteriarum perforantium	Accompanying veins of perforating arteries
Junctio saphenofemoralis	Saphenofemoral junction
Confluens venosus subinguinalis	Subinguinal venous confluens
Valva terminalis (venae saphenae magnae)	Terminal valve (of great saphenous vein)
Valva preterminalis (venae saphenae magnae)	Preterminal valve (of great saphenous vein)
Junctio saphenopoplitea	Saphenopopliteal junction
Extensio proximalis/cranialis venae saphenae parvae	Proximal/cranial extension of small saphenous vein
Vena intersaphena femoris	Femoral intersaphenous vein
5. Systema lymphaticum	
Systema lymphaticum	Lymphatic system
Segmentum polare anterius et posterius (splenis)	Anterior and posterior polar segment (of spleen)
Segmenta interposita (splenis)	Interposed segments (of spleen)
Crenae splenis	Notches of spleen
Margo intermedius (splenis)	Intermediate margin (of spleen)
Nodus lymphaticus arcus venae azygoi	Lymph node of arch of azygos vein
Confluens lymphaticus abdominalis	Abdominal lymphatic confluens
Nodi lymphatici mesenterici superiores intermedii et centrales	Intermediate and central superior mesenteric lymph nodes
Nodi lymphatici epicolici	Epicolic lymph nodes
Nodi lymphatici mesenterici inferiores intermedii et centrales	Intermediate and central inferior mesenteric lymph nodes
Plexus lymphaticus palmaris	Palmar lymphatic plexus
Truncus lymphaticus lateralis, medialis et anterior (membri superioris)	Lateral, medial and anterior lymphatic trunk (of upper limb)
Plexus lymphaticus plantaris	Plantar lymphatic plexus

(Contd...)

TABLE 1. *(Continued)*

Latin term	English term
Truncus ulnaris	Ulnar trunk
Truncus interosseus anterior et posterior	Anterior and posterior interosseous trunk
Truncus radialis	Radial trunk
Truncus brachialis	Brachial trunk
Truncus lymphaticus medialis (membri inferioris)	Medial lymphatic trunk (of lower limb)
Fasciculus medialis et lateralis	Medial and lateral fascicle
Truncus lymphaticus lateralis et posterior (membri inferioris)	Lateral and posterior lymphatic trunk (of lower limb)
Truncus tibialis posterior et anterior	Posterior and anterior tibial trunk
Truncus fibularis	Fibular trunk
Truncus popliteus	Popliteal trunk
Truncus femoralis	Femoral trunk

Each indentation in the hierarchies is the expression of a "part_of" relation: When an anatomical entity A is indented below B, it means "A part_of B." Terms stated in parentheses are variable.

cutaneous nerve is accompanied by a superficial vein. The bundle is encompassed in a fibrous sheath and consists of homonymous or heteronymous structures (*nervus ulnaris – vasa ulnaria*; *nervus fibularis profundus – vasa tibialia anteriora*) [11].

- ***Angiosoma**** is an anatomical unit of tissue composed of skin, subcutaneous tissue, fascia, muscle, and bone which is nourished by a specific artery and drained by specific veins [22]. The whole human body consists of 40 angiosomes [23]. ***Arteriosoma*** is such anatomical unit supplied by a specific artery [24] and ***venosoma**** is the same unit drained by a specific vein. In case the extent of the venous drainage is different from arterial supply of the *angiosoma*, the anatomical unit is termed ***phlebosoma**** [25]. The anatomical unit drained by superficial lymphatic vessels is then termed ***lymphosoma*** [13,26].
- Some organs (lungs, liver) feature two types of circulation – nutritive and functional. It is necessary to denominate them also in Latin and there exist terms: The ***vasa privata*** for the nutritive circulation and the ***vasa publica*** for the functional one [27].
- ***Vincula arteriarum*** are thin fibrous bands fixating arteries (with accompanying vessels) to adjacent tissue, e.g. *vasa tibialia anteriora*, hidden in fibrous sheath, to the *membrana interossea cruris*.
- General term for the venous valve – *valvula venosa* – is not precise as a classical venous valve comprises two swallow-nest-shaped cusps, called *valvulae*, and that is why the term has to be redressed to the ***valva venosa*** consisting of two *valvulae*. These valvules are attached to the venous wall by a firm ***margo affixus* (*margo parietalis*)** and their free concave ***margo liber*** protrudes into the lumen of the vein. The blood current travels on the ***facies luminalis valvulae***, when it is stopped and turns back, the ***margo liber*** is deflected from the wall toward the opposite valvule, and the lumen is closed. A space formed then by the ***facies parietalis valvulae*** is termed the ***sinus valvulae***. A junction between the *margo affixus* and the *margo liber* is denominated the ***cornu valvulae*** and the slightly elevated parts between adjacent ends of the *margines affixi* are termed the ***commissurae valvae*** as they connect the two valvules. The body of the valvule is called the ***cuspis valvulae*** and it is thickened at the *margo affixus* in the double-horseshoe-shaped ***agger valvulae*** (clinically frequently called "tuberculum" or "limbus") [28].
- ***Vasa gonadalia*** is a general term which can be used either during the early development when the gender of the embryo is still indifferent or if referred to the *vasa testicularia* in male or to the *vasa ovarica* in female unspecificly, i.e. when general features of these vessels are discussed, not related to the gender.
- ***Vasa cruralia*** is a general term for the principal trunks of the leg (*vasa tibialia anteriora, vasa tibialia posteriora,* and *vasa fibularia*) and can be used when they are considered as general vessels coursing within the leg and supplying the leg and foot.

