“OVIDIUS” UNIVERSITY CONSTANŢA
DOCTORAL SCHOOL OF THE MEDICINE FACULTY

THE NORMAL MORPHOLOGY AND VARIANTS OF THE ARTERIES AND NERVES OF THE UPPER LIMB

PHD THESIS SUMMARY

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INTRODUCTION

[Fontaine] stated in 2001 that "in recent years, the number of papers appearing in various specialized publications on the anatomical vascular and nerve variants has risen", primarily due to the increase in their frequency compared to the classical descriptions and those considered to be normal. From these findings neither the arterial system of the superior member, nor the morphology of the brachial plexus do not deviate, both in terms of formation and its collateral and terminal branches. "The novelty of some of these variants and the frequency of their usage, show that there are cases where what seemed a variant in the eighteenth century, in our century it can be cathegorized as normality" [Fontaine].

This explains the intensification of research by various means and methods, classical and modern, seeking to highlight new vascular-nerve morphological characteristics, applicable in medical practice, these variants bearing importance not only for the morphologist but also for the practitioner. The particular origin of some arterial branches, their mode and level of branching, their number and morphometry, adult persistence of some embryonic arteries, atrophy or absence of arterial vessels, the histological structure of some arteries represent only some aspects requiring detailed morphological descriptions in order to use the special features in medical practice.

Thus, in 1973, Carpentier, quoted by Acar, proposed the use of the radial artery in coronary artery surgery, but the method was quickly abandoned due to the increased number of early failures of this type of clock, using the internal thoracic artery. The comparative study of internal radial and thoracic arteries, comparing the anatomical and histological characteristics of the two arteries, concluded that the ideal graft for coronary surgery was the radial artery and, since 1989, the radiographic arterial time trial for myocardial revascularization . Another example is the introduction of the radial antebrahial flap in 1981, criticizing the morbidity related to the necessary slaughter of the radial artery. Research has shown that, contrary to what was believed

"the results of the vascular examinations showed that the global arterial flow in the arteries of the donor forearm was more important than the one at the level of the controlateral limb, the anterior interosseous artery presenting the greatest difference in the blood flow" [Ciria-Llorens]. This indicates that another major vascular shaft constituted by the anterior interosseous artery develops after an interruption of the radial artery when the radial flap rises and that the global vascular flow in the hand is not affected "[Ciria-Llorens].”In developing the evolution of flap surgery the distribution of the superficial (anterior) ram of the radial nerve plays an important role, its sensitive branches being used in the treatment of neurological sequelae through medial nerve trauma. Neurosis of the median nerve, through the anastomosis between the radial nerve sensors and the median alenerv, the transfer being done either at the fist or crossing the interoscopic spaces [Ciria-Llorens].

"The neurocutaneous nerve of the forearm cut nerve is drawn between the second and third perforating ram, its rotation spring comprising the anterolateral region of the elbow. The neurocutaneous forearm of the medial cutaneous nerve of the forearm is taken at the level of the second and third perforating ram, the interest of this flap being in the reconstruction of the posterior side of the elbow "[Bertelli].

Knowing the formation and morphology of the brachial plexus nerves and their surgical approach is of particular importance for the repair of root abnormalities. "Radial cervical cord abutments have been considered to represent irreparable lesions, even by well-known neurosurgeons which have a recognized expertise in this field. Numerous experimental studies have shown that if the continuity between the spinal cord and the avulsed roots is restored, the axons of the spinal motoneurons can be restored by re-implanting the radicles or through the peripheral nerve grafts with the re-emergence of a motor activity [Fournier].

There are many other aspects of the morphology of the arteries and nerves of the upper limb that are currently being studied, which proves that in any area of the anatomy there may be some additions and clarifications, which, extending to those already

established, aid to complete the morphological knowledge of some human body formations.

MATERIAL AND WORK METHODS

The study of upper limb arterial blood vessels was performed on a number of 54 limbs, coming from adult and fetal human corpses, fresh and formalinized, as well as CT angiographs performed on a 64-slice Lightspeed VCT.

When stuying the vessels of corpse subjects, the study methods employed were the dissection and plastic injection followed by dissection. As a plastic mass, I used the German-made Technovit 7143, an autopolymerizable resin based on methyl methacrylate powder and liquid methacrylate.

What was to be observed: the level of origin of the main trunks of the arteries and the anatomical characteristics of their collateral and terminal branches, their trajectory, the anastomoses they presented, and the relationships they were contacting with the adjacent anatomical elements, especially the nerves with which they formed vasculo-nerve bundles.

Upper limb nerve study was performed only by dissection in adult and fetal human corpses, with some corpses injected with the red plastic artery (Technovit 7143), highlighting the nerve trajectory and the rapport to neighboring arterial vessels. There were 54 brachial plexuses where the anatomical characteristics of the brachial plexus trunks and fascicles were studied, as well as the origin of the nerve branches, their trajectory and their relations with the neighboring anatomical elements (muscles, vessels), the collateral and terminal branching at the level of topographical regions of the upper limb, the absence of nerve branches, also following the anastomoses existing between the different neighboring nerves.

PERSONAL RESULTS

THE UPPER LIMB ARTERIES

I encountered the axillary artery giving rise to different levels of the axillary region (behind the large pectoral muscle), to two brachial, middle arterial branches that continue with the ulnar and lateral artery which continues with the radial artery, the profound brachial artery originating from the lateral brachial artery.

