„OVIDIUS" UNIVERSITY OF CONSTANŢA

MEDICINE FACULTY DOCTORAL SCHOOL

MORPHOLOGICAL CONSIDERATIONS, ANATOMICAL VARIANTS AND VASCULARITY TERRITORIES OF SUPERIOR MESENTERIC ARTERY

DOCTORAL THESIS ABSTRACT

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INTRODUCTION

Cardiovascular system in general and in particular the arterial system, has a multitude of variations on the origin, trajectory and relationships, morphometry (diameter, length), method of distribution of collateral branches and terminals, as well as on the vascularization territory. In the arterial system, superior mesenteric artery is the largest vascular branch, which, by [1], is the largest nutritional artery for parts of the intestine and the entire mesentery. Together with celiac trunk and inferior mesenteric artery provides the vascularisation of the entire digestive tract, participating largely in the vasculature of its accessory glands, pancreas and liver. Containing about one-third of cardiac output, superior mesenteric vascular system is one of the body's main blood tanks, holding for this reason an important role in physiological hemodynamic. Thus the superior mesenteric artery (arteria mesenterica superior) or the great mesenteric artery or cranial mesenteric artery, plays an important role in the diverse pathology of the digestive system, circulatory insufficiency of mesenteric arterial origin being involved in acute or chronic disorder type. Reduction of arterial or venous circulation from the small intestine and colon produce a range of variable disorders related to the speed of installment of the decrease or eliminate irrigation, dimensions and capacity of interested vascular sector and compensation of vascular deficit by vascular anastomotic existing branches. Enteromesenteric infarction was long regarded as the only intestinal manifestation of vascular pathology. Based on clinical observations, statistics autopsy on the state of pathological mesenteric vessels, and some observations obtained through the study of selective angiography, were individualized other forms of mesenteric vascular disease with intestinal manifestations such as intestinal angiodysplasias and colic ischemia. Pathological involvement of superior mesenteric artery occurs in the case of thoracic and abdominal aorta aneurysm, [2] talking about the superior mesenteric artery syndrome, which, [3] thinks may be congenital. [4] recommends axial computed tomography to determine the maximum diameter of the abdominal aorta in patients with abdominal aortic aneurysm. [5] shows the importance of superior mesenteric artery in occlusive disease of celiac artery which sometimes is diagnosed late during pancreatic resection, inducing sudden ischemic threat to the liver, stomach, pancreas, and achieve revascularization by performing a termino-lateral anastomosis of the celiac artery to superior mesenteric artery.

To determine the territory of the superior mesenteric artery blood supply, it is important to be known: the origin of the artery from the abdominal aorta, establishing the existing relationships with other branches, particularly digestive aortic branches; It must be determined endoaortic artery orifice characteristics, especially morphometric characteristics, the arterial volume having a major importance on the territories of vascularity; not least, origin and anatomical features of its collateral branches depend on the arterial path, which depends largely on the angle it makes aortic artery wall.

The development of vascular exploration methods and especially selective angiography, color Doppler ultrasound, magnetic resonance, computed tomography, and after [6], multidetector CT (MDCT), [7] recommending spiral CT angiography (CTA), allowed precise diagnosis of the exact site of the vascular obstruction and the extent of affected intestinal ischemia, which could not be specified than with exploratory laparotomy or during the necropsy.

The study of morphological characteristics of superior mesenteric artery and its collateral branches is a valuable indicator not only in diagnosis but also in treatment of detected diseases, thereby reducing mortality, which for example is high after surgery for aortic aneurysms, [8] finding it 11%. Endoaortic features and characteristics of the superior mesenteric artery orifice have a particular importance in the endolumenal treatment for abdominal aortic aneurysm [9], which after [10,11] is a therapeutic alternative with good results, [12] stating that endovascular treatment of symptomatic abdominal aortic aneurysm is a better therapeutic alternative even in emergency. The distance between the branches of the abdominal aorta is important for aortic clamp placement above the renal arteries.

Given the aforesaid, it results the importance of knowing the normal morphology of superior mesenteric artery and its collateral and terminal branches, important not only for anatomist and radiologist, but especially for the surgeon, which often can be put in difficulty by some vascular variants they may face. This is the reason why I chose as the subject of my PhD thesis the anatomy and morphology of the superior mesenteric artery, which in addition to classical studies, absolutely necessary for the presentation, bring a totally unique aspect: presentation of endoaortic and endolumenal mesenteric aspects, subject which although it has great practical significance is less debated in the literature. In conducting thesis it helped me very much my specialty and modern equipment which we can work.

In the chapter of current state of knowledge about the superior mesenteric artery, I make a brief description of the arteries, as reflected in the classical anatomy, represented by famous anatomy books of Testut, Rouvière, Paturet, Gray, Sobotta. Added to this are newer works which will bring some clarification, confirm and supplement those described by classical explanations or even come up with news in relation to them. It's about books of Chevrel, Bouchet, Kamina, Moore, Schunk. The issues presented in these treaties are exemplified by the original images of the respective authors. The concepts presented in the treaties consulted are complemented by a number of authors published in journals since the early twentieth century, which proves the interest of specialists for superior mesenteric artery. Novelties brought by them is mainly due to improvement of means of exploration, imaging playing an important role in diagnosing and determining the various aspects, in particular variants of arterial vascularization and territory served by the superior mesenteric artery.

The personal part of the thesis begins with the method and material, my study being conducted only on CT angiographyes performed on patients who have addressed our clinic.

Further I expose the results that we have obtained, expressed through personal pictures, graphs and tables, while achieving a comparison with existing data in the literature that I had the opportunity to consult. Personal data covers both external morphological characteristics of superior mesenteric artery and the morphological endolumenal characteristics of both superior mesenteric artery and its collateral and terminals.

In conclusions chapter, are clarifications on some morphological characteristics with practical applicability, especially surgical, some particular aspects must be known by the interventionist, not to be surprisingly found during surgery, superior mesenteric artery showing a large number of vascular origin variants and especially in relation to the distribution and the number of its collateral branches.

The bibliography is presented in the order of citation in the text at the end of each chapter and in alphabetical order at the end of the thesis.

Finally, I want to thank associate professor. Dr. Radu Baz, my chieff at the level of discipline and in the imaging center where I work, with whom I consulted for the execution and diagnostics of CT angiographies examined for achieving the thesis. Thanks also to the staff members of the faculty anatomy laboratory and especially to Prof. dr. Dr. Petru Bordei, scientific leader of the thesis, whose guidance I received during its realization.

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MATERIAL AND METHOD

Our study was conducted on a total of 46 CT angiographies, being pursued: the origin of the superior mesenteric artery relative to the vertebral column, arterial orifice dimensions at endoaortic level, the angle that superior mesenteric artery forms with the abdominal aorta and the distance between the origin of the artery, the celiac trunk, the renal arteries (right and left) and inferior mesenteric artery. Outer size of the superior mesenteric artery was followed from its origin in the aorta and its branching up to the terminal, analyzing decreases of arterial caliber after issuing its collateral branches. The diameters of the two terminal branches were measured, both the exterior and endolumenal, and the angle between the two terminal branches. Collateral branches of the mesenteric artery were pursued in terms of size (exo and endolumenal), their origin level in relation to the origin of the superior mesenteric artery and upper and lower collateral. Benchmarks were followed in relation to the gender of the person examined and I specify that these were not always determined in the same number of cases, either because of a or because the existence of two renal arteries. There have been described also variants of the superior mesenteric artery, focusing more on the mesenteric origin of the right hepatic artery and especially on morphological characteristics of encountered coeliomesenteric trunks. I measured the length of the superior mesenteric artery from its aortic origin until above its terminal branch, sometimes being forced to measure the segments, due to its wavy path.

All CT angiographies were performed on a Lightspeed VCT 64 slices installation, manufactured by General Electric and in possession of Pozimed Diagnostic Imaging Center Constanta. To view the arteries it is necessary to administer a iodinated contrast agent, iodine representing a chemical element that has the ability to intensely capture X-rays and thus, by contrast difference it can be achieved endolumenal assessment of the circulatory system.

PERSONAL RESULTS AND DISCUSSIONS

SUPERIOR MESENTERIC ARTERY ORIGIN

The origin of the superior mesenteric artery relative to the spine I followed on the 46 cases, of which 24 female cases (52.17% of cases) and 22 cases of male (47.83% of cases). In 43 cases (93.48% of cases) superior mesenteric artery originated directly from the abdominal aorta and in 3 cases (6.52% of cases) had its origin in a celiomesenteric trunk all three cases being males.

In the cases where the superior mesenteric artery originated in the abdominal aorta, the artery origin was located in a range between T12 vertebra and L1-L2 intervertebral disc.

The T12 vertebra origin was found in 2 cases (4.35% of cases), in a particular case to the upper ½ of the vertebral body, closer to its middle, and in the other case in lower ½ vertebra, closer to the lower edge.

Fig. 19. Superior mesenteric artery origin at the level of lower edge of L1 vertebral (female case)

At the level of L1 vertebra, superior mesenteric artery originated in 36 cases (78.26% of cases), finding three variants. In 14 cases (30.43% of the cases) the artery origin was located at the upper ½ of the vertebra, in 9 cases (19.57% of the cases) the origin of the artery was located in the middle of L1, and in 13 cases (28, 26% of cases) in the bottom ½ of the vertebra. In 8 cases (17.39% of cases) the origin of the superior mesenteric artery was located at the L1-L2 intervertebral disc.