COR

- ***Crux cordis*** is an area on the *facies posterior cordis* where the *sulcus coronarius* and the *sulcus interventricularis posterior* meet.
- In pathology, the division of the heart atrium into the ***corpus atrii*** and the ***vestibulum atrii*** is used. Both parts of the atrium are smooth due to the absence of the *musculi pectinati*. On the right side, *musculi pectinati* are overlapping from the auricle onto the free atrial wall and they divide the *atrium dextrum* into the *vestibulum atrii* and the *corpus atrii*. On the left side, the *musculi pectinati* are reduced to the auricle only and thus, the *vestibulum atrii* and the *corpus atrii* are in direct continuation. The *corpus atrii sinistri* receives the *venae pulmonales* (comprises the *ostia venarum pulmonalium*) and the *vestibulum atrii sinistri* is a smooth part of the atrium below this level.
- *Cuspis valvae mitralis/tricuspidalis* features three parts: The ***apex***, the ***margo,*** and the ***basis***.
- Each leaflet (*cuspis*) of a cuspidal valve (*valva mitralis et tricuspidalis*) is separated from the other(s) by commissures: The ***commissura anterolateralis*** and the ***commissura posteromedialis*** are present in the *valva mitralis* between its two leaflets and they are denominated according to their location; the ***commissura anteroposterior***, the ***commissura posteroseptalis*** and the ***commissura anteroseptalis***

are present in the *valva tricuspidalis* between its three leaflets and they are denominated according to which leaflets they connect.

- ***Trigonum nodi atrioventricularis*** (of Koch) is a triangle in the right atrium and is defined by three angles: The *ostium sinus coronarii*, the *tendo valvulae venae cavae inferioris* (of Todaro) and the *cuspis posterior valvae tricuspidalis* (or more precisely its *commissura anteroseptalis*). Underneath its surface, the *nodus atrioventricularis* is situated.
- *Crus sinistrum fasciculi atrioventricularis* (of Tawara) terminates by a bifurcation into the ***crus anterosinistrum*** and ***crus posterosinistrum***.
- ***Skeleton cordis*** is a general term for the fibrous scaffold supporting the valves and muscle fibers and electrically isolating the atria from the ventricles. It comprises four anuli, two triangles, three ligaments, *pars membranacea septi,* and some other parts [29].
    - ***Anulus aorticus*** *et* ***anulus trunci pulmonalis*** are integral parts of the *skeleton cordis*, encircling the corresponding ostia, and forming scaffold for corresponding valves.
    - ***Fila coronaria*** ("subvalvar collar"; "subvalvar membrane") are fibrous subendocardial cords, extensions of the *trigona fibrosa*, forming approximately 75% of the *anuli fibrosi* of the heart skeleton (the rest is only a less distinct sheet of fibroelastic tissue).
    - *Pars membranacea septi* is a small fibrous part of the *skeleton cordis* which contributes to the separation of the right and left atria (***subpars interatrialis partis membranacae septi***) and of the right atrium and left ventricle (***subpars atrioventricularis partis membranaceae septi***). Due to its complex structure, its subparts deserve their own denominations.
    - ***Septum intervalvulare ventriculi dextri*** ("subaortic curtain") is a part of the fibrous *skeleton cordis* having the shape of a sheet that spans the gap between the fibrous arches supporting the *valvula semilunaris sinistra et dextra valvae aorticae.* It passes caudally within the wall of the right atrium and blends with the fibrous core of the *cuspis anterior valvae mitralis.*
    - ***Continuum aortomitrale*** ("fibrous aortic-mitral continuity") is a fibrous area between the *trigonum fibrosum dextrum et sinistrum* (laterally), the *anulus fibrosus sinister* (ventrally), and the *anulus aorticus* (dorsally) and is important in aortic valvular replacement surgery.
    - ***Trigona subcommissuralia*** (interleaflets triangles) are located between the *valvulae semilunares valvae aortae* and their commissures and should be left free in aortal valvuloplasty.
    - ***Tendo coni*** is an inconsistent fibrous band at the contact point of the beginning of the *truncus pulmonalis* and *aorta ascendens*, extending somewhere between the *commissura sinistrodextra valvae aortae* and the pulmonary valvar sinuses.
    - ***Tendo infundibuli*** is an inconstant fibrous band within the *crista supraventricularis*, arising at the level of the *pars membranacea septi interventricularis* and extending cranially to connect with the posterior surface of the *conus arteriosus* ("infundibulum; pars glabra") at the base of the *truncus pulmonalis.*
    - *Commissurae valvularum semilunarium* are three in each outflow valve and should be distinguished according to their position. *Valva aortae* contains the ***commissura sinistrodextra, commissura posterosinistra*** *et* ***commissura posterodextra***; *valva trunci pulmonalis* contains the ***commissura sinistrodextra, commissura anterosinistra*** *et* ***commissura anterodextra***.
- ***Isthmus cavotricuspidalis*** is a fibrous tissue in the lower part of the right atrium, located between the *vena cava inferior* and the *valva tricuspidalis*.
- ***Plica ventriculoinfundibularis*** is a fine muscular bundle interposed between the leaflets of an atrioventricular (cuspidal) and a ventriculoarterial (semilunar) valve, i.e. it separates the inlet (inflow part) of the ventricle from its outlet (outflow part). The *plica* is a relatively fine sheet of a muscle that is folded back on itself [30].
- ***Junctio sinutubularis*** is a narrow zone (2-3.5 mm high) of the *aorta ascendens* above the *bulbus aortae* where the normal tubular configuration of the aorta is attained.
- *Nodus sinuatrialis* can be subdivided into the ***caput*** and the ***cauda***.
- All the vascular openings in the heart cavities are termed *ostia* except the smallest ones, *foramina venarum minimarum*. The term *foramen* is in heart related to the developmental structures (*foramen ovale, foramen primum, foramen secundum,* and *foramen interventriculare*) and that is why the term for openings of the *venae cardiacae minimae* should be changed to the ***ostia venarum (cardiacarum) minimarum***. Similarly, terms for innominate openings of the *venae ventriculi dextri anteriores* should be created – ***ostia venarum ventriculi dextri anteriorum***.
- ***Ostium arteriae coronariae*** is the opening of a coronary artery located in the lateral wall of the *sinus aortae* (of Valsalva).