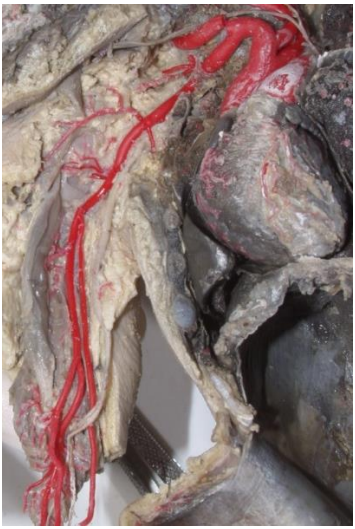


Fig. 17. Bifurcation of the axilla artery, behind the lower portion of the large pectoral muscle, into two brachial arteries, one of which will continue with the radial artery and the other with the ulnar artery. From the radial artery it separates at the brachial level the interossox trunk.

Fig. 18. Axillary bifurcated artery in two superficial branches from the lower part of the axillary region, from the medial branch (ulnar artery), resulting in the inferior part of the arm, the truncated inteosseous arteries, which becomes profuse under the elbow, the ulnar and radial arteries retaining their supraphasial.

Sometimes, the two brachial arteries resulting from bifurcation of the axillary artery had a superficial surface trajectory in the lower

arm of the medial branch (the ulnar artery) detaching the truncated interosseous arteries, which at the level of the elbow were becoming profound, the two radial and ulnar arteries keeping its superficial trace at the level of the forearm.

Fig. 19. Early bifurcated axillary artery in two closely aligned braces, originally superimposed, after which the two rams cross, the medial brachial passes posterior to the lateral brachial artery. At the level of the elbow, the two brachial rams encounter anastomosis, continuing in the ulnar artery. Cranial anastomosis, in the lateral ram the radial artery is detached, having a caliber smaller than the ulnar artery, which ends at the palmar level, contributing to the formation of the palm arch.

I have encountered a particular case of an early bifurcation of the axillary artery into two closely aligned braces, initially superimposed, after which the two rams crossed, following which a short trace left the medial brachial ram passing behind the lateral one, still having a corrugated lateral tract, the medial ram being rectilinear. At the level

of the elbow, the two brachial rams are anastomosed, continuing with the ulnar artery, from which the trunk of the interosseous arteries is detached under the elbow. Cranial anastomosis from the elbow fold, the radial artery of the lateral ram, has a caliber smaller than the ulnar artery, which ends at the palmar level, thus contributing to the formation of the palm arch.

I have encountered an early bifurcation of the axillary artery in two brachial arteries in 4 cases (7.41% of cases), and in 2 cases (3.70% of cases), the two resulting arteries had superficial trajectory.

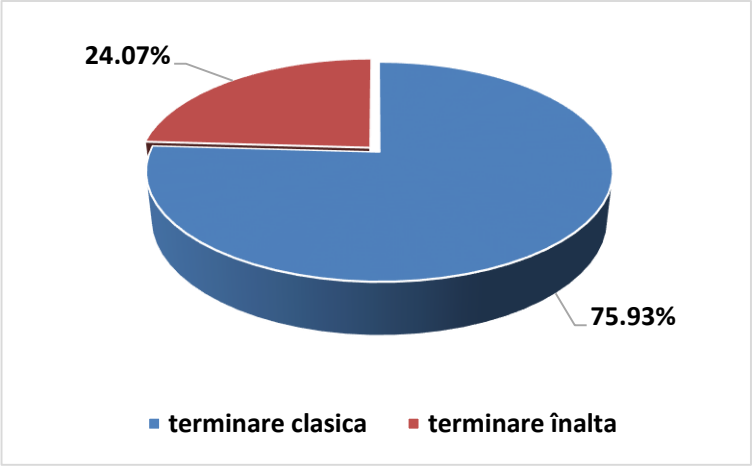
Fig. 22. Upper limb arterial system. The right brachial artery bifurcates from the upper third of the brachial region. The trunk of the right interosseous arteries originates at the level of the upper third of the ulnar artery. The left brachial artery is ramified under the elbow, and the trunk of the left interosseous arteries also originates at the level of the upper third of the ulnar artery.

Most anatomical variants in the upper limb arteries have been encountered in the brachial artery, presenting variants of origin, of collateral and terminal ramification, and of traumatic and morphometric variation.

I found the terminal ramification of the brachial artery at very

divergent levels between the upper arm and the lower elbow: at the level of the upper arm, at the middle of the brachial region, at the lower third of the arm above and below the interoppicillary line. At the brachial level, the two arteries resulting from the trifurcation of the brachial, radial and ulnar arteries can be arranged from the beginning according to their normal anatomical position, or they may be located viceversa, initially being medially radial disposed, after which the two arteries cross-end in their physiological position, typically the radial artery passing anterior to the ulnar artery. Also, in the case of the superficial brachial artery, the same levels of terminal branching are encountered.

Out of the 54 cases I tracked, I found that the brachial artery ended in the elbow in 41 cases (75.93% of cases) and in 13 cases (24.07% of cases), showing a high termination.



GRAPH NO. 1 – The level of the brachial artery ending

Ouf of the cases with high termination, in 6 cases (11.11% of cases) the brachial artery terminates at the level of the brachial region, in 4 cases (7.41% of cases) ending at the upper 1/3 level of the arm, and in 1 case (1.85% of cases) at 1/3 medium and 1/3 lower of the arm.

In relation to the interepicondillary line, the brachial artery terminates in 2 cases (3,70% of the cases) above and at the level of the interepicondylation line and in 3 cases (5,56% of the cases) under the interepicondilar line.