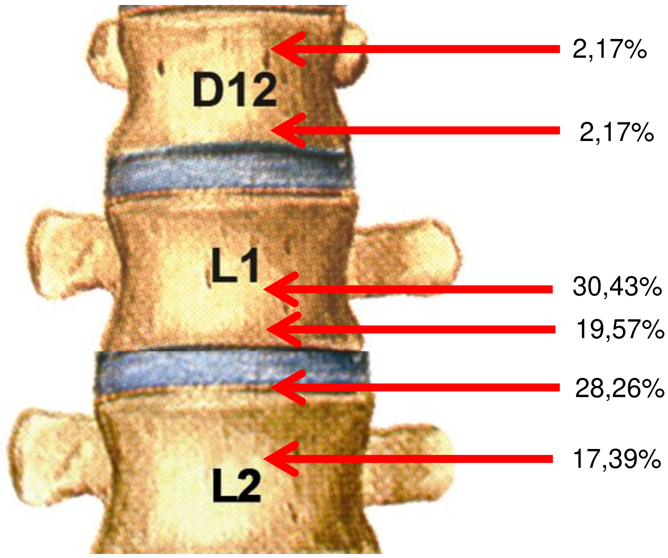

Fig. 21. Superior mesenteric artery origin related to the spine

Author	**SMA origin**
Rouvière	uppper edge L1 or T12-L1 iv disc
Paturet	uppper edge L1 or T12-L1 iv disc
Testut	under T12
Chiriac	uppper edge L1 or T12-L1 iv disc
Kamina	upper edge L1
Pillet	L1
Moore	L1
Schunke	L1
Sakher	L1
Paris	L1
Pennington	upper 1/3 L1
Gray	L1-L2 iv disc
Personal results	*T12- L1-L2 iv disc* *males: upper edge L1- L1-L2 iv disc* *females: T12- L1-L2 iv disc*

Table 1. Superior mesenteric artery origin related to the spine compared with literature data

Comparing our obtained results regarding the origin of the superior mesenteric artery relative to the spine, it appears that most authors [9,10,11, 12,13] indicate the L1 vertebra, without other remarks, [7] stating the upper edge of L1 vertebral body. [3, 4, 8] locate the origin of the artery at the level of the upper edge of the vertebra L1 or the iv disc T12-L1 and [5] at the upper edge of L1 vertebra or iv disc T12-L1. [1, 2] locates the origin of the superior mesenteric artery 1-2 cm below the origin of the celiac trunk, which lies to the lower body T12 vertebra.

In males, at the level of L1 vertebra had their origins 20 superior mesenteric artery (90.91% of male cases) and in 2 cases (9.09% of male cases), superior mesenteric artery originated at the level of the intervertebral disc L1-L2.

Fig. 23. Superior mesenteric artery origin at the level of L1-L2 iv disc (male case)

In women, two cases (8.33% of cases) had the origin of the superior mesenteric artery located at the level of T12 vertebra, in 16 cases (66.67% of the cases), the artery origin was located at the L1 vertebra level, and 6 cases (25% of women cases) superior mesenteric artery originated at the level of the L1-L2 intervertebral disc.

In the studied literature we have not found the origin of the superior mesenteric artery specified by gender. It appears that the origin of the superior mesenteric artery T12 vertebra I met only in women, something that we have not met in men. I found that the origin of the superior mesenteric artery is more common in males at the level of L1 vertebra by 24.24% than in women, in which is more common the origin at the level of the intervertebral disc i.v L1-L2 with 7.61%.

Endoaortic orifice of the superior mesenteric artery was studied in terms of its shape and dimensions, measuring vertical and horizontal diameters and differences between them.

Vertical diameter was followed in a total of 48 cases, 22 cases were in males (45.83% of cases) and 26 cases in females (51.17% of cases). Its dimensions were between 5.6 to 10.9 mm. Males had a vertical diameter size ranging from 6.9 to 10.9 mm, extreme dimensions being found in a single case (4.55% of cases). In women vertical diameter was found between 5.6 to 8.6 mm, 5.6 mm dimension finding it in two cases (7.69% of cases).

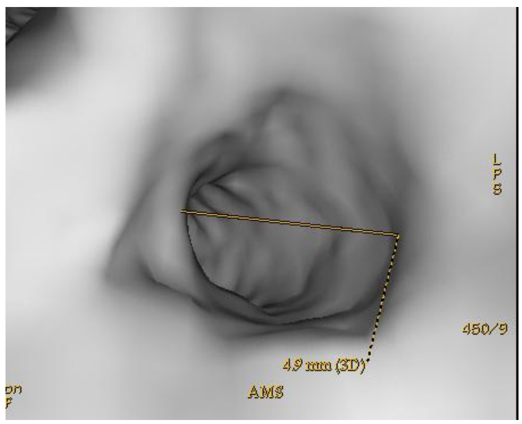

Fig.27. Horizontal diameter of superior mesenteric artery aortic orifice is 4,9 mm (female case)

Horizontal diameter of the endolumenal orifice of superior mesenteric artery I measured it on a number of 50 cases, 22 cases in males (44% of cases) and 28 cases in women (56% of cases) finding it between 4.9 to 9.7 mm. In males dimensions we found between 6.4 to 9.7 mm and in women horizontal diameter size we found between 4.9 to 8.3 mm.

Comparing the two diameters, I found that the vertical diameter was larger in 26 cases (54.17% of cases) with differences between 0.1 to 2.4 mm, in 22 cases (45.83% of cases) the horizontal diameter being larger, with differences of 0.1 to 2.2 mm. Vertical diameter in males was higher in 13 cases (59.09% of cases), with differences of 0.1 to 2.4 mm, in 9 cases (40.91% of cases) was higher the horizontal diameter, with difference between 0.1 to 2.1 mm. Vertical diameter in women was higher in 13 cases

(50% of cases), with differences of 0.1-2.0 mm, and in 13 cases (50% of cases) was higher the horizontal diameter, with differences contained between 0.1 to 2.2 mm.

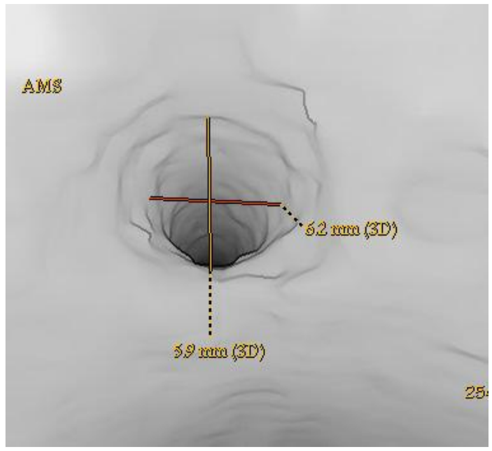

Fig. 28. Vertical diameter of superior mesenteric artery orifice is 5.9 and the horizontal one is 6.2 mm (female case).

Regarding endolumenal orifice dimensions of the superior mesenteric artery, the results show that it is always oval, encountering no case in which the vertical diameter is equal to the horizontal diameter. In 54.17% of cases the orifice was oval with big vertical axis, and in 45.83% of cases was oval, with large horizontal axis. Endoaortic oval orifice in males with large vertical axis was more frequent than in women in 9.09% of cases, in women being more frequently encountered higher orizontal axis in 9.09% of cases.

The distance between the aortic origin of the celiac trunk and superior mesenteric artery, I studied on 38 cases, including 16 cases in males (42.10% of cases) and 22 cases in females (57.89% of cases). Between the two arteries we found a distance of 5.0 to 13.6 mm.

Fig. 30. Distance between celiac trunk and superior mesenteric artery is 11.1 mm (male case)

In males it was 5.0 to 12.1 mm distance, and in females between 6.9 to 13.6 mm distance.

Author	**CT-SMA distance (mm)**
Testut	10-20
Rouvière	10
Gray	10
Paturet	8-10
Pillet	10
Kamina	10
Butoi	Males: 10,5-23,7 mm Females: 3,8-17,8 mm
Personal results	*5-16,5* *males: 5,0-12,1;* *females: 6,9-16,5*

Table 2. Distance between the origins of celiac trunk and superior mesenteric artery.

The minimum value of this distance found by me is less with 5 mm than [1,2,3, 7,11,14] and with 3 mm from [4]. The maximum value found by us is higher by 3.6 mm to [3,4,7,11,14] and less than 6.4 mm to [1.2], I have not encountered a maximum distance greater than 13 6 mm, this distance finding it only in one case in women. The distance between the two arteries was greater in women with 1.9 to 4.4 mm.

Only [15] individualize this distance by gender, in males finding the minimum distance of 10.5 mm, so higher than me by 5.5 mm, and 3.8 mm in women, lower by 3 1 mm than the distance found by me. Maximum distance [15] finds in males to be 23.7 mm, 7.2 mm greater than that found by me, and in women finds this distance of 17.8 mm, greater than that found by me with 1.3 mm. In the personal cases, we found that distance between the celiac trunk and superior mesenteric artery is higher in women, the difference between the minimum distances being higher by 1.9 mm, and the difference between maximum distances is higher by 1.5 mm.

The distance between the origin of the superior mesenteric artery and renal artery was studied on 36 cases, 12 cases in males (33.33% of cases) and 24 cases in females (66.67% of cases). I found this distance to range from 6.2 to 23.5 mm. In males the range was from 6.5 to 19.1 mm, while in women the distance between the origin of the superior mesenteric artery and right renal artery origin we found between 6.2 to 23.5 mm.

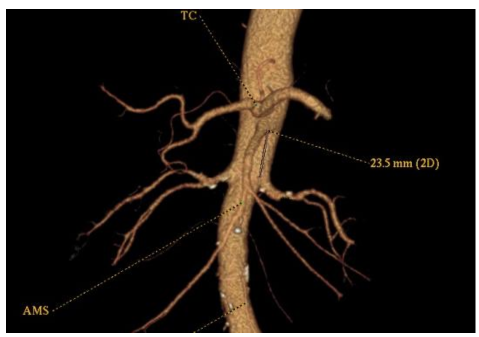

Fig. 35. Distance between superior mesenteric artery and right renal artery is 23,5 mm (female case)

The distance between the origin of the superior mesenteric artery and left renal artery was measured in 32 cases, 12 cases in males (37.5% of cases) and 20 cases in females (62.5% of cases). I found this distance to range from 5.7 to 23.5 mm.

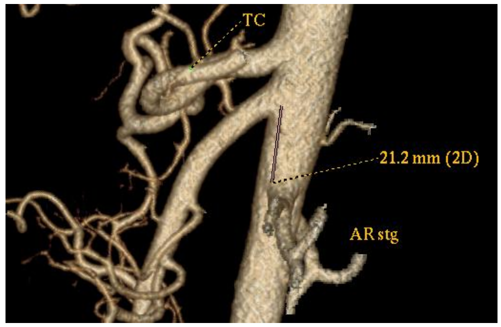

Fig. 37. Distance between superior mesenteric artery and left renal artery is 21,2 mm (male case).

In males the distance was 5.7 to 21.2 mm, and in females the distance we found it between 6.2 to 23.5 mm.

[15] individualize this distance by sex, finding the distance between the superior mesenteric artery and renal arteries between 3.9 to 25.8 mm in men and 3.1 to 25.37 mm in women.

The distance between the origin of the superior and inferior mesenteric artery have been studied in a number of 38 cases, including 16 cases in males (42.11% of cases) and 22 cases in females (57 89% of cases). I found the distance between 50.6 to 91.2 mm. In relation to the minimum distance found by [4] this is is higher than that found by me with 21.8 mm, but the author does not determine this distance by gender.