- ***Ramus diagonalis*** is a clinically used term for the *ramus lateralis*, branch from the *ramus interventricularis anterior*. Its course is oblique (or diagonal) across the ventral surface of the left ventricle toward the *apex cordis* and due to the anatomical position and the preference by clinicians, the term *ramus diagonalis* should be preferred. Sometimes, it can be doubled or tripled (***ramus diagonalis primus, secundus et tertius***).
- ***Ramus posterolateralis sinister*** is a variant largest *ramus posterior ventriculi sinistri* (a terminal branch of the *ramus circumflexus arteriae coronariae sinistrae*), being present in the case of dominance of the *arteria coronaria sinistra* (in that case a bypass can be applied to the stenotic *ramus posterolateralis sinister*).
- ***Valva terminalis venae cardiacae magnae*** (of Vieussens) is a nearly constant (75%) ostial valve at the transition between the *vena cardiaca magna* and the *sinus coronarius*, located at the *margo sinister cordis*.
- ***Cavitas pericardiaca*** is a serous cavity between the *lamina parietalis pericardii* and the *lamina visceralis pericardii*, containing a small amount of the *liquor pericardii*.
- ***Porta arteriarum*** (obsolete term "vagina serosa arteriarum") is a transition of the *lamina parietalis pericardii* into the *lamina visceralis pericardii*, encompassing both the *aorta ascendens* and the *truncus pulmonalis* in the extent of 2 cm. ***Porta venarum*** (obsolete term "vagina serosa venarum") is a similar transition on the *venae cavae* and the *venae pulmonales*, located caudally to the former in the posterior wall of the pericardium.