In the case of high branching of the brachial artery, the deep brachial artery originates either in the brachial artery above its terminal bifurcation or in the lateral brachial artery (radial artery). In one case (1.85% of cases), I found two deep arched braces, originating in the brachial artery, which traversed the intermuscular septum one above the other, prior to the radial nerve, to engage in the radial nerve ditch.

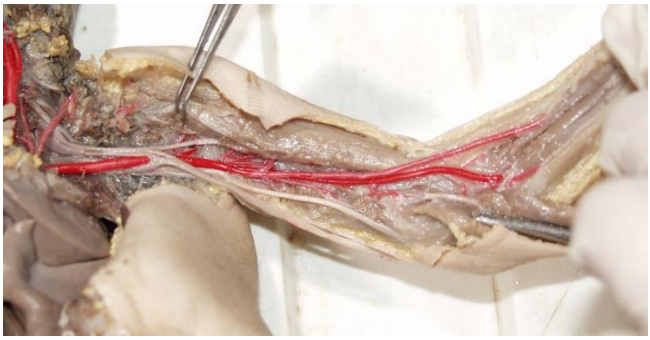


Fig. 23. Terminal ramification of the brachial artery in the middle of the brachial region, in their trajectory towards the pre-frontal region, the two arteries crossing at the brachial level, the radial artery passing anterior to the ulnar artery. The deep brachial artery arises from the brachial artery, above its terminal bifurcation, being located anterior to the radial nerve.

The brachial arteries give articular rams, sometimes multiple and bulky joints for the upper radius and elbow joints, joints that can receive arterial branches and arterial arteries that participate in the formation of the periarticular arterial artery of the elbow.

In the case of anterolateral arteries, irrespective of their origin, the forearm has approximately parallel trajectories, with a greater or lesser interval between them, at which the median nerve with its artery

and the truncated interosseous arteries are at the half segment superior to the forearm, after which only the anterior interosseous artery remains, but which becomes deeper than the two anterolateral arteries.

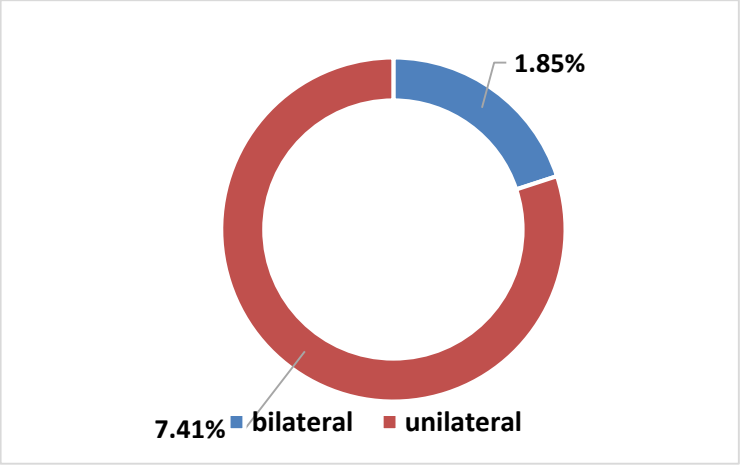
When the antebrachial arteries have a suprafascial tract, they can continue the superficial trajectory of the brachial artery or even the axillary artery, or may have a superficial tract only from the heel elbow, the brachial artery having a deep brachial tract and becoming superficial only at the elbow waist, under the brachial biceps muscle

Fig.24. The deep double brachial artery, originated in the brachial artery, is superimposed and engages one above the other through the intermuscular septum.

Fig. 27. The bifurcation of the brachial artery in the elbow, the two branches having an equal caliber, from the ulnar artery under the elbow envelope, first produced the trunk of the medial recurrences, and below it the truncated interosseous arteries. The brachial artery becomes superficial in the lower part of the arm, emerging under the biceps and bifurcating in the ulnar and radial arteries, which also have a superficial tract. At the origin the trunk of the interossoes has a superficial trait.

Of the 54 cases of arteries studied, in 8 cases (14.81% of cases) they had a superficial trace, in one case (1.85% of cases) the variant was bilateral and in 6 cases (11.11 % of cases) unilateral.

The trunk of the intesrosseous arteries originate in the ulnar artery closer or further from the terminal branching of the brachial artery, sometimes its origin being very close to it, so it gives the appearance of trifurcate termination of the brachial artery.



GRAPH NO. 4 – THE NUMBER OF CASES WITH SUPERFICIAL ARTERIES

If the anterolateral arteries have a high origin in the brachial artery or even the axillary artery, the interosseous artery can originate at the level of the brachial region. I identified in only in three cases that the trunk of the interosseous arteries came from the radial artery, being voluminous, having a caliber roughly equal to that of the radial and ulnar arteries, thus being able to speak of a radiopausal arterial artery which is bifurcated.

In all three cases, the axillary artery bifurcates behind the lower part of the large pectoral muscle in two brachial, medial and lateral (ulnar and radial) arteries; on the medial face of the radial artery the branch of the interossoas separated at the brachial level. The deep brachial artery originated from the anterolateral lateral artery. In the first case, the trunk of the interosseous arteries was originally located

between the radial and ulnar arteries, being on a slightly anterior plane. Later on, it was aligned inferiorly, having a postero-medial plane on the radial artery, crossed it on the posterior face to dispose laterally. After the cross with the interosseous trunk, the radial artery, sinuously trailing in the lower half of the forearm, approached the ulnar artery, with which they descended together at the level of the fist region.

In the second case, the truncated interosseous arteries initially had a superficial trace, and above the middle of the forearm became deep, while the antebraal arteries continued their superficial trajectory.