[15] found that distance from 42.1 to 62.1 mm, which is lower by 8.5 mm the minimum distance and 29.1 mm maximum distance found by me. [16] finds the distance between the two mesenteric arteries from 58.8 to 77.6 mm, so the minimum distance is 8.2 mm greater than the distance that I found myself, and the maximum distance being higher with 13.6 mm in my study. [9] finds the distance between mesenteric arteries between 50.0 to 82.0 mm, so the minimum distance has a difference of only 0.6 mm and is smaller, and the maximum distance is less than that found by me with 9.2 mm.

In males the distance was between 50.6 to 91.2 mm, and in women this distance we found between 58.2 to 88.4 mm.

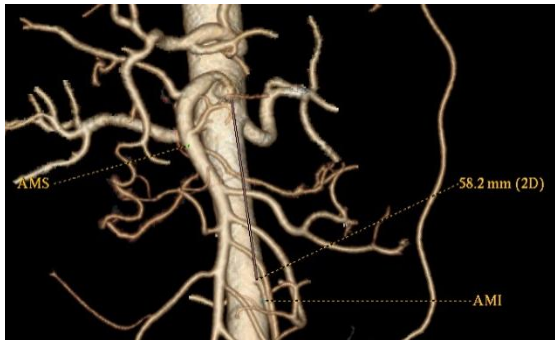

Fig. 43. The distance between superior and inferior mesenteric arteries is 58.2 mm (female cases).

[4] gives the distance of 80-100 mm, I encountering the higher maximum value of 91.2 mm, which is lower by 8.8 mm.

EXTERNAL MORPHOMETRY OF SUPERIOR MESENTERIC ARTERY

Fig. 45. Superior mesenteric artery diameter of 9.9 mm (male case)

In males, in 22 cases (47.83% of cases), superior mesenteric artery diameter we found between 4.4 to 9.9 mm, and in women, in 24 cases (52, 17% of cases), I found a diameter between 5.4 to 8.8 mm. The difference between the maximum and the minimum caliber in women was 3.4 mm, so a smaller difference of 2.1 mm from males.

Fig. 47. Superior mesenteric artery diameter is 8.8 mm (female case)

Author	**SMA diameter**
Paturet	8-9 mm
Testut	8-10 mm
Gray	8-10 mm
Kamina	8 mm
Pennington	9,1+/-2 mm
Paris	8-12 mm
Sacker	5,7-10,2 mm
Personal results	***Males: 4,4-9,9 mm*** ***Females: 5,4-8,8 mm***

Table 3. Superior mesenteric artery diameter

Analyzing the literature, it appears that I have not found any case where the outer maximum diameter of the superior mesenteric artery is 10 mm [which 1, 2 quote and found by 9], [5] giving a maximum diameter of to 11.1 mm. Only [10] gives a maximum diameter of 12 mm. Most classical authors [1,2,4,7,14] do not give a smaller diameter of 8 mm, only [5] giving the lower limit to 7.1 mm, and [9] to 5.7 mm, this author minimum size is close to that found by me in females (5.7 mm). It’s important to tell that none of the cited authors does not specify gender.

COMPARISON BETWEEN THE DIAMETERS OF SUPERIOR MESENTERIC ARTERY AND ABDOMINAL AORTA

This comparison I did it on a number of 46 cases, of which 22 cases in males (47.82% of cases) and 24 cases in the female sex (52.17% of cases). I measured the diameter of the aorta at the level of the superior mesenteric artery, categorizing the findings according to sex. The diameter of the abdominal aorta at the level of the origin of the superior mesenteric artery I found it to range between 13.4-22,2 mm.

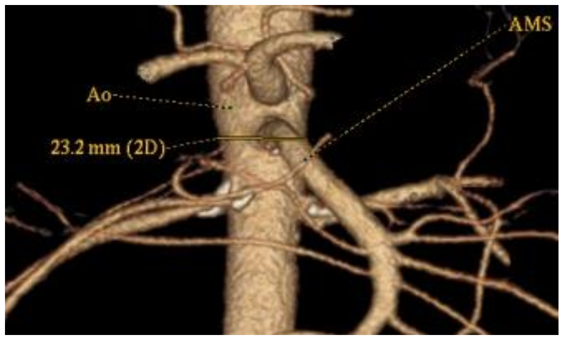

Fig. 49.External diameter of abdominal aorta at the level of superior mesenteric artery origin is 23.2 mm (male case).

In males the aortic diameter was between 14.8 to 22.2 mm, and in women aortic diameter at the origin of the superior mesenteric artery was between 13.4 to 20.4 mm. Overall, the superior mesenteric artery, had a size which represented between 6.9 to 14.9% of aortic caliber, in males superior mesenteric artery caliber representing 7.6 to 14.9% of the abdominal aorta, and in women the caliber representing 6.9 to 13.1% of aortic caliber.

Although there are authors [17] which states that morphometric parameters of the abdominal aorta has no significant differences between the two sexes, I found that these differences exist, sometimes significant. Differences also found [15], which find at the origin of the superior mesenteric artery diameters of 8.7 to 27.2 mm, males having 15.4 to 27.2 mm, and women 8.7- 20.0 mm. Related to my results, [15] finds males aortic caliber smaller with 2.4 mm and the level of maximum diameter greater with 5.0 mm. In women, [15] finds the minimum diameter 4.7 mm smaller and maximum size lower with only 0.4 mm.

COMPARISON BETWEEN THE DIAMETERS OF SUPERIOR MESENTERIC ARTERY AND CELIAC TRUNK

Celiac trunk caliber I've studied on a number of 46 cases, 22 cases in males (47.82%) and 24 cases in the female sex (52.18% of the cases). Its caliber I've found between 5.1-8.6 mm. In males, celiac trunk caliber was 5,1-8.6 mm, and in the females I found the caliber of the celiac trunk between 5.4-8,6 mm.

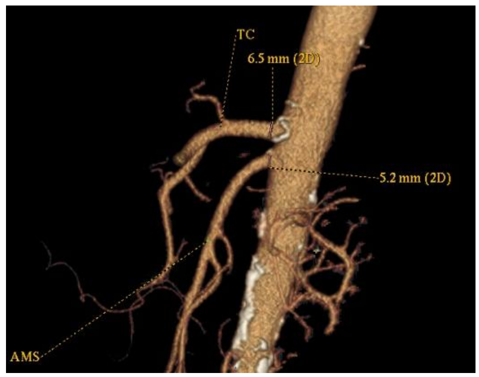

Fig. 55. Celiac trunk diameter of 6.5 mm and superior mesenteric artery diameter is 5.2 mm (female case).

Compared with the literature, minimum diameter given by [4,18] is 6 mm, higher than that found by me with 0.9 mm for males and with 0.6 mm for women, and the maximum diameter is greater than 0.6 mm comparing to [4] and with 0.65 mm versus [Nguyen], in both sexes, the two authors notspecifiyng diameter values according to sex. In relation to the results found by [19], which also does not specify gender, maximum diameter found by me is greater with 2.1 mm in males and with 2.4 mm in females. Maximum diameter of the celiac trunk [19] find it greater than 10 mm, and so higher in both sexes than the diameter of the celiac trunk found by me, with over 1.5 mm.

Celiac trunk diameter compared to superior mesenteric artery in the male sex, was lower in 18 cases (81.82% of male cases), and in 4 cases (18.18% of male cases), celiac trunk diameter was greater than the diameter of the superior mesenteric artery

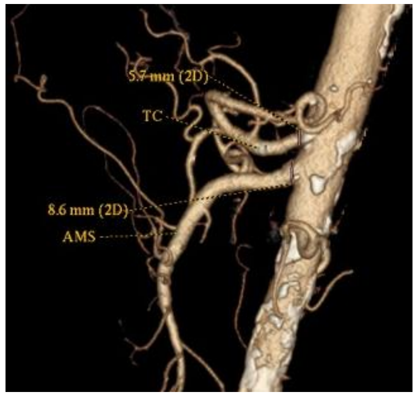

Fig. 57. Celiac trunk diameter is 5.7, and superior mesenteric artery diameter 8.6 mm (male). The difference between the two is 2.9 mm for SMA, celiac trunk representing 66.28% of SMA caliber (male).

For the female sex, the superior mesenteric artery diameter was larger than the diameter of the trunk of celiac in 16 cases (66.67% of female cases), in 2 cases (8.33% of female cases) superior mesenteric artery diameter was equal to the diameter of the celiac trunk, and in 6 cases (25% of female cases) celiac trunk had a diameter larger than the diameter of the superior mesenteric artery.

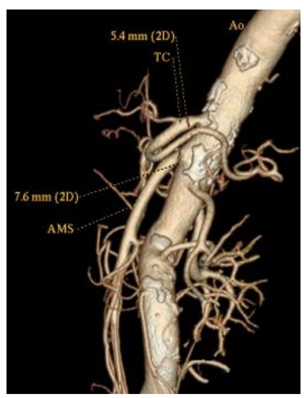

Fig.58. Celiac trunk diameter is 5.4, and superior mesenteric artery diameter 7.6 mm (female sex). The difference in size between the two is 71.05% in favor of superior mesenteric artery (female).

COMPARISON BETWEEN THE DIAMETERS OF SUPERIOR AND INFERIOR MESENTERIC ARTERIES

Inferior mesenteric artery caliber I have measured it on a number of 46 subjects, among which 18 males (39.13%) and 28 females (60,87% of cases), finding a diameter between 1.9-4.1 mm.

[16] found a caliber of inferior mesenteric artery between 2,7-4,0 mm, so minimum diameter higher with 0.8 mm and the maximum diameter 0.1 mm lower than the results found by me.

For the male sex inferior mesenteric artery diameter was between 2.1-3.4 mm, and in the female sex, the diameter of the inferior mesenteric artery was between 1.9-4.1 mm.

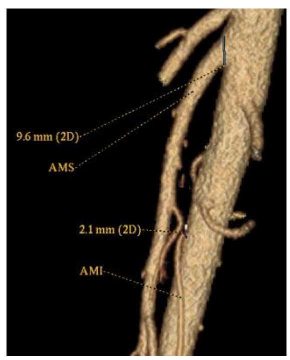

Fig.72. The diameter of the inferior mesenteric artery is 2.1 mm (male)

Compared to the diameter of the inferior mesenteric artery, superior mesenteric artery diameter was always greater, with differences ranging from 2.1-7,1 mm, media being 5.0 mm. By percentage, the less inferior mesenteric artery diameter was less than superior mesenteric artery, representing 28,26-59,62% from its caliber, the average being 44,09%, larger 48.85% being encountered only in one single case (2.17% of the cases). In males, the superior mesenetric artery was greater than inferior mesenteric artery with differences of 5.0-7.1 mm, in percentage the later representing 28,40-48,62% of its caliber, media being 34,37%.