ARTERIAE

- *Arteriae ciliares posteriores longae* are two in each eyeball and can be distinguished as the medial ***arteria ciliaris posterior longa nasalis*** and the lateral ***arteria ciliaris posterior longa temporalis***.
- ***Rami trabeculares*** are branches from the *ramus anterior arteriae hypophysialis superioris*, descending in front of the *infundibulum* and terminating in a large arterial stem, the *arteria trabecularis*, along the *pars tuberalis hypophysis*.
- ***Arcus labiorum superior*** is an arterial anastomosis of the *arteria labialis superior dextra et sinistra* located in the mass of the *musculus orbicularis oris* of the upper lip. Similarly, ***arcus labiorum inferior*** is an arterial anastomosis of the *arteria labialis inferior dextra et sinistra* in the lower lip.
- ***Arteria subclavia dextra aberrans (ASDA)***** is a clinically relevant but rather rare variant (approximately 1% of cases) of the *arteria subclavia*, ramifying as the very last branch from the *arcus aortae*, left (distally) to the origin of the *arteria subclavia sinistra*, and crossing the midline to the right side. It may run in front of the trachea as the *ASDA pretrachealis* (5% of all *ASDA*), between the trachea and the esophagus as the *ASDA retrotrachealis* (15%) and between the esophagus and the vertebral column as the *ASDA retrooesophgea* (retro-esophageal right subclavian artery/RRESA/), found in about 80% of all *ASDA*). In the two latter cases, it could compress the esophagus and may cause problems with swallowing termed dysphagia lusoria that is why in the case of present clinical symptoms, the variant artery used to be called the "arteria lusoria" [11,31].
- ***Arteria pyramidalis*** is a variant branch from the distal part of the *arteria thyroidea superior*, just before its bifurcation into its *ramus anterior et posterior*, supplying the *lobus pyramidalis glandulae thyroideae*, when present (40% of cases) [32].
- ***Arteria supraclavicularis*** is a smaller branch either from the *arteria transversa cervicis* directly [10] or from its *ramus superficialis*, coursing within the *regio cervicalis lateralis* and supplying the fascia and the skin above and below the clavicle.
- The variations of the main upper limb arterial trunks occur in about 20% of cases. They comprise trunks with superficial course, high origins of the forearm trunks, variant vessels or combinations (*arteria brachialis superficialis****, arteria brachialis accessoria, arteria brachioradialis superficialis, arteria brachioulnaris superficialis, arteria brachioulnoradialis superficialis, arteria brachiomediana superficialis, arteria comitans nervi mediani manus et antebrachii****, etc.) [12,33-42].
- ***Arteria cubitalis inferior*** (obsolete terms "arteria antebrachialis volaris superficialis; arteria antebrachialis mediana") is the first branch of the *arteria radialis* and is the largest perforating artery in the forearm. It passes superficially between the *musculus brachioradialis* and *musculus pronator teres* and its branches spread across the *fascia antebrachii* along the medial aspect of the *vena cephalica* toward the *processus styloideus radii*. The area of the skin fed by this artery is considered to be the largest nourished by a single cutaneous arterial perforator [43-44].
- *Arteria interossea anterior* bifurcates into two terminal branches: The ***ramus palmaris*** supplying the *musculus pronator quadratus*, running deep underneath, and joining the *rete carpale palmare*; and ***ramus dorsalis*** penetrating the *membrana interossea anterior* to anastomose with the *arteria interossea posterior* which then joins the *rete carpale dorsale*.

- *Ramus carpalis dorsalis arteriae ulnaris* (obsolete term "dorsal ulnar artery") bifurcates into the ***ramus ascendens et descendens***, the latter anastomosing with the *ramus profundus arteriae ulnaris* [45].
- ***Rete carpale palmare*** is a small anastomotic network on the anterior aspect of the wrist, fed by the *ramus carpalis palmaris arteriae radialis, ramus carpalis palmaris arteriae ulnaris,* and *ramus palmaris arteriae interosseae anterioris*.
- The thumb is fed by four arteries, two dorsal and two palmar, coursing along the nerves in neurovascular bundles. The palmar arteries are larger and nearly constant, the dorsal are smaller and rather variable. Their terminology is not coined and Miletin et al. proposed the descriptive terms ***arteria digitalis ulnopalmaris pollicis*** *et* ***arteria digitalis radiopalmaris pollicis*** for the palmar arteries and ***arteria digitalis ulnodorsalis pollicis*** *et* ***arteria digitalis radiodorsalis pollicis*** for the palmar arteries. Based on the statistics, the current terminology using the term *arteria princeps pollicis* is not specific enough as the word princeps describes the principal (largest) source artery which rather varies for the thumb – the largest caliber features the *arteria metacarpalis palmaris prima* – that is why the term "*arteria princeps pollicis*" should be abandoned and removed from the TA [46].
- An inconstant artery branches from the *arteria radialis* at the dorsum of the hand just before it enters the space between the heads of the *musculus interosseus dorsalis primus*. This artery then runs distally on the dorsal surface of the muscle and at the distal margin of the first web space, it turns back into the palm and forms an anastomosis with the *arcus palmaris superficialis*. Miletin et al. reported its incidence (12%) and proposed the term ***ramus superficialis dorsalis arteriae radialis*** [47].
- *Arteria spinalis anterior* is an unpaired vessel originating as a confluence of a short paired innominate artery branching from the *arteria vertebralis*. These short transverse vessels can be denominated as the ***ramus vertebrospinalis dexter et sinister.***
- *Arteria medullaris segmentalis* is a term of the TA replacing the clinically used ***arteria radiculospinalis***; another vessel, ***arteria radiculopialis***, is important in clinical medicine and gives off the pial ***vasocoronae***, encompassing the spinal cord horizontally and emanating the ***rami perforantes*** to supply the white matter; finally, the *arteria spinalis anterior* branches off the ***arteriae sulcocommissurales*** into the *fissura mediana anterior* to supply the grey matter [48,49].
- *Arteria radicularis magna* (listed in TNA [21]) or the "artery of Adamkiewicz" is the largest and clinically the most important *ramus spinalis arteriae intercostalis posterioris* and thus it should be termed the ***ramus spinalis magnus (arteriae intercostalis posterioris)***.
- The variations of the *truncus coeliacus* are quite frequent and its incomplete formation appears in 8% of cases as ***truncus gastrosplenicus*** (3.46%), ***truncus hepatosplenicus*** (3.88%), and ***truncus hepatogastricus*** (0.24%) [50].
- *Arteria splenica* bifurcates into the ***ramus anterior et posterior arteriae splenicae***, which then further ramify into the segmental *rami splenici*.
- The mighty vasculature of the intestine consists of source arteries (and draining veins), their main macroscopic branches (and tributaries), fine vessels supplying the intestinal wall called ***arteriae*** *et* ***venae intestinales rectae***** and then by intramural plexuses. Their terminology should match the nervous counterparts, i.e. ***plexus vasculosus myentericus*** located between the *stratum longitudinale* and *stratum circulare tunicae muscularis* and ***plexus vasculosus submucosus*** located with the submucosa [3,51].
- ***Rami retroperitoneales anteriores**** are direct fine branches from the *aorta abdominalis,* the *arteria renalis* and the *arteria renalis accessoria,* the *arteria testicularis* or the *arteria ovarica*, and the *arteria iliaca communis*. They feed the adjacent lymph nodes (*nodi lymphatici lumbales et iliaci communes*), ureter, peritoneum, loose connective tissue around the *aorta abdominalis* and the *vena cava inferior*, autonomic nervous plexuses and their ganglia and the vascular wall of both the *aorta abdominalis* and *vena cava inferior* forming their *vasa vasorum*. These *rami* are followed by homonymous fine veins (***venae retroperitoneales anteriores***), emptying into the ventral aspect of the *vena cava inferior* and its tributaries [52,53].
- *Arteriae sacrales laterales* are usually two branches (***arteria sacralis lateralis superior*** *et* ***inferior***) emanating from the *divisio posterior arteriae iliacae internae*, descending and bifurcating into the corresponding *rami spinales* to enter four *foramina sacralia anteriora ossis sacri* to supply the bone, contents of the *canalis sacralis* and adjacent part of the deep back muscles.
- The *arteria obturatoria* is usually a branch from the *arteria iliaca interna,* but sometimes it can ramify from the *arteria epigastrica inferior*. In such case, it should be termed ***arteria obturatoria aberrans***. If there are two arteries present, one originating from the *arteria iliaca interna* and the other from the *arteria epigastrica inferior*, they should be called as the ***arteria obturatoria propria*** and ***arteria obturatoria acesssoria***