Fig. 29. Axillary bifurcated artery at the lower axillary axis in two brachial arteries (lateral or radial and medial or ulnar), parallel brachial tract; on the medial face of the radial artery, the truncated interosseous arteries of the elbow (Case I), which are located between the ulnar and radial arteries, on a slight plane before them, have an approximate trajectory in the "S" italic, with the upper concave range.

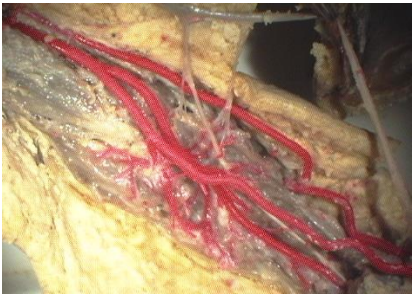


Fig. 30. Superficial trajectory of radial and ulnar arteries resulting from branch of the axilla artery. The radial artery in the elbow fold gives rise on its medial face to the trunk of the interosseous arteries (case II), which is initially ordered between the radial and ulnar arteries, and under the envelope of the elbow it crosses the radial artery posteriorly, laterally, becoming deeper than this.

In the third case, the two brachial, lateral and medial arteries in the arm had an approximately parallel trace, the radial (lateral) artery having a slightly larger caliber, in the lower part of the radial artery arm, lateral, a level at which the trunk of the interosseous arteries was born, which would continue its vertical antebrachial tract between the radial and ulnar arteries. All three arteries had an approximately equal caliber.

Fig. 31. The trunk of the interosseous arteries originates on the medial face of the ulnar artery (case III).

Fig. 32. The superficial palmar arch in which only the termination of the ulnar artery participates, the radial artery terminating with a superficial ram emerging above the retinaculum of the flexors, which anastomoses with the digital palm of the patient's lateral lateral surface. The ulnar artery gives rise to five common palmar digital arteries, which will form their own palmaral arteries.

In the palmar, superficial and profound arch, three particular cases were encountered, two of which within the corpse, which were partly similar to the third one on a CT angiogram.

In the first case, only the termination of the ulnar artery is involved in the formation of the superficial palmar arch, the radial artery ending with a superficial ram emerging above the retinaculum of the flexors, which is anastomosed with the lateral digital artery of the pedicle. The ulnar artery had a tract in front of the retinaculum of the flexors, and at the level of the pizziform it described a medial concavity curve (hugging the bone) and then descended vertically on the anterior-lateral face of the prominence of the muscles of the hypnotic eminence to the middle of the palm of the hand, laterally transverse, at the base of the eminent toughness, describing in its entirety a slight curve with the super-lateral concavity. From the convexity of the palmar arch, five common palmar arteries were born. The first (digital) palmar digital artery was inferior-medial, walked antero-laterally above the muscles of the eminent tall, and shaped the digital palate of its own small finger. The second common palm-joint digital artery also had a inferior-medial trajectory to the fourth interdigital space at the base of which it is bifurcated, giving rise to its own palpable digital arteries, lateral to the small and medial finger of the ring. The third common digital palm artery had a vertical trajectory to the third interdigital space at the base of which it is ramified, giving rise to its own palpable digital arteries, lateral to the small and medial ring of the medius. The fourth common digital palpable artery had a inferior-lateral oblique trajectory toward the second interdigital space, at the base of which it is bifurcated, giving rise to its own palmal arteries, lateral medial and medial index. The fifth common palmar digital artery had an inferior lateral oblique trajectory greater than the previous one to the first interdigital space proximal to which it was bifurcated, emerging to a more massive midbrain that gave rise to the lateral digital palms of the index and medial index The second ram forming the lateral palm of his own digital artery, this ram rising with the superficial terminal ram of the radial artery.

THE UPPER LIMB ARTERIES – DISCUSSIONS

TABLE NO. 1 – THE FREQUENCY OF THE SUPERFICIAL ULNAR ARTERIES

AUTHOR	YEAR	COUNTRY	CASES NUMBER	SUPERFICIAL NUMBER	%
Adachi	1928	Japan	1198	9	0,7
McCormack	1953	USA	750	17	2,26
Hazlett	1949	Canada	188/ 542	6/15	3,1/2,7
Miller	1939	USA	480	0	0
Weathersby	1956	USA	451	3	0,6
Quain	1844	England	422	29	6,8
Rodriguez-Baeza	1995	Spain	150	8	5,3
Nakatani	1998	Japan	150	1	0,7
Coulouma	1934	France	144	5	3,4
Uglietta&Kadir	1989	USA	100	1	1
Devansh	1996	India	32/76	3/7	9,38/9, 21
Fadel& Amonoo-Kuofi	1996	Egypt/ Saudi Arabia	72	1	2,8
Personal cases	***2017***	***Romania***	***54***	***7***	***12,96***

TABLE NO. 2 – THE FREQUENCY OF UNILATERAL AND BILATERAL CASES WITH SUPERFICIAL ULNAR ARTERIES

AUTHOR	UNILATERAL	BILATERAL
Quain	13	8
Hazlett	4	1
Hazlet (palpated)	9	3
Fuss	-	1
Rodriguez-Baeza	6	1
Fadel	-	1
Personal cases	5	1

TABLE NO. 3 – THE PERSISTENCY OF THE MEDIAN NERVE ARTERY

AUTHOR	YEAR	CASES NUMBER	%
Adachi	1928	200	8
Mc Cormack	1953	750	4,43
Misra	1955	66	8,33
Coleman	1961	650	9,9
Kenesi	1967	33	3
Janevski	1982	750	2,2
Srivasta	1990	134	1,5
Henneberg	1992	158	27,2
Kopuz	1997	60	20
Personal cases	***2017***	***54***	***3,70***