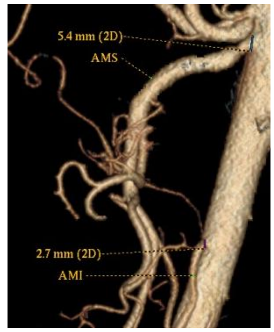

Fig. 76. The diameter of the inferior mesenteric artery is 2.7 mm and the diameter of superior mesenteric artery on the same subject has 5.4 mm, so between the two arteries is a 2.7 mm caliber difference inferior mesenteric artery representing 50% of the caliber of the superior mesenteric artery (females).

In the female sex, superior mesenteric artery have a diameter larger than the inferior mesenteric with 2.1-5.5 mm, the average being 3.8 mm, in percentage inferior mesenteric artery representing 32,10-59,62% from superior's caliber, 45,86% being the average.

ANGLE BETWEEN SUPERIOR MESENTERIC ARTERY AND ABDOMINAL AORTA

The angle that superior mesenteric artery forms with abdominal aorta at its origin, I've measured on a number of 40 cases, 16 of the male cases (40%) and 24 cases in women (60% of cases), being comprised between 16.7 -120, 8^{o}.

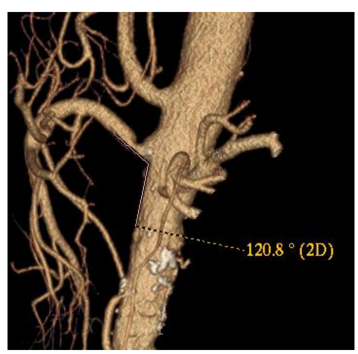

Fig. 77. The angle that makes the superior mesenteric artery with aortic wall is 120, 8^{o} (male).

For the male sex the angle was between 24.8 -120, 8^{o}, and for the female sex the angle between the superior mesenteric and aortic wall i've found between 16.7-95,9^{0}.

LENGTH OF SUPERIOR MESENTERIC ARTERY

I measured it from the aortic origin up above its terminal branch, on a number of 44 cases, of which 20 cases in males (45.45% of cases) and 24 cases females (54.55% of cases). I found it between 77.2-170,2 mm, in males finding it between 83.3-170.2 mm, and for the female sex between 77.2-136.7 mm.

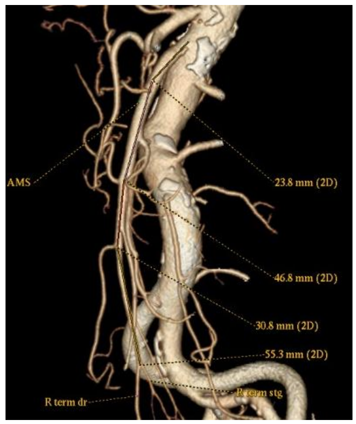

Fig.83. The length of the superior mesenteric artery is 136.7 mm (female).

Author	**Length in mm**
Testut	150-300 (average: 25)
Paturet	200
Chevrel	100-300 (average: 24)
Kamina	200
Chiriac	200
Personal results	***Males: 83,3-170,2*** ***Females: 77,2-136,7***

Tabel 4. The length of the superior mesenteric artery

Compared with data from the surveyed literature, I have found a maximum length of 170.2 mm and this only in the male sex, being shorter with 29.8 mm than [4, 7, 8] and less with 129.8 mm than [1, 2]. Even in relation to the average length of [1, 2, 6], the values found by me are lower with 69.8 mm compared to [6] and 79.8 mm to [1,2]. These differences are larger compared to the maximum length found by me to the female sex, which is 163.3 mm compared to [1, 2, 6], and compared to the average length of these authors, my results are lower with 102.3 mm compared to [6] and 112.3 mm compared to [1,2]. [4, 7, 8] give a single length of the superior mesenteric artery, without specifying a minimum and maximum length. For minimum length, that I found is less with 67.9 mm compared to [1, 2, 6] for the males and with 72.8 mm for the females. None of the authors cited do not give the length as per gender.

MORPHOLOGY OF COLLATERAL BRANCHES OF THE SUPERIOR MESENTERIC ARTERY

INFERIOR PANCREATICODUODENAL ARTERY

I found that this artery had its origin from superior mesenteric at a distance between 15.8 mm-56.8 of his origin. When the superior mesenteric artery does not give a right hepatic artery, it is the first branch of the superior mesenteric artery, mentioned by [4]. The origin of this artery was pursued on a number of 38 cases, of which 18 cases in males (47.37%) and 20 cases in women (52.63% of cases).

Fig. 85. The distance between the origin of pancreaticoduodenal artery and the origin from the aorta of the superior mesenteric artery is 36.7 mm (male).

In males, this artery originated at a distance between 15.8-49.8 mm from its aortic emergence and for the females this distance was between 17.1-56.8 mm.

External diameter of inferior pancreaticoduodenal artery I've found between 1.1-3.5 mm, for males being between 1-3 mm, and for the females between 1.1-3.5 mm.

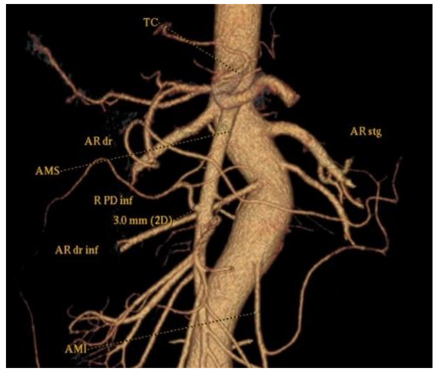

Fig.87. The outer diameter of the inferior pancreaticoduodenal artery is 3.0 mm (male).

RIGHT COLIC ANGLE ARTERY

I found it present in all cases, with different variations, [Lippert] finding it present also in all cases. In terms of external diameter, it was between 1.0-3.4 mm, for the males being between 1.5-3 mm, and for the females between 1.0-1.5 mm.

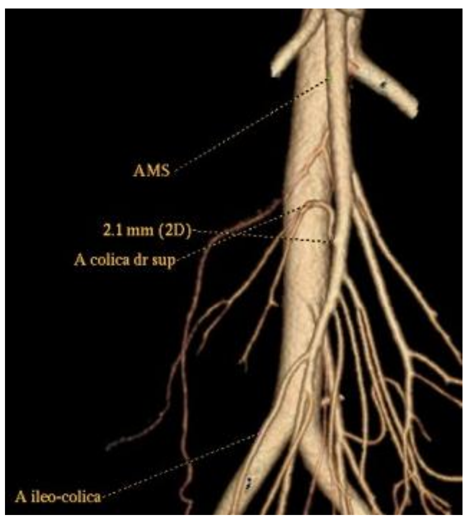

Fig. 93. The outer diameter of the right colic angle artery is 2.1 mm (female).

The vertical diameter of the right colic angle artery orifice I've found between 1.0-3.9 mm.

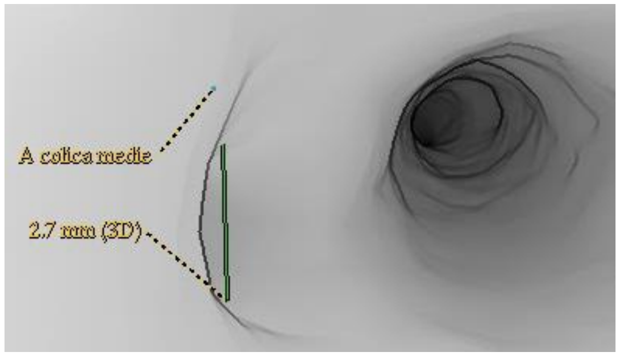

Fig.95. Vertical diameter of the orifice of right colic angle artery has 2.7 mm (male).

The males had a vertical diameter of 3,1-3,7 mm and the diameter for the females was between 1.4-2.7 mm.

The horizontal diameter of the orifice of right colic angle artery had a value in a range between 1.4-4.5 mm, the males having 1.5-4.5 mm, and the females 1.4-2.7 mm.

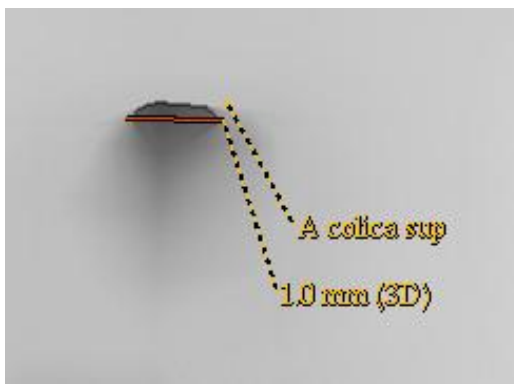

Fig. 98. The horizontal diameter of the right colic angle artery is 1.0 mm (female).

The distance at which had its origin the right colic angle artery with respect to the aortic origin of mesenteric artery was 2,4-6,8 mm, in males the distance being of 4.2-6,8 mm, and for the females 2.4-6.5 mm.

The distance between the origin of right colic angle artery and the origin of ileocolic artery I found it between 4.7-59.6 mm, in males being 8.9-42.5 mm, and for the female sex of 4,7-59.6 mm. Most frequently the distance was 19.7-27.8 mm in 11 cases (50% of male cases), while for the female sex 10.7-27,5 mm, in 13 cases (65% of female cases).

RIGHT COLIC ARTERY

The outer diameter of the artery I've found between 1,0-3,0 mm, in male sex being between 1.0-3.0 mm, and for the female sex between 1.1-1.8 mm

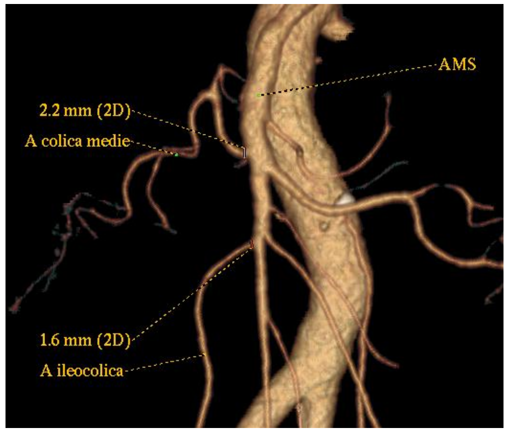

Fig.99. The outer diameter of the right colic artery is 2.2 mm and diameter of ileocolic artery 1.6 mm (males).