aberrans, respectively. Similar approach can be applied to the veins: ***Vena obturatoria aberrans*** and ***vena obturatoria accessoria aberrans***.

- In angiology and vascular surgery, the proximal segment of the *vasa femoralia*, from the arbitrary beginning under the *ligamentum inguinale* within the *lacuna vasorum* to the branching of the *arteria profunda femoris* (and termination of the *vena profunda femoris*, respectively), are termed the ***arteria femoralis communis**** and the ***vena femoralis communis****. The distal segment is then in vascular surgery termed "arteria et vena femoralis superficialis," but phlebologists do not accept this terminology as they consider superficial veins only those coursing above the layer of muscular fascia, e.g. *venae saphenae* [4-6,13,54], which can be agreed to.
- Three branches of the *arteria profunda femoris*, supplying the posterior and medial groups of the thigh muscles are called the *arteriae perforantes* and classified using numbers according to the level of their origin as the ***arteria perforans prima****, ***arteria perforans secunda****,* and ***arteria perforans tertia****. Their accompanying veins are denominated in a bit different way as the ***venae comitantes arteriarum perforantium**** due to the fact that the term *venae perforantes* is reserved for the veins interconnecting the superficial and deep venous systems [9,13,15,54].
- ***Truncus tibiofibularis**** is the short proximal segment of the *arteria tibialis posterior*, between its origin from the *arteria poplitea* to the branching point of the *arteria fibularis* [13].
- *Arteriae tarsales mediales* should be specified as the ***arteria tarsalis medialis proximalis**** and the ***arteria tarsalis medialis distalis****; *arteriae tarsales laterales* as the ***arteria tarsalis lateralis proximalis**** and the ***arteria tarsalis lateralis**** [13].
- ***Arteria sinus tarsi medialis*** ("arteria canalis tarsi; arteria of Salvi") and ***arteria sinus tarsi lateralis*** ("arteria anastomotica tarsi; ramus anastomicus tarsi; perforating vessel of sinus tarsi") are important feeding arteries of the talus with variable origin from the *arteria tibialis posterior* (or less often from the *arteria plantaris medialis*), and from the *arteria dorsalis pedis* (or less often from the *arteria tarsalis lateralis proximalis* or *arteria malleolaris lateralis anterior*), respectively [13,55].