TABLE NO.4 – THE FREQUENCY OF THE SUPERFICIAL PALMAR ARCHES

AUTHOR	CASES NUMBER	COMPLETE %	INCOMPLETE %
Colleman	650	78,5	21,5
Ikeda	220	96,4	3,6
Ruengsakulrach	50	66	34
Jelicic	50	97	3
Gellman	45	84,5	15,5
Bilge	50	86	14
Personal cases	***54***	***94,44***	***5,56***

MORPHOLOGICAL ASPECTS OF THE TERMINAL BRANCHES OF THE BRACHIAL PLEXUS

Once they are formed, the trunks of the brachial plexus are spaced apart, having no contact or cranial areas, or at the formation of the beams, yet they previously present a convex area due to their pre-rib first position. The axillary artery often passes ahead of the lateral beam, disposed between it and the medial beam, being located anterior to the posterior beam. Sometimes the middle trunk is the most voluminous one, and it is possible to observe on its surface the limits of separation between the future nerve branches that will arise from its level. Frequently, the origin of the nerve truncates is not at the same level, the middle trunk being the first ramification, at the level or even above the posterior rim of the first rib, the lower trunk bifurcating the second (at the upper face of the first cost) and the last bifurcating the upper trunk at or even the caudal edge of the first rib. The final bifurcation of the nerve trunks in the bundles forms an acute angle of 45 ° on average. The name of the nerve trunks is made in relation to the provision of the roots of the spinal nerves that enter their constitution, because in the upper part of the clavicle the nerve trunks are located on the same plane, from the lateral to the medial being placed the upper trunks, which thus become lateral, inferior, which is thus mediated. More rarely, the three trunks bifurcate to the same level. Frequent anastomoses are noted between nerve bundles. The collateral branches of the axilla artery traveled through the nerve bundles, passing past or behind them.

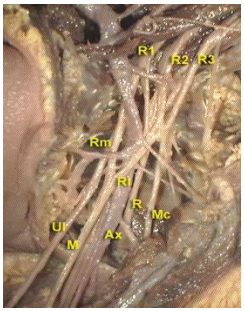


Fig. 41. Trunks, fascicles and peripheral nerves of the brachial plexus. Once formed the trunks of the brachial plexus are spaced apart, both cranically, or at the level of the beams, they present a convex anterior region due to their previous situation with respect to the first rib. The middle trunk is the most voluminous. The three trunks bifurcate to the same level.

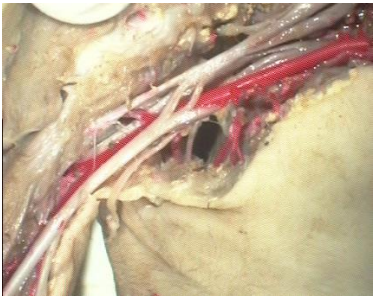


Fig. 42. Anastomosis between the lateral brace of the brachial plexus and the medial root of the median nerve (passing behind the axillary artery), which could be considered the second beam of the medial root, having the exile artery between them.

Sometimes, an anterior ram can form a single nerve (or nerve) beam, such as the anterior trunk of the middle torso which forms a single medial nerve origin alone, and the anterior trunk of the lateral trunk forms the single musculo-nerve nerve alone between the two beams, previous anastomosis being present from the middle anterior beam to the lateral anterior.

The ulnar nerve, located medial and positioned slightly behind the axillary and brachial artery, and less frequently at the same level of the axillary artery, has a vertical and rectilinear trace at the level of the arm, penetrating into the posterior lobe in the lower 1/3 of the arm, sometimes engaging in the epitrohleo-olecranian channel, and sometimes just above the medial epicondyle.

Most frequently, the musculocutaneous nerve penetrates the biceps muscle in its upper 1/3, giving it the most voluminous ram. It is located laterally axillary and radial arteries. I wish to highlight the absence of the musculocutaneous nerve, a variant on which I will

return to the presentation of the median nerve.

The radial nerve is located initially behind the exile artery, passes behind the medial root of the median and postero-medial nerve artery, posterolateral laterally to the brachial artery, and before it enters the radial nerve ditch, again posterior to the artery.

Fig. 47. The radial nerve is located initially behind the axillary artery, passes behind the medial root of the median nerve and the medial nerve, before entering the humeral channel, again posterior to the artery. The ulnar nerve is disposed throughout the arterial medial pathway up to the cubital channel entry.

MORPHOLOGICAL ASPECTS OF THE MEDIAN NERVE

54 nerve trunks were traced, recording the morphological characteristics of the median nerve from its formation to its branching into its terminal branches.

We have found that the median nerve is always formed from two medial roots, originating in the medial and lateral beams, in the lateral beam of the brachial plexus. The union of the two roots was made at different levels of the upper limb, between the axile and the fold of the elbow.