Vertical diameter of right colic artery orifice, I've found between 1.1-3.0 mm, dimensions that correspond to the male sex, for the female sex the vertical diameter being between 1.1-2.1 mm.

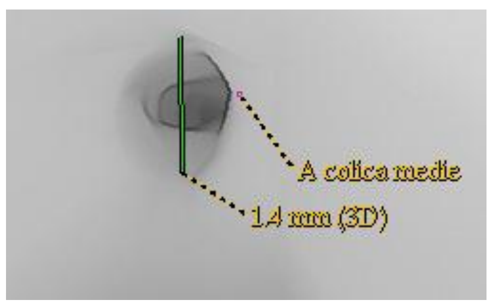

Fig. 101. Vertical diameter of right colic artery orifice has 1.4 mm (female).

Horizontal diameter of right colic artery orifice I've found between 0,9-2,7 mm, the males having a size range of 1,3-2,7 mm, and for the female sex between 0,9-1,6 mm.

Making a comparison between vertical and horizontal diameter of right colic artery orifice, I found that in 26 cases, of the 36 tracked (72.22% of cases), the vertical diameter was higher than horizontal with 0,1-0,5 mm, and in 10 cases (27.78%) horizontal diameter was greater than the vertical differences being 0.1-0.4 mm.

ILEOCOLIC ARTERY

The outer diameter of the artery I've found between 1.1-4.0 mm, the male being comprised between 1.2-4.0 mm and the female sex having 1.1-3.5 mm.

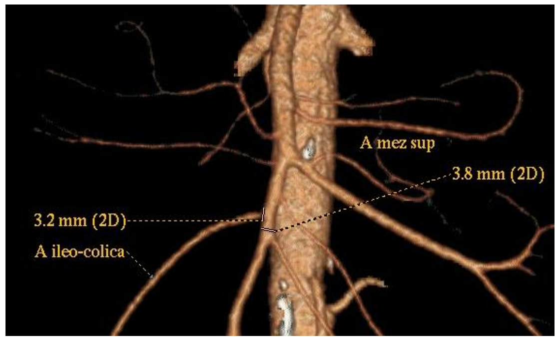

Fig. 102. The outer diameter of the ileocolic artery is 3.2 mm (male).

The vertical diameter of the orifice of the ileocolic artery was between 1.6-4.5 mm in males this diameter having 1,9-4,5 mm, and in women 1,6-3,5 mm.

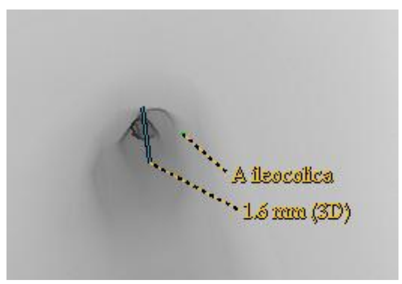

Fig. 106. The vertical diameter of the orifice of the ileocolic artery is 1.6 mm (female).

For the horizontal diameter of the ileocolic artery I found a value in a range between 1.4-3.8 mm, for the males this diameter was 1.8-3.8 mm, and for the females 1.4-2.8 mm.

Making a comparison between vertical and horizontal diameters of ileocolic artery, I found that in 29 cases (69.5%) the vertical was greater with differences of 1.3 mm, in 12 cases (28.57%) the horizontal was greater with differences of 0.1-0.8 mm, and in one case (2.38% of cases) the two diameters were equal.

The distance between the origin of the superior mesenteric artery and the origin of ileocolic artery, I found it between 53.7 to 98.0 mm, with ranges in males of 53.7 to 97.1 mm, and in women from 54.6 to 98.0 mm.

Regarding the caliber of ileocolic artery, [4] gives a value of 3-4 mm, so much bigger than my results, the value of 4 mm finding it in one case, and only in males. In women I met one case where the artery had a caliber of 3.5 mm. Comparing with the diameter of the artery given by [4] I found that minimum size is smaller than the minimum size given by [4] with 1.8 mm in males and 1.9 mm in females, and the maximum size (except one case of 4 mm) is less with 0.3 mm in men and 1.9 mm in women (well, except for one case of 3.5 mm which I met in my study). Most authors consider the ileocolic artery as the biggest branch [1, 2, 3, 4], from my resulting that are frequent cases where ileocolic artery caliber is lower than other colic arteries sometimes with differences up to a millimeter.

MIDDLE COLIC ARTERY

Outer diameter of middle colic artery I've found between 0,8-2,5 mm, the males having 1.1-2.5 mm, and the females 0.8-2.2 mm.

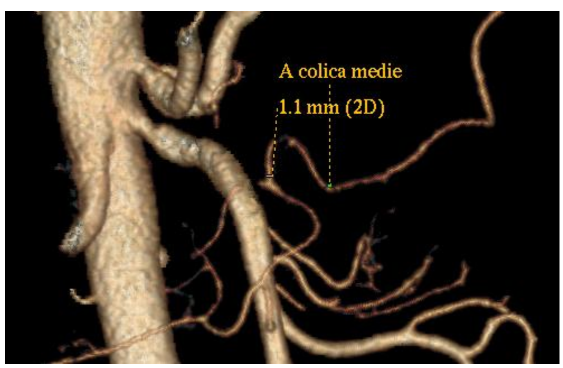

Fig. 111. The outer diameter of the middle colic artery is 1.1 mm (female).

The vertical diameter of the orifice of middle colic artery has a value of 1,0-3,7 mm, the male diameter value being of 1.1-3.7 mm, and for the females of 1.0-1.5 mm.

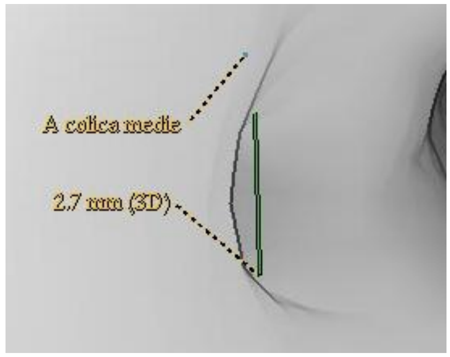

Fig. 113. The vertical diameter of the orifice of middle colic artery is 2.7 mm (male)

The horizontal diameter of the orifice of middle colic artery I've found between 0.9-1.5 mm, the males having between 1.0-1.5 mm, and the females 0.9-1.5 mm.

Comparing the vertical diameter with the horizontal diameter I found that in 19 cases (52.78%) horizontal diameter was greater, with differences of 0.1-0.2 mm, in 16 cases (44.44% of cases) vertical diameter was greater, with differences up to 0.3 mm, and in one case (2.78% of cases) the two diameters were equal.

In males, the vertical diameter was greater than the horizontal in 8 cases (40% of male cases), with differences of 0.1-0.3 mm, and in 12 cases (60% of male cases) horizontal diameter was greater than the vertical diameter, with differences of 0,1-0,2 mm.

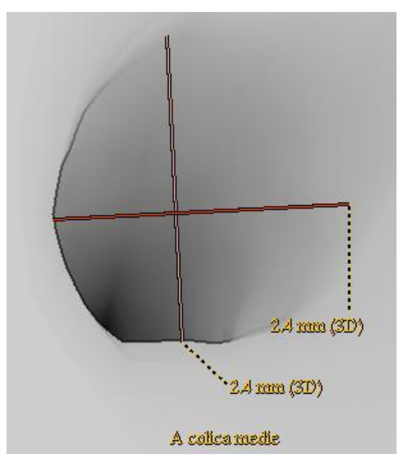

Fig. 116. The two diameters of orifice of middle colic artery are equal, each having 2.4 mm (female).

CONSIDERATIONS REGARDING THE SIZE OF THE SUPERIOR MESENTERIC ARTERY FROM ITS ORIGIN UP TO THE TERMINAL BRANCHING

Under the right colic angle artery I've found a value of 2.3-6.4 mm, in males the diameter of superior mesenteric artery under right colic angle artery origin I've found between 4.0-6.4 mm and the diameter in women have 2.3-3.8 mm. The decreases of superior mesenteric artery diameter under the right colic angle artery in males we've found in 19 cases (97.5% of male cases), in a single case the mesenteric artery having the same diameter. Except in this case, the diameter percentage declines were from 25,58-51,52%. In women, the decrease in the diameter I met it in all cases, the percentage being of 3,7-64,62%, with a higher difference (64.25%) in relation to the male sex (25,67%).

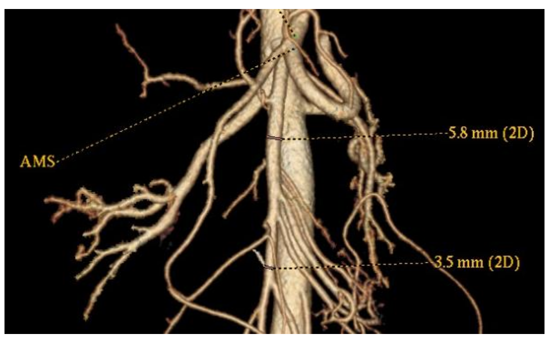

Fig. 130. Superior mesenteric artery diameter under the right colic angle artery is 5.8 mm, at its origin being 6.5 mm, with a decrease of 0.7 mm, meaning that the arterial caliber decreases with 10.77%; superior mesenteric artery diameter above its terminal branch is 3.5 mm, less with 3.0 mm from its origin, the decrease being 46.15% (male case)

The superior mesenteric artery diameter under the origin of ileocolic artery, we've found to be ranged between 1.6-5.4 mm, in males being 2.5-5.4 mm and in women 1.6-4.1 mm.

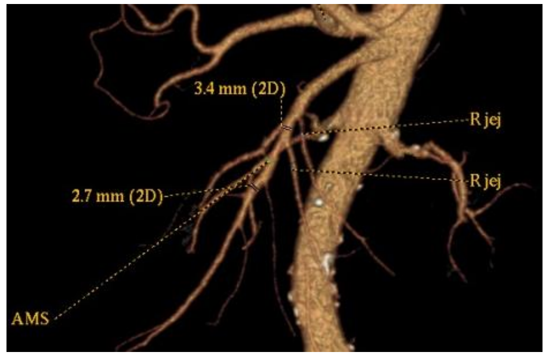

Fig. 131. Superior mesenteric artery diameter under the origin of ileocolic artery is 3.4 mm, at its origin superior mesenteric artery having 8.1 mm, the decrease of mesenteric diameter being with 58.13%; the diameter of right terminal branch is 2.7 mm, which presents a decrease of the diameter of 66.67% (female case).