VENAE

- *Vena retromandibularis* terminates in a specific way by a bifurcation (similarly to the *vena portae hepatis* and the *vena dorsalis penis/clitoridis profunda*) into the ***ramus anterior*** draining into the *vena facialis* and the ***ramus posterior*** forming the *vena jugularis externa* by the confluence with the *vena auricularis posterior*.
- ***Vena facialis communis*** is a short terminal segment of the *vena facialis* after it is joined by the *ramus anterior venae retromandibularis*; then, it usually drains into the *vena jugularis interna*.
- Some tributaries of the *plexus pterygoideus* are missing in the TA: The ***vena sphenopalatina***, the ***venae palatinae***, the ***vena infraorbitalis***, and the ***plexus cavernosi concharum***, especially in the area of the *concha nasalis inferior*.
- *Zona bilaminaris* (of Rees) [56], also called "retroarticular/retrodiscal plastic pad/cushion (of Zenker)" [57] or "trilaminar zone (of Smeele)" [58], is the posterior continuation of the *discus articularis articulationis temporomandibularis*, consisting of the *stratum superius* (fibroelastic loose network of elastic and collagen fibers, adipose tissue and fine vessels, attached to the posterior margin of the *fossa mandibularis ossis temporalis*), *stratum inferius* (stiff/non-elastic network of collagen fibers, attached to the *caput mandibulae*), and in between interposed ***genu vasculosum*** (adipose tissue, connective tissue and mainly a venous plexus, a dorsal extension of the *plexus pterygoideus*), which serves as shock-absorber during the joint movements.
- ***Arcus venosus xiphoideus*** is a transverse venous arch (present in approximately 80%) connecting the *venae thoracicae internae dextrae et sinistrae* across the midline, located ventral to the *symphysis xiphosternalis* [59].
- ***Vena incisurae scapulae*** is a variable vein (58%), originating on the *facies costalis scapulae*, below the *incisura scapulae*, either from a vein accompanying the nutrient artery of the scapula and/or veins located beneath the fascia of the *musculus subscapularis*. It passes through the *incisura scapulae* and drains into the *vena suprascapularis* immediately after passing the notch [60,61].
- ***Vena perforans cubitalis**** (of Gracz) is the thickest perforating vein of the upper limb, located in the *fossa cubitalis*, usually connecting the *vena mediana cubiti* and the *venae radiales* and present in 100% of cases [12,62].
- ***Truncus splenomesentericus*** is the last segment of the *vena splenica*, between its confluence with the *vena mesenterica inferior* (present in approximately 60-70% of cases) and the beginning of the *vena portae hepatis* [63].
- ***Truncus gastropancreatocolicus*** (of Henle) is a short venous trunk, formed usually by the confluence of the *vena gastroomentalis dextra*, the *vena pancreaticodudenalis superior anterior,* and the *vena colica dextra superior*, draining into the *vena mesenterica superior* and located

behind the *caput pancreatis.* It is present in 87% of cases [64].

- *Vena azygos* originates usually by the confluens of the *vena lumbalis ascendens dextra* and the *vena subcostalis dextra* and immediately receives the variant ***vena azygos lumbalis dextra***, branching from the posterior aspect of the *vena cava inferior* at the level of the opening of the *vena lumbalis secunda* (often a common trunk with the *vena lumbalis secunda dextra* or the *vena renalis dextra*) and present in 34% of cases. *Vena hemiazygos* receives a corresponding contralateral variant vessel – ***vena azygos lumbalis sinistra*** – branching from the posterior aspect of the *vena renalis sinistra* and present in 28% of cases [65]. *Vena renalis sinistra* features rather frequently (64% of cases) a communicating vein dorsally into the retroperitoneal tissue, either the *vena azygos lumbalis sinistra* draining into the *vena hemiazygos* or the ***vena communicans lumbalis*** emptying into the upper *venae lumbales* or into the *vena lumbalis ascendens sinistra* (64% of cases) [66,67].
- ***Vena cremasterica*** is a gentle vein accompanying the *arteria cremasterica* in male and draining into the *vena epigastrica inferior*. ***Vena ligamenti teretis uteri*** is a gentle vein accompanying the homonymous artery in female [8].
- ***Plexus pudendus**** (of Santorini) is a small pelvic venous plexus located within the lower part of the *spatium retropubicum* (of Retzius) behind the inferior part of the *symphysis pubica* and in front of the inferior part of the urinary bladder and on the anterior and inferolateral surfaces of the prostate [8,13,54].
- *Vena portae hepatis* is the only vessel with the non-concordant adjective "portae" and thus the specifying word "hepatis" can be omitted and the term for the main vessel of the liver can be shortened to ***vena portae***.
- Under pathological condition called the portal hypertension, veno-venous bypasses (shunts) open to relieve hypertension in the system of the *vena portae*. These are enlarged naturally formed veno-venous anastomoses in specific locations and they deserve to be officially termed as the ***anastomoses portocavales***. They comprise the following major routes:
  - ***Anastomosis portocavalis gastrooesophagea (submucosa et adventitialis)*** – between tributaries of the *vena gastrica sinistra* and the *venae oesophageae* including both the submucous and adventitial levels, sometimes presenting as esophageal and paraesophageal varices;
  - ***Anastomosis portocavalis rectalis (submucosa et adventitialis)*** – between tributaries of the *vena rectalis superior* and the *venae rectales mediae et inferiores* including both the submucous and adventitial levels, the former sometimes presenting as internal hemorrhoids;
  - ***Anastomosis portocavalis subcutanea*** – between the *venae paraumbilicales* (of Sappey) and tributaries of the *venae epigastricae superficiales et venae thoracoepigastricae* of both sides, presenting rather more rarely as "caput Medusae;"
  - ***Anastomosis portocavalis muscularis*** – between the *venae paraumbilicales* (of Sappey) and tributaries of the *venae epigastricae inferiores et superiores* of both sides within the *musculus rectus abdominis*;
  - ***Anastomosis portocavalis preperitonealis*** (veins of Burrow) – between the *venae paraumbilicales* (of Sappey) and tributaries of the *plexus venosus vesicalis* running in the midline along the *ligamentum umbilicale medianum*;
  - ***Anastomosis portocavalis retroperitonealis*** (veins of Retzius) – between veins of the spleen and veins within the *mesenterium* and/or the *mesocola*, and the retroperitoneal veins and veins of the posterior abdominal wall (tributaries to the *venae suprarenales, renales, tesiculares/ovaricae, lumbales, phrenicae inferiores et iliolumbales*);
  - ***Anastomosis portocavalis hepatica*** – between veins of the hepatic capsule and veins of the diaphragm in the extent of the *area nuda hepatis*.
- Similarly to the portocaval anastomoses, under pathological condition with obturated *vena cava superior* or *vena cava inferior*, veno-venous bypasses (shunts) open to relieve the hypertension in the system of one of the *venae cavae*, termed the ***anastomoses cavocavales***, which can be classified into the following groups:
  - ***Anastomosis cavocavalis subcutanea***–between tributaries of the *venae epigastricae superficiales* and those of the *venae thoracoepigastricae* within the subcutaneous layer of the anterolateral trunk wall;
  - ***Anastomosis cavocavalis muscularis*** – between tributaries of the *venae epigastricae inferiores* and those of the *venae epigastricae superiores* within the *musculus rectus abdominis*;
  - ***Anastomosis cavocavalis retroperitonealis*** – between tributaries of the *venae lumbales* and those of the *venae lumbales ascendentes* draining into the *vena azygos* and *vena hemiazygos*;
  - ***Anastomosis cavocavalis vertebralis*** – between tributaries of the *plexus venosi vertebrales (externi et interni)* (plexus of Batson) extending along the *columna vertebralis* and within the *canalis vertebralis.*