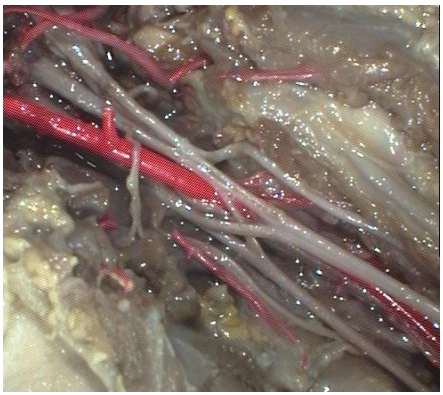
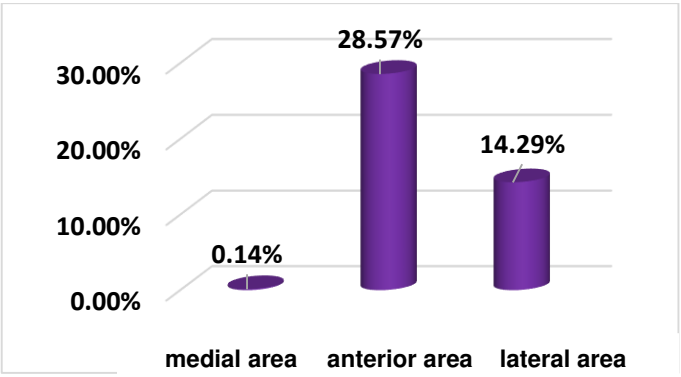


Fig. 48. Medial nerve consisting of 2 roots (medial and lateral), anterior to the axillary artery. The medial root passes behind the axilla artery, mediating it with the ulnar nerve. The lateral root is formed from two bladders (medial and lateral), located laterally in the axillary artery, joining anterolateral laterally to the axilla artery, maintaining a demarcation area between them to the level of union with the medial root.

At the level of the axillar level the axilla nerve trunk was formed in 21 cases (38,89% of cases):

- in 12 cases (57.14% of these cases), in the medial aspect of the axillary artery;
- in 6 cases (28.57% of these cases) on the anterior face of the axillary artery;
- in 3 cases (14.29% of these cases) on the lateral side of the axilla artery.



GRAPH NO. 5 – FORMING OF THE MEDIAN NERVE AT THE AXILE REGION IN RELATION TO THE AXIAL ARTERY

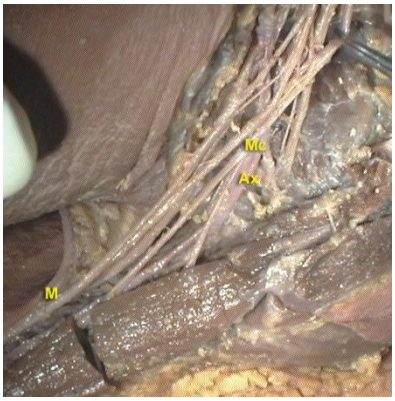


Fig. 50. The two roots of the median are joined together in the middle of the arm, medial to the brachial artery; The medial root is composed of two medial and lateral bundles medically joining the axillary artery; The lateral root is also formed of two bundles, which are joined laterally by the axillary artery, cross the axillary artery anteriorly to join with the medial root.

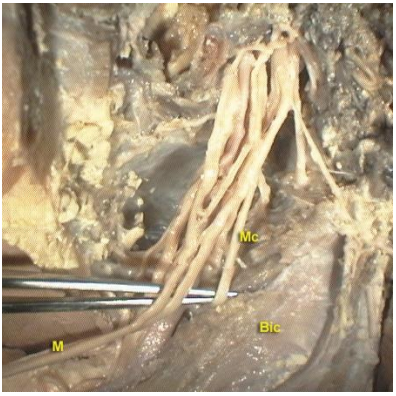


Fig. 51 The medial radius is made up of two bundles, which are joined medial to the axilla artery, continuing this trajectory to the elbow's waist; the lateral root is also formed of two bundles joining the axillary artery previously; above the elbow, the lateral root passes medially to the brachial artery and posterior to the medial root, postero-medial.

In 12 cases (22.22% of cases) the union of the two roots was made **at the level of the brachial region**, in 9 cases (75% of these cases) on the medial face of the brachial artery and in 3 cases (25% of these cases) The lateral side of the brachial artery.

In the other 21 cases (38.89% of the cases) the union of the roots was made **in the fold of the elbow**, in 12 cases (57.14% of these cases) on the medial face of the brachial artery in 6 cases (28.57% of the cases These cases) on the anterior face of the brachial artery, and in 3 cases (14.29% of these cases) on the lateral side of the brachial artery.

The medial nerve **lateral root** was formed in 30 cases (55.56% of cases) from a single nerve beam, while the rest of the cases consisted of two nerve bundles (44.44% of cases). These nerve bundles conjoined in 12 cases (50% of these cases) on the anterior face of the axilla artery, in 10 cases (41.67% of these cases) on the lateral side of the axilla artery and in 2 cases (8.33% These cases) on the medial face of the axillary artery.

The **medial root** of the median nerve was formed in 33 cases (61.11% of cases) from a single nerve beam, in 21 cases (38.89% of cases) consisting of two nerve bundles, forming the medial root of the medial nerve root in all cases on the medial face of the axilla artery, in 12 cases (57.14% of these cases) between the two medial root beams, the axillary artery is located.

In 15 cases (27.78% of cases) the medial root passed behind the exile artery to medially dispose this artery, and in 3 cases (5.56% of cases) the medial fascicle of the root was passed behind the axillary artery.

Regarding the volume of the two roots of the median nerve, I found that in 24 cases (44.44% of cases) the lateral root was more voluminous, in 15 cases (27.78% of cases) the medial root was more voluminous and, moreover, in 15 cases (27.78% of cases) the two roots were approximately equal.

I have encountered a single case where the median nerve inches the anterior muscles of the arm, missing the musculocutaneous nerve. In cases of low joining of the roots, we have encountered cases in which the lateral root gave rise to a ram for the forearm muscles.