In males, the superior mesenteric artery diameter decrease under ileocolic artery origin was between 13,64-69,70% from the diameter of the mesenteric artery, while in females the decrease of the diameter was 33,87-75,38%.

Superior mesenteric artery diameter measured above its terminal bifurcation, I've found between 2.0-3.5 mm, with a male diameter between 2.0-4.8 mm and the diameter of the women 2.1-5.1 mm.

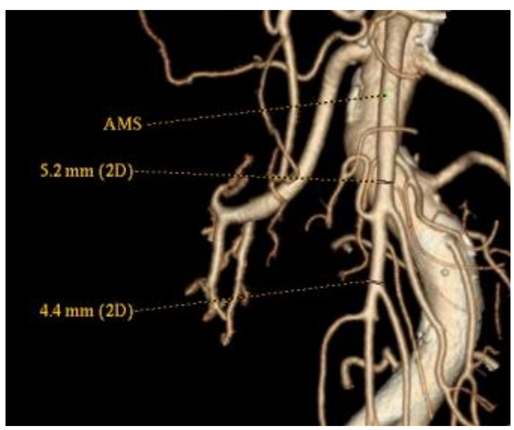

Fig. 133. Superior mesenteric artery diameter above its terminal bifurcation has 4,4 mm; at its origin the mesenteric artery has 7.6 mm, so there is a reduction with 3.2 mm, representing a decrease with 57.89% (female case).

Above its termination, superior mesenteric artery diameter decrease with 17,74-78,72%, this reduction in males being 39,24-78,72% and for the females 17,74-71,62%.

SUPERIOR MESENTERIC ARTERY TERMINAL BRANCHES MORPHOLOGY

Right terminal branch of the superior mesenteric artery had a diameter of 1,0-5,1 mm, in males having 1,0-4,3 mm, and in females 1,1-5,1 mm.

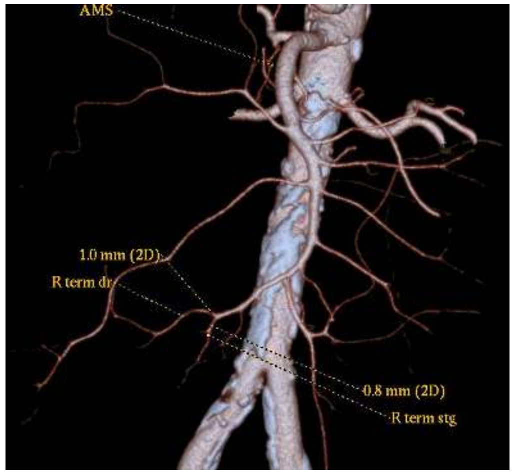

Fig. 134. Right terminal branch diameter is 1,0 mm, and left terminal branch diameter is 0,8 mm, right branch being larger with 0.2 mm (male case).

Left terminal branch of superior mesenteric artery presented a diameter between 0.5-2.5 mm, in males having 0.8-1.7 mm and in women 0.5-2.5 mm.

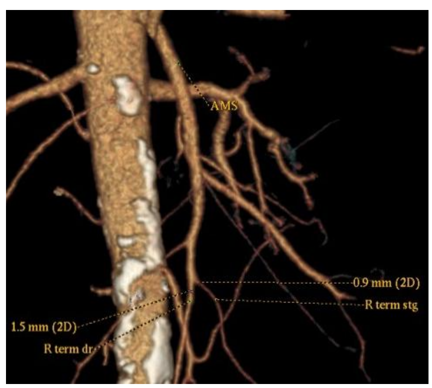

Fig. 140. External diameter of left terminal branch has 0.9 mm and right terminal branch diameter has 1.5 mm, with a difference between them of 0.6 mm for the right one (female case).

In 38 cases (86.6%) the right branch was larger than the left one with differences of 0.1-3.2 mm and only in 6 cases (13.64%) the left one was larger with differences of 0,2-0,5 mm. In males, the right terminal branch was larger than left in 18 cases (90% of male cases), while for the females in 20 cases (83.33% of female cases).

The angle between the two terminal branches in male cases was 32,7-97,1^{o}, and for the females the angle was 33,5-71,6^{o}.

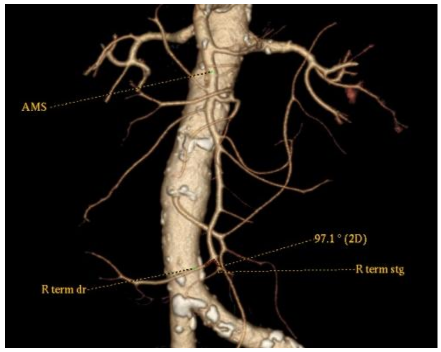

Fig. 143. The angle between the terminal branches of superior mesenteric artery has 97,1^{o} (male case).

SUPERIOR MESENTERIC ARTERY VARIANTS

SUPERIOR MESENTERIC ARTERY ORIGIN OF HEPATIC ARTERY

Of the 46 CT angiographies, in 5 cases (1.87% of cases) a hepatic artery had its origin in the superior mesenteric artery, 3 cases being females (12.5% of female cases) and 2 cases in males (9.09% of male cases).

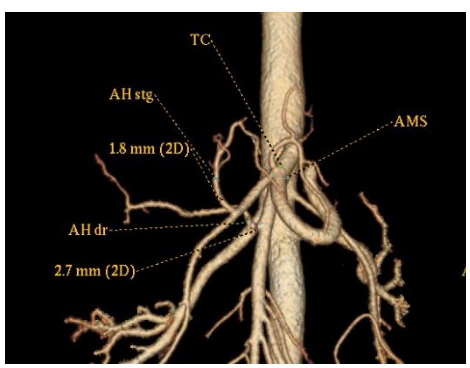

Fig. 155. Hepatic artery diameter with origin in the superior mesenteric is 2.7 mm and the diameter of the left hepatic artery with origin in the celiac trunk has 1.8 mm, thus the right hepatic being bigger with 0.9 mm (female).

In all five cases it was a right hepatic artery, in 2 cases (both women) being the only right hepatic artery, from celiac trunk taking birth only the left hepatic artery. In the other 3 cases, the right hepatic artery with origin in superior mesenteric artery doubled the right hepatic artery originated from proper hepatic which originated from the common hepatic artery, branch of the celiac trunk. This gave rise, after gastroduodenal artery branches into two branches, right and left. In all cases encountered gastroduodenal artery had its origin in hepatic artery originating from the celiac trunk.

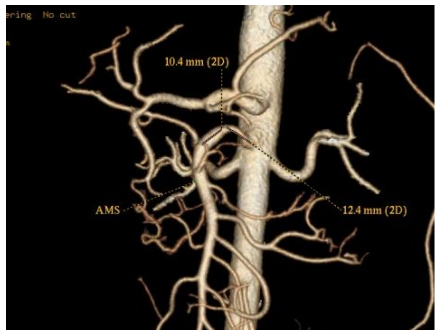

Fig. 156. The distance between aortic origin of superior mesenteric artery and origin of right hepatic artery from mesenteric is 22.8 mm (female case).

Hepatic artery arrised from the superior mesenteric artery at a distance of 7,1-24,9 mm from its aortic origin, as the first colateral branch, anteriorly form inferior pancreaticoduodenal artery at a distance of 10,4-35,3 mm.

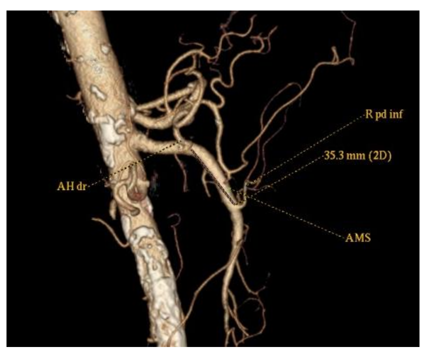

Fig. 157. The distance between the origin of right hepatic artery and inferior pancreaticoduodenal artery is 35.3 mm (male case).

Author	Percentage
Paturet	8%
Michels	11%
Rio Branco	15%
Lippert	16%
Retelli	11%
Yadav	11,5%
Alakkam	10-12%
Sree	5%
Hiatt	10,6%
Lin	19%
Jones	19%
Koops	1,9%
Chaib	8,25%
Chen	11% (CT); 4,9% (cadavers)
Ahmadpur	11,5%
Lopez-Andujar	7,8%
Krisdee	16%
Sangam	5%
Chiriloaie	4,17%
Personal cases	***10,87%; males: 9,09% females: 12,5%***

Table 8. Origin frequency of right hepatic artery from superior mesenteric artery.

From the literature consulted it is clear that the frequency of the presence of right hepatic artery with origin in superior mesenteric artery is highly variable from one author to another, being between 1,9-19% of the cases, so the percentage difference 17.1%. We noted that no author is giving percentages according to gender, although I did find this artery more common in females with 3.41% of cases.

Comparing my results with those in the literature, I found that they are smaller with only 0.13% compared to [29,30], with 0.63% compared to [31], with 4.13%

compared to [32], with 5.13% compared to [28, 33] and with 7.13% compared to [34,35]. My results are greater than those reported by [36], with 0,27%, with 2.62% compared to [37], 2.87% compared to [4], with 3.07% compared to [38], with 5.87% compared to [39,40], with 6.70% compared to [19] and with 9.97% compared to [41]. [42] gives two percentages: 11% in CT angiographies, so very close to my results (greater only with 0,13%), and a percentage of 4.9% on cadavers. Other authors have noted the existence of this variant, but without giving a percentage [7,43].

CELIOMESENTERIC TRUNK

In the study, on the 46 cases, I encountered 3 cases (6.53% of cases) in which there are celiomesenteric trunks, all cases being males (13.64% of male cases). In relation to the spine, the origin of the trunk was situated in a case at the level of the vertebra L1, and the other 2 cases had their origin at the level of L1-L2 intervertebral disc.

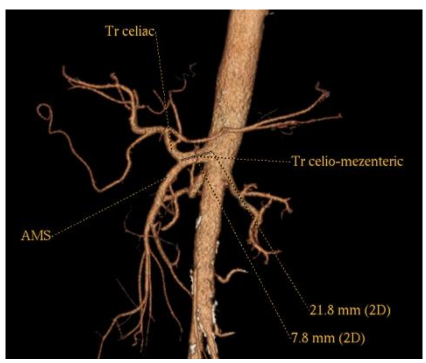

Fig. 160. Celiomesenteric trunk with 21.8 mm length and 7.8 mm caliber.