- Many new terms have been added concerning the lower limb veins, mainly concerning the superficial and perforating veins interconnecting the superficial and deep venous systems (*venae perforantes*). Among others, it is necessary to emphasize the following:
  - The termination of the *vena saphena magna* into the *vena femoralis communis* is called the ***junctio saphenofemoralis**** and it is an integral part of the ***confluens venosus subinguinalis**** ("crosse; bulbus; venous star of Paturet"), bordered by two valves of the *vena saphena magna*: The ***valva terminalis**** (situated 1-2 mm distal to the *junctio saphenofemoralis*) and the ***valva preterminalis**** (located 3-5 cm distally). This confluence receives the centripetal segments of the smaller venous tributaries: *Vena epigastrica superficialis, vena circumflexa ilium superficialis, vena pudenda externa superficialis, vena saphena magna accessoria anterior et posterior,* and *vena circumflexa femoris anterior*. Similarly, the term ***junctio saphenopoplitea**** is applied to the termination of the *vena saphena parva* into the *vena poplitea* [9,13,54].
  - ***Extensio proximalis/cranialis venae saphenae parvae**** ("vena femoropoplitea of Hyrtl;" "extensio cranialis venae saphenae parvae") is a proximal continuation of the *vena saphena parva*. It ascends from the *fossa poplitea* on the posterior aspect of the thigh and terminates in more variants: It can submerge as the *vena perforans femoris posterior/posterolateralis* and drain into the *vena profunda femoris*; it can terminate in the muscular or subcutaneous venous plexus; it can continue as the ***vena intersaphena femoris**** (of Giacomini) and drain into the *vena saphena magna* or its tributaries; or rarely, it can ascend as high as the gluteal region and empty into the *venae gluteae inferiores*. The *extensio proximalis/cranialis* is present in approximately 95% of cases [6,13,68,69].
  - *Venae perforantes* of the lower limb are numerous communications between the superficial and deep systems. Their extensive nomenclature has been proposed in 2005 and explained in detail by our team in 2019. The major impact consists in the rule that eponyms should be replaced with systemic terminology, e.g. first Cockett's perforator with the ***vena perforans cruris tibialis posterior inferior**** [15,70].

SYSTEMA LYMPHATICUM

Generally, the term "lymphoid" meaning from the linguistic point of view precisely "similar to lymph" ("eidos" is a Greek term for the form) should be abandoned and instead the term "lymphatic" should be preferred in all terms related to the lymph, i.e. also in the denomination of the whole chapter: ***Systema lymphaticum***.