The median nerve presents numerous anastomoses, which are present at all levels of the upper limb. Anastomoses between the two median nerve roots can sometimes be located just above their union or anterior lower axillary artery.

In just one of the cases I have encountered the existence of three oblique anastomoses, between the two roots, above their union, the two upper ones from the lateral to the medial root, and the third from the medial root to the lateral root, past the lateral roots.

Fig. 55. The muscles of the arm are innervated by the median nerve, without the musculocutaneous nerve.

Fig. 56. A ram of the antebrachial muscles is detatched from the lateral root of the median nerve, and after the joining of the two roots of the medial nerve, a ram intended for the antebrachial muscles is also detached.

The anastomoses between the fascicles of the roots and the root on the opposite side are quite common. I have encountered anastomosis between the lateral bracelet of the brachial plexus and the medial root of the medial nerve, which could be considered the second beam of the medial root, with the exile artery between them. The most common are the anastomosis between the medial beam of the lateral root and the medial root of the median nerve.

In one case, I encountered a strong anastomosis between the medial beam of the medial root and the radial nerve.

Furthermore, one of the cases presented a three-fold anastomosis: upper, middle and inferior, disposed between musculoskeletal and median nerves. The upper anastomosis was transversal, situated between the musculocutaneous nerve and the medial root of the median nerve, passing its anterior lateral roots. The middle anastomosis was oblique between the musculocutaneous

nerve and the lateral root of the median nerve, and the lower anastomosis also established between the musculocutaneous and lateral root of the median nerve, double at origin, the two oblique nerve branches joining approximately midway between the two nerves.

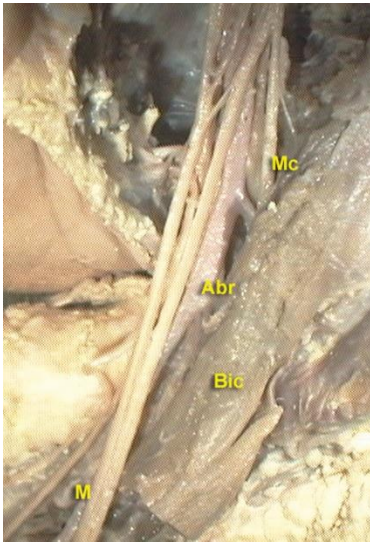


Fig. 57. The median nerve roots are joined to the elbow in front of the brachial artery to which the medial root is medially disposed to the axillary and brachial arteries, and the lateral root in the axilla is initially lateral to the axillary artery, crosses it anteriorly and at the lower axillary axis The medial artery, a tract that also keeps it in the brachial artery.

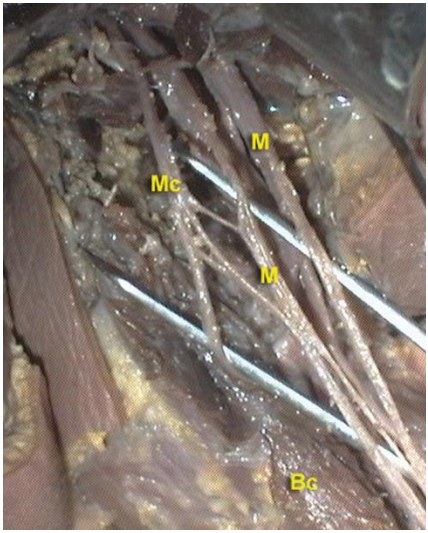


Fig. 58. Triple anastomosis between musculoskeletal and median nerves: the first one is transversal, situated between the musculocutaneous and medial root of the median nerve, passing its lateral roots later; the following two middle and lower anastomoses are oblique between the musculocutam and the lateral root of the median nerve, the lower one being double in origin, the two oblique nerve branches joining approximately midway between the two nerves.

Common at all levels of the upper limb are the anastomoses of the median and ulnar nerves as well. In the case of low unification of the two median roots, I encountered anastomoses between a

fascicle of the root and the ulnar nerve, or between a root of the median nerve and the ulnar nerve, anastomoses that passed anterior or posterior to the axillary or brachial artery.

I encountered a single case with a Martin-Gruber anastomosis, which was previously passing through the ulnar and interosseous-like arteries and from which previous anterior antebral muscles were detached.

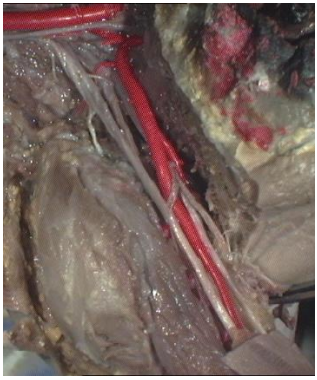


Fig. 59. Anastomosis between the median and ulnar nerves that pass before the brachial artery, located caudally to the origin of the deep brachial artery.

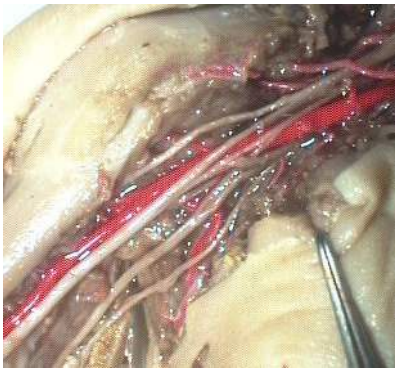


Fig. 60. Median nerve consisting of two roots that are medially joining to the axillary artery, the lateral root being slightly more voluminous; Strong anastomosis between the medial root and the ulnar nerve, anastomosis passing behind the artery.

Fig. 61. Martin-Gruber anastomosis, which passes anterior and interoscopic arteries and from which the anterior forebrain muscle shoots.