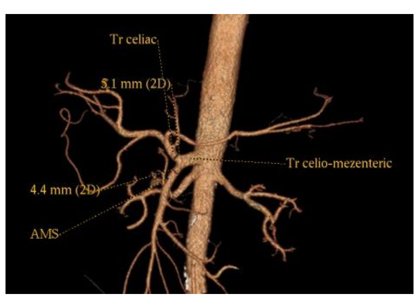

Fig. 161. Celiomesenteric trunk diameter is 5,1 mm, and superior mesenteric artery diameter is 4,4 mm.

From its aortic origin until the bifurcation, the length of celiomesenteric trunks was 21.9 mm, 30.8 mm şi 42.5 mm, their caliber being 7.2 mm, 7.8 mm and 8.7 mm. The bifurcation angle between the two terminal branches was 82.2°, 99.0° and 118.2°.

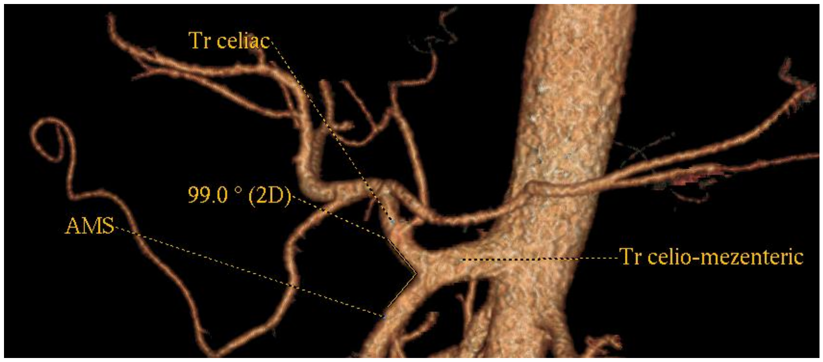

Fig. 162. Bifurcation angle of celiomesenteric trunk is 99,0°.

The resulted celiac trunk had a caliber of 5.1 mm, 6.4 mm and 6.6 mm, representing 65.38%, 73.56% and 91.67% from the native celiomesenteric trunk.

Superior mesenteric artery caliber was 4.4 mm, 6.6 mm and 7.4mm, representing 56.41%, 91.76% and 85.06% of the celiomesenteric trunk.

At the level of the origin of the celiomesenteric trunk, the abdominal aorta had an outer diameter of 20.1 mm, 21.7 mm and 23.1 mm.

Author	**Celiomesenteric trunk frequency**
Adachi	2,4%
Michels	2,5%
Rossi	1,96%
Leriche	1,8%
Piquand	2,0%
Rio Branco	3,0%
Eaton	0,54%
Lipshutz	2,4%
Tzukamotu	1,5%
Mu CG	0,98%

Manyama	1-2,7%
Alakkam	under 2%
Tuncai Hazir	under 2%
Kornafel	1,5%
Babu	0,54-3,4%
Imakoshi	0,9%
Nelson	2,0%
Jones	1,7%
Ferrari	1,7%
Chen	0,7%
Song	1,06%
Yadov	2,5%
Panagouli	0,76%
Chiriloaie	1,39%
Sacker	3,80%
Cazuri personale	***6,52%***

Table 9. Celiomesenteric trunk incidence

Compared to the percentages quoted in the literature consulted, the results found by me in respect to the frequency of the presence of celiomesenteric trunk is in all cases larger, with differences between 2,72-5,98%. Thus, the differences compared to [19,42,44, 45, 46, 47, 48] are being smaller than my results with 5,02-5,98%. For the rest of the authors [49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61] differences were between 4,02-4,98%. Only for one author [9] the differences were somewhat reduced, 2,72%.

In terms of size for the celiomesenteric trunk, [62] find a diameter of 13.98 mm, so greater than the maximum diameter that I met with 5.28 mm. Compared to my results, [62] find a celiac trunk diameter (7.09 mm), resulting through bifurcation of celiomesenteric trunk, higher with 0.49 mm versus maximum diameter found by me, and at the level of the superior mesenteric artery a diameter (5.25 mm) higher with 0.85

mm than minimum diameter found by me and less with 2.15 mm than maximum diameter found by me.

VASCULAR TERRITORIES OF SUPERIOR MESENTERIC ARTERY

Superior mesenteric artery presents five vascular territories. First a territory provided by the inferior pancreaticoduodenal artery and inferior pancreatic artery. Second, the ceco-apendicular insured by the ileocolic artery; the third territory represented by ascending colon and right colic flexure, supplied by right colic arteries; the fourth territory secured by the right colic angle artery and middle colic artery; fifth, most sprawling, represented by the mobile small intestine, supplied by the artery of duodeno-jejunal angle, jejunal and ileal arteries, terminal branches of superior mesenteric artery and ileal branch of ileo-apendicular artery.

Pancreaticoduodenal territory is served also by the superior pancreaticoduodenal artery, branch of the hepatic artery, the superior mesenteric artery ensuring partially (about half) the vascularization of the duodenopancreatic complex. At this complex vascularisation also take part right gastric artery, retroduodenal branches of the hepatic artery and the superior pancreaticoduodenal arteries, anterior and posterior, and for the vascularisation of the last portion of the duodenum participates also the duodenojejunal angle artery. At the vascularisation of the body of the pancreas, the superior mesenteric artery participates through inferior pancreatic artery(of Testut), which provide blood for the inferior part of the body of the pancreas and most notably by the pancreatic branches of splenic artery: dorsal pancreatic arteries, prepancreatic artery and artery for the tail of the pancreas.

This territory modifies the ensurance of its circulation in cases when the common hepatic artery has its origins in the superior mesenteric artery (hepatomesenteric trunk), which is situation never met by me in the study, but that is cited by many authors: [63] in 15% of cases, [36] in 1.5% of cases, [29, 64, 65] in 2% of cases, [42, 66, 67] in 3.5% of the cases and [28] in 5% of cases.

Participation of mesenteric artery is altered and when from this artery arise right hepatic artery, with or without the gastroduodenal artery origin, so also the pancreaticoduodenal artery.

Ceco-apendicular territory, an area greatly reduced, being provided by three of the his classics branches: cecal arteries, anterior and posterior, and the apendicular artery. Is a territory with the most constant vascularisation, not describing in general than variations of ceco-apendicular arteries related to their origin within the arteries. [28] described in 28% of cases bifurcation of ileocecal artery, of each trunk taking birth a cecal artery; in 12% of cases the posterior cecal artery takes birth through a common trunk with ileal artery; in 20% of cases the anterior cecal artery arise from a common trunk with ileal artery; apendicular artery may arise in less than 1% of cases from the anterior cecal artery.

The vascular territory of the ascending colon and right colic flexure is the most variable territory in terms of arterial branches involved in his vascularisation. Classically, there are three arteries that give blood to the right colon: right colic angle artery, the right colic artery and colic branch of ileocolic artery. These three arteries presents a different caliber, most frequently the colic branch of ileocolic artery having the lowest caliber, the other two branches, even the right colic (when present) with a size comparable to that of ileocolic artery, from which it derives its colic branch, which provides vascularisation of lower segment of ascending colon. Having different calibers, it appears that the participation of the three branches at the vascularisation of the colon is uneven.

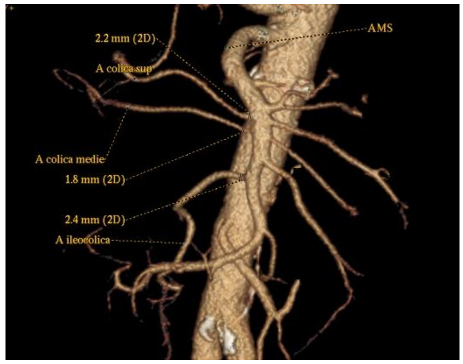

Fig.165. Presence of three right colic arteries. External diameter of right middle colic artery is 1.8 mm, the one of right colic angle artery is 2.2 mm and for ileocolic artery is 2.4 mm (male case).

Sometimes, the caliber of ileocolic artery can be lower than the caliber of the other two branches, which change much the participation of the branches to vascularity of ascending colon, which may be modified in other variants of the origin and the size of these arteries, whose variability has been shown in previous chapters: the absence of right colic artery; the presence of two middle colic arteries, which [28] gives in 6% of cases; the presence of three middle colic arteries, [28] gives in 2% of the cases. Vascularity of right colic flexure is only given by the artery with the same name, which I have found it present in all cases.

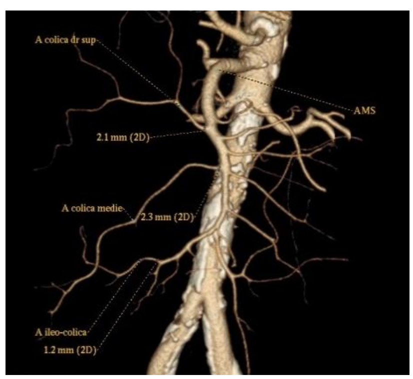

Fig. 166. Ileocolic artery diameter is lower with 0.9 mm than right colic angle artery diameter and with 1.1 mm than right colic artery diameter, which is higher than previous one with 0.2 mm.

There are cases in which the right colic artery has a reduced caliber, its origin being in the right colic angle artery or in the ileocolic artery, the two arteries of origin having a well represented caliber.

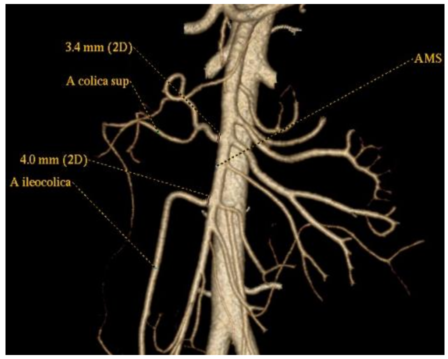

Fig. 167. Right colic artery with origin in right colic angle artery, which has a diameter of 3.4 mm, the diameter of ileocolic artery being 4.0 mm (male case).

The territory of the transverse colon is also variable, being related with the caliber of the arteries, the presence or absence of arteries and their origin. Thus the superior mesenteric artery assures vascularity of nearly 2/3 right from the transverse colon when there is a middle colic artery and with certainty when there are two middle colic arteries either both originating from the superior mesenteric artery, aspect [Lippert] mentions in 1% of cases, or one with its origins in the superior mesenteric and the other originated in the right colic angle artery, variant [Lippert] found in 1% of cases. In case of absence of the middle colic artery, the superior mesenteric artery ensures even the right ½ or 1/3 of transverse colon, the same situation as when the middle colic artery originates in the inferior mesenteric artery, aspect which [Lippert] puts it in 5% of cases. The transverse colon territory is altered and when there are two middle colic arteries, one right with origin in superior mesenteric and another left with origins in the inferior mesenteric artery, variant which [Lippert] gives in 5% of cases.