- Spleen can be divided into segments separated by avascular planes; constant are polar segments: ***Segmentum polare anterius et polare posterius***, and variable is/are central segment(s): ***Segmentum interpositum / segmenta interposita***.
- ***Crenae splenis*** are deep clefts or notches (reaching some 2-3 cm in depth) located predominantly on the *margo superior splenis* (former "margo crenatus") and *facies diaphragmatica splenis* [71].
- ***Margo intermedius (splenis)*** is a ridge separating the spleen surface for the kidney and that for the stomach.
- ***Nodus lymphaticus arcus venae azygoi*** is a lymph node from the group of the *nodi lymphatici bronchopulmonales* situated in the concavity of the ***arcus venae azygoi***, the terminal segment of the *vena azygos* turning above the right lung hilum. It has to be stressed that the genitive of the Greek word azygos is azygoi.
- ***Confluens lymphaticus abdominalis*** describes the very variable confluens of lymphatic *trunci lumbales et intestinales*, sometimes forming the *cisterna chyli*, located retroperitoneally approximately at the level of the first or second lumbar vertebra.
- Lymph nodes draining the small and large intestine are arranged in groups which can be classified into three or four rows/levels, respectively. The small intestine lymph nodes comprise: *Nodi lymphatici juxtaintestinales* located close to the intestinal wall, ***nodi lymphatici mesenterici superiores intermedii*** located along the jejunal and ileal vessels, and ***nodi lymphatici mesenterici superiores centrales*** situated around the *radix mesenterii* along the trunk of the *arteria mesenterica superior*. The large intestine lymph nodes consist of four rows/levels: ***Nodi lymphatici epicolici*** stuck closely to the intestinal wall, *nodi lymphatici paracolici* located along the *arteria marginalis coli* (of Drummond), ***nodi lymphatici mesenterici inferiores intermedii*** located along the colic vessels (and classified in detail according to certain vessels: *Nodi ileocolici, appendiculares, colici dextri, colici medii, colici sinistri, sigmoidei, et rectales superiores*), and finally ***nodi lymphatici mesenterici inferiores centrales*** situated along the trunk of the *arteria mesenterica inferior*.
- The lymphatic trunks of the limb (also known as "collectors") can be divided into the superficial and deep, the former running independently on the superficial veins, and the latter extending in intimate relation to the deep vascular bundles. The term "*lymphaticus*" should

be preferred to its grammatically incorrect synonym "*lymphoideus*" – see above [4,10].

- Three main superficial lymphatic trunks of the upper limb constitute from the ***plexus lymphaticus palmaris**** on the palmar aspect of the digits and hand: ***Truncus lymphaticus lateralis membri superioris**** travels on the lateral side of the forearm and arm and empties into the *nodi lymphatici axillares* or directly into the *plexus lymphaticus axillaris* and *nodi lymphatici cervicales lateralis profundi*; ***truncus lymphaticus medialis membri superioris**** courses on the medial side of the forearm and arm and empties into the *nodi lymphatici axillares*; and ***truncus lymphaticus anterior membri superioris**** runs on the ventral side of the forearm and empties into one of the former trunks [12].
- Three main superficial lymphatic trunks of the upper limb constitute from the ***plexus lymphaticus plantaris**** on the inferior aspect of the toes and sole: ***Truncus lymphaticus medialis membri inferioris**** ascends in front of the *malleolus medialis* on the ventromedial aspect of the leg dividing into the ***fasciculus medialis**** (traveling medially to the *condylus medialis femoris*) and the ***fasciculus lateralis**** and drains into the *nodi lymphatici inguinales superficiales*; ***truncus lymphaticus lateralis membri inferioris**** courses on the lateral aspect of the leg and usually drains into the *nodi lymphatici inguinales superficiales*; and ***truncus lymphaticus posterior membri inferioris**** runs on the posterior aspect of the leg and drains into the *nodi lymphatici poplitei profundi* [13].
- The deep lymphatic trunks are termed according to the blood vessel they accompany: ***Truncus ulnaris****, ***truncus radialis****, ***truncus interosseus anterior*** *et* ***posterior****, and ***truncus brachialis****; ***truncus tibialis posterior*** *et* ***anterior****, ***truncus fibularis****, ***truncus popliteus****, and ***truncus femoralis****. In the pelvis, the situation is more complicated, see [13].

DISCUSSION

Some anatomically and/clinically very important terms have been already mentioned in our previous articles, but we felt inevitable to remind readers of them [6,8,9,11-13,15]. If we check the anatomical terminology in current journals, monographs, and textbook, there are still many terms found to be obsolete, incorrect, or even eponymic although the last revision of the anatomical nomenclature – Terminologia Anatomica (TA) – has been issued more than 20 years ago and eponyms have been banned from the anatomical nomenclature already in the Parisiensia Nomina Anatomica (PNA) in 1955 [16,72-76].

If we check the new proposal of Terminologia Anatomica 2 (TA 2), posted online [17] as a not yet approved version (the approval is planned at the next IFAA meeting in Istanbul in 2022), there are not many changes concerning the vessels, but there are some substantial changes concerning the heart which should be thoroughly reviewed and considered if they are appropriate and if they have a chance to be accepted by clinicians [e.g., change of the *sulcus interventricularis posterior* (including the *ramus interventricularis posterior*) to "sulcus interventricularis inferior" (and "ramus interventricularis inferior")].

The main task of every anatomist and all anatomical societies, which continues and never stops, is to cultivate, clean, and revise the anatomical nomenclature not only in the anatomical field, education, journals, and textbooks but above all among clinicians, physicians, secondary school teachers, as well as lay public not only in English and Latin but also in individual languages.

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