TABLE NO. 5 – THE ANASTOMOSES FREQUENCY OF MUSCULOCUTAN NERVE WITH MEDIAN NERVE

AUTHOR	YEAR	CASES NUMBER	ANASTOMOSES NUMBER	%
Testut	1888	105	40	38,1
Ker	1918	75	21	28,0
Hirasawa	1931	106	46	43,4
Monden	1942	120	33	27,5
Horiguchi	1985	67	19	28,4
Kosugi	1986	110	24	21,8
Kosugi	1992	75	41	54,7
Personal results	***2017***	***54***	***18***	***29,63***

CONCLUSIONS

There is a great variability of the morphology in origin and formation of the arteries and the nerves of the upper limb, the trajectory and their rapports, the collateral and terminal branches, the established anastomoses, as well as in their morphometry, its number or in the absence of one of these elements. The importance of their knowledge is useful not only to the morphologist, radiologist and internist in order to establish a diagnosis, but also to the surgeon when performing surgical interventions, given the frequency and diversity of pathology at the level of the upper limb. Specifically for this, the knowledge of vascularization and innervation is utmost essential. These aspects are highlighted by the multitude of scientific treaties and works that have emerged over time, and which continue to occur in current times, in view of the improvement and multiplication of exploration methods. Morphology also brings important contributions to the field, as many findings have come to confirm that what was once described as a variant has become dominant today.

This idea is underlined by many practitioners and here, I will only list a few opinions expressed in this regard.

Thus, [Celik] states that it is "important for the surgeon and radiologist to know these variants in order to avoid any complication in diagnosis and treatment," and others present this importance to certain topographical regions of the upper limb. [Erbil, Olave] underlines the "importance of knowing the arterial variations for palmar region surgical protocols."

The importance of arterial anastomoses established at different levels of the upper mammary region (axilla, elbow, hand) is indisputable, hence increasing the likelihood of blood pressure in case of arterial obstruction in different areas of the upper limb. However, these anastomoses are sometimes not enough, with certain "critical areas". [4] describes axially two anastomotic territories and states that "between upper and lower territories, the anastomoses are thin and

the ligament of the axillary artery between the subcapular artery and the truncated circumferential arteries is frequently followed by ischemic disorders of the upper limb, this segment of the axillary artery being considered a "dangerous area." Often, these anastomoses do not exist, the subscapular arteries and circumflexes arise from a common trunk." "In other cases, the movement can be restored by muscular anastomoses, whose importance should not be underestimated. Consequently, in practice, the ligature of the basal portion of the axillary artery must be done above the origin of the subscapular artery" [Bouchet].

[Sargon] states that "the proximal trajectory of the axially ectopic nerve branch can diminish the vascular flow of the upper limb through compression."

At the end of the 20th century, [Kopus] shows that "the radial artery appears the ideal graft for coronary surgery compared to the internal thoracic artery, resuming the timing of this artery that was originally interrupted."

The adult persistence of some arteries that are commonly present in the fetal period, sometimes in significant percentages, such as the median nerve artery, which may have multiple origins outside the intestinal artery, determines Kopus to undertake a study on newborn babies, finding that "the median nerve artery persists in 20% of cases, with no significant statistical differences with a previous study of the authors performed on adults".

[Drizenko] states that "its high brachial artery originates in an early bifurcation or persistent duplication and the existence of a ram or even both, superficially present in the arm and forearm, evoking the hemodynamic insufficiency of the axial vascular network that persists some portions of the superficial system of the thoracic limb.The confusion of these unusual arteries with the subcutaneous veins can explain the accidental injections of drug agents and distal necrosis of the limb. This knowledge could favor facilitating ascending catheterization of the cardiac cavities.

It is specified that a variant detected in a region of the superior member also requires searching for the possible existence of variants in the supra or underlying regions.

It is important to know the normal anatomy of the radial artery and of the brachial and antebrahial cutaneous nerves in the flap [Wafae], arguing that "arterial vascularisation is ensured by the nerve vessels and the venous drainage by the neighboring veins. It is preferable that a flap taken on the branch Anterior to the lateral and medial cutaneous nerve, as well as to the back of the medial forearm nerve.

[Gümüsburun] states: "Knowing the anatomical variations of the peripheral nervous system is of great utility to clearly explain some clinical symptoms."

This explains why research has been stepped up on the morphological features of the upper limb nerves, seeking to bring new details about the formation of the brachial plexus, its collateral branches, and anestomoses in the trunk and plexus bundles [Yan].

Fournier's accomplishments for re-implantation of the nerve in the case of multiple root-skulls are probably the future technique and the real hope for patients with such diseases, but they must be very well explored through myeloscanner, MRI and electromyogram. This makes a disease considered irrecoverable to be treated, most often successfully. He finds that the posterior pathway should be used for the surgical approach, and that re-implantation of the ventral roots in the marrow is mild for C5-C7, more difficult for C8 and problematic for T1. Reinstalling dorsal roots is easy from C5 to T1.

After consulting the literature, we found some significant, differences between the percentages reported regarding some findings from different authors. These differences are due to the number of cases that have been worked, the working methods used, and [Kopuz] also mentions the ethnicity. I would add the geographical area and the time period of the study, which would explain the differences encountered by the same author [Kosugi, Kopuz] who repeated the study at more or less long time intervals, sometimes these differences being appreciable [Kopuz].

I have also found that some authors une different naming of anatomical components, for example by naming branches of the median nerve root, so I consider the last anatomical terminology [TA] to be respected.

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