Fig. 168. Right colic artery together with the three arteries for ascending colon and right colic flexure.

The vascular territory of the mobile small intestine has its vascularity ensured by the duodenojejunal angle artery and the first jejunal loop artery, serving a reduced territory, by jejunal and ileal arteries, by the terminal branches of the superior mesenteric and ileal branch of the ileocolic artery.

Although it is said that each artery serves one jejunoileal loop, there are cases in which an artery may provide partial vasularity for two neighboring intestinal loops or two arteries can have their origin from the same arterial trunk.

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CONCLUSIONS

The conducted study shows that the anatomy of superior mesenteric artery is highly variable, with multiple features in relation to those clasically described. This issue extends to the entire human body, but mostly at the level of the vascular system. For example, [1], through dissection, find valid the classical description of arterial anatomy of the subdiafragmatic digestive system in fairly low percentages: for celiac trunk just in 24% of cases, for the superior mesenteric artery in 22% of cases and for the inferior mesenteric artery only in 16% of cases. [2], studying the anatomy of the liver and its vascularity, finds it corresponding to the classical description in 76.82% of cases, in the remaining 23.18% cases finding variants and even anomalies. [3] states that "these arterial variations are of maximum clinical importance, the presence of such variations may affect procedures done on the abdominal organs and their results; It is also of very great importance in radiological diagnostic procedures, such as abdominal or vascular angiography and magnetic resonance angiography ". Therefore, knowledge of these findings is very useful for surgeons and radiologists for planning and managing interventions in the abdominal region. This is supported also by [4].

These differences occur due to particular methods used, modern imaging investigation bringing information that cannot be reported by classical methods of work in anatomy: dissection and injecting of various substances in the vascular system. Thus, [5] states that 64-MSCTA improves largely the results of origin, trajectory and anatomical variations in the vascular system in explored patients and recommend that 64-MSCTA to be a routine preoperative procedure in patients, particularly in patients with digestive cancer. [6] states that the MDCT angiography has distinct advantages compared to conventional angiography in the arterial mesenteric vascularisation imaging, stating that it is a method that facilitates rapid and comprehensive evaluation of the mesenteric vessels in a non-invasive manner. These methods also allow rapid diagnosis of various diseases, [7] stating that they allow this even if the patient does not show any clinical symptoms, for example in acute and chronic mesenteric ischemia. Such conditions would be observed during surgery, which is why blood circulation in the celiac trunk and superior mesenteric artery should be "studied carefully and meticulously." After [8], " 64 slices angioCT allows visualization of small vessels and arteries, difficult to identify using other methods. This high sensitivity allowed the detection of a large number of variants and vascular abnormalities, which could not be revealed through other methods, as shown by the literature ". Still [8] says that "the latest CT scanners with 64-slices allow a very high spatial resolution (up to 0.4 mm) and a temporal resolution of only a few seconds. These technical developments have made possible the acquisition of detailed knowledge on the abdominal vascularization prior to surgery. This makes the technique essential for surgeons, for example, in planning a liver transplant or, more commonly, in implementation of intestinal anastomoses, whose success depends on proper vascularization ". [9] comes to the conclusion that a particular importance have the knowledge of the type of anatomic variations and their subtypes, fundamental to proper pre-operative vascular planning of surgical abdominal procedures or radiation. Multidetector -Slice CT (MDCT) provides high-quality images, in 3D, and allows the non-invasive assessment of normal anatomy and anatomic variants.

[10] says that " vascular anatomical variations are very common and can affect the arterial supply of any abdominal organ; coexistence of fluctuation in different organic systems is less commonly found, but their existence is of great clinical importance in a number of clinical conditions, such as organ transplantation surgery and preoperative planning „.

[11] states that "the testimonies about the existence of vascular abnormalities or changes with regard to the specific region of the body, helps during surgical intervention planning and prevent errors due to lack of awareness. This is particularly important in the centers in which are not carried out angiographies regularly ". [12] says, "knowing these variations helps reduce the risk in surgery and also plays an important role in radiological interventions".

The fact that results are dependent on the working method used, is exemplified by [13] who finds the frequency of origin of the right hepatic artery from superior mesenteric artery in 11% of cases using the method of CT angiography and a smaller percentage, 4.9% of cases, through dissection. This aspect is highlighted also by [14].

The results depend also on the number of cases on which worked, some authors [5, 15, 16, 17, 18] describing and publishing a single case that featured a variant of a mesenteric vascular branch and comparing it with data from the literature, the way that I do not consider conclusive. A comparative study is done when you have a representative number of variants, what can allow you the extraction of particular conclusions that can be drawn on a particular morphological marker. There are interesting also some rare variants, and that should be noted and brought to the attention of specialists. Such variant is the presence of an pancreatico-colic artery, reported by [19], with its origins in the celiac trunk, which ensure the proximal transverse colon vascularity, in which case the middle colic artery was missing. Such a variant has a particular importance during surgery for pancreatic resections and can lead to serious bleeding and colic necrosis. [20] says that such a variant that supplies the vascularity of transvers colon has not been reported by other authors.

Another rare variant, which I haven't found it in the study is represented by the common hepatic artery origin from the left gastric artery, signaled by [21], but this raises the question, as always common hepatic artery has a caliber superior to left gastric artery, and that's why I think it would be more correct to origin the left gastric artery from common hepatic artery regardless of whether it comes from the celiac trunk or superior mesenteric artery.

[4] describes a case of splenic artery with its origin from the superior mesenteric artery, variant described also by [22].

There are opinions that the statistical differences between the various authors, beside of working methods and the number of cases, would be due to the geographical area in which you make the study and I would add the time period in which it is carried out, the conclusive example being the differences between my results and results obtained by [22, 23, 24, 25, 26] who have executed the studies within the same geographical area.

Also, the differences would be due to morphological type to which belongs to the topic researched, my study revealing common statistical differences according to sex, this being inextricably tied to morphological type.

There are some aspects of the use of various specialized terms related to the arterial system, clinicians and especially radiologists, using other names, different from those in Anatomical Terminology [27]. I think it should be a unique name, because, for example, radiologists use use the name middle colic artery for both the right colic and colic artery of Frantz.

I have met frequently in the literature studied the term hepatomesenteric trunk for both the mesenteric origin of common hepatic and right hepatic artery, my opinion being that the name should be mesenterico-hepatic trunk and only in the case of origin from the mesenteric artery of common hepatic artery. In cases where the right, or sometimes left, hepatic artery arise from superior mesenteric artery use the term of collateral branch.

Also consider that it is not correct to use, in case of two right hepatic arteries, for one of them, usually for the one with origin in the mesenteric artery, the term of accesory artery, as this artery has a territory of arterial blood supply well specified and its ligation would cause necrosis of the vascularised territory.

Of particular importance are the territories supplied by the superior mesenteric artery, blood vessels which provide their vascularity form anastomosing arcades, thus making the connection between them, which shows that these territories are not isolated vascularised, presence of anastomoses achieving suplement of deficient areas.

[28,29] considers that vascularisation of the gastrointestinal tract is a three-leveled system consisting of celic trunk and mesenteric arteries, both superior and inferior, which are connected to each other via arterial anastomoses, such as so-called and well-known arcades Riolan, Villemin, Buhler, Barkow, Drummond, or the supramarginal arcades.

Study of morphological peculiarities of the superior mesenteric artery and its collateral branches has great importance in the treatment of some diseases at the level of its vascular territories, such as:

- endovascular treatment of abdominal aortic aneurysms in the less invasive cases [30, 31] stating that "the endovascular treatment of abdominal aortic aneurysm is a good therapeutic alternative in emergency and in case of a correct planning the technical results are comparable to those obtained in elective conditions."

- [15]: „for the treatment of an aneurysm where is found the absence of blood flow through the celiac axis, the blood supply is achieved through superior mesenteric artery through an enlarged and elongated pancreaticoduodenal artery and the gastroduodenal artery";

- common hepatic artery reconstruction for the total pancreatectomy using a splenohepatic bypass [32];

- making an end-to-side anastomosis of celiac artery with superior mesenteric artery in the case of atherosclerotic occlusive disease of celiac artery [33];

- solving ischemic colitis that occurs in 60% of cases after surgery for an abdominal aortic aneurysm [34];

- chemoembolization of pancreatic and liver tumors, in which knowledge of the morphology of superior mesenteric artery and celiac trunk permits identifying and careful dissection of these vessels and the embolization, in order to avoid iatrogenic injury [35];

- [36]**:** „knowledge of anatomical variations of the superior mesenteric artery, are useful in laparoscopic surgery, where it could help surgeons to successfully achieve abdominal interventions and avoid catastrophic complications";

- [14]: „knowledge of variations of hepatic artery will allow the surgeon to practice laparoscopic colecystectomies, liver resections, vascular or recombination in transplant and thus avoid the errors and patient morbidity";

- [37] : „changes in the anatomy of the abdominal aorta and its branches are of interest because of the vessel geometry which determine not only the dynamics of flow, but is also essential in the pathogenesis of vascular disease”;

- [38] states that „detailed morphometric data of the abdominal aorta and its branches provide a database for ultrasound exams in early diagnosis, monitoring and managing malformations and arterial variants”;

- [39]: „careful dissection and identification of these vessels is important for avoiding iatrogenic injury after surgical procedures, which can be a source of complications during resection of a tumor of pancreatic head, but also in other invasive interventions in celiacographias and pancreatic tumors and liver chemoembolization”;

- [35]: „any pathology involving the celiacomesenteric trunk, can result in catastrophic consequences that endanger the vascular supply of major abdominal organs; that's why knowledge of these anatomical variants is of paramount importance for laparoscopic surgery, interventional radiology, but also for clinicians in the adequate preprocedural planning to prevent any accidental injury of arterial trunks variations”.

- [14]: „a new emphasis was given to the anatomy of celiac trunk and superior mesenteric artery by inserting the liver transplantation; arterial variations are of particular importance in the planning and execution of all surgical and radiological procedures to the abdomen; however, surgical errors occur because the anatomy of arterial vessels is not assesed, thing that continues to lead to errors with serious consequences for the patient and legally related”.

The importance of superior mesenteric artery study follows numerous studies on its morphology, published in various magazines from all meridians, which, I am sure, will continue to appear.

I do not claim to have exhausted the subject on the morphological aspects of superior mesenteric artery, but I think I contributed and I clarified some anatomical landmarks on this morphology.

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