Scholars Journal of Applied Medical Sciences
OPEN ACCESS
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com
Radiological and Nuclear Medicine Science

Measurement of Superior Mesenteric Artery using Computed Tomography Angiography

Ala. M. Abd Elgyoum[1], Abdalbagi A.M Amer[1*], Musab Mergani AbdAlla Abdelmagid[1], Abbas Omer[2], Hisham A.Y Gasmallah[2] and Salah Albagir[3]

[1]The National Ribat University, Faculty of Radiological and Nuclear Medicine Science, Khartoum, Sudan
[2]Al-Ghad International College for Applied Medical Science, Medical Imaging Technology Department, Qassim, Saudi Arabia
[3]Al-Ghad International College for Applied Medical Science, Medical Imaging Technology Department, Abha, Saudi Arabia

DOI: 10.36347/sjams.2021.v09i06.033 | **Received:** 12.05.2021 | **Accepted:** 19.06.2021 | **Published:** 26.06.2021

***Corresponding author:** Abdalbagi A.M Amer

Abstract **Original Research Article**

A number of diseases are accompanied by the altered size of various abdominal vassals, including aneurysms, atherosclerosis, and infection conditions. Computed tomography (CT) has played an important role in helping physicians and surgeons for taking normal anatomical measurements and establishing a diagnosis. The present study attempts to measure the normal superior mesenteric artery (SMA) for the healthy Sudanese population using computed tomography angiography. A total of 113 CT abdominal angiography cases were retrospectively investigated in spinning from February 2020 to May 2021. Both 32-slice CT units (Siemens Medical Systems) were used to examine patients at two hospitals in Khartoum, Sudan. All measurements were calculated manually using the standard clinical method. The study shows that SMA length and diameter were 101.1±24.6 mm and 5.274±1.5 mm, retrospectively. The distance between the celiac trunk and SMA was 4.6±1.4 mm. Furthermore, the angle between the abdominal aorta and SMA was 66.1±29.5 mm. In conclusion, this study had established baseline measurements for SMA for the healthy Sudanese population. Furthermore, it found that CTA of abdomin is the best for investigation of the SMA and can provide a guide for the clinicians to manage SMA abnormalities.
Keywords: computed tomography, celiac artery, and angiography.

INTRODUCTION

Three unpaired splanchnic arteries are arising from the abdominal aorta, the celiac trunk, the superior mesenteric artery (SMA), and the inferior mesenteric artery (IMA)[1]. The superior mesenteric artery is the second major branch of the abdominal aorta; it originates on the anterior surface of the aorta at the level of the L1 vertebrae, approximately 1 cm inferior to the celiac trunk and superior to the renal arteries [2]. Anterior to the superior mesenteric artery lies the pylorus of the stomach, the neck of the pancreas, and the splenic vein; posterior to the artery lies the uncinate process of the pancreas, the inferior portion of the duodenum, and the left renal vein [2].

The left renal vein courses directly between the aorta and the takeoff of the superior mesenteric artery. This artery provides blood flow to the third portion of the duodenum, the jejunum, the ileum, the cecum, the ascending colon, and the proximal of the transverse colon[2].

This study was designed to measure the normal superior mesenteric arteries using computed tomography angiography for the healthy Sudanese population.

MATERIALS AND METHODS

This descriptive-analytic retrospective study intended to measure normal superior mesenteric artery using Computed Tomography Angiography (CTA) for the healthy Sudanese population. The data used in this study were collected from two hospitals in Khartoum state: El NILEIN MEDICAL DIAGNOSTIC CENTRE and BEST CARE HOSPITAL. The data collected from August 2020 to April 2021. The study included all adult patients ranged from 18 years to 60 years old and having no vascular disorders, but patients whose vessels appeared abnormal on computed tomography (CT) scans were excluded. Also, the subjects with pathologies potentially involving the cardiovascular system (HTN), subjects with vasculitis, subjects with atherosclerosis, and subjects with congenital anatomical variants was excluded from study.

Two Siemens CT machines were used to collect data during this study installed in two radiological departments with thirty-two detector configurations. All quality control tests were performed on the devices before any data collection. A total of 113 patients, 50 cases in EL NILEIN MEDICAL DIAGNOSTIC CENTER and 63 in BEST CARE HOSPITAL, were used to measure normal superior mesenteric artery. The data were collected for a patient during CT abdomen imaging protocols.

In CTA protocol an anteroposterior scan projection was obtained, starting 5 cm above the diaphragm and ending at the level of the iliac crest. From this image, 10 mm adjacent sections were prescribed through the abdominal area. Scanning was performed on arrested expiration. If spiral options were available, using a 5 mm slice thickness and a 5 mm table increments, but with a 3mm reconstruction index to give overlapping sections. Two radiology specialists, each with at least five years' experience, evaluated abdominal CT images. The images were considered on the same computer. We used a picture archiving and communication system (PACS) and using CD and reported the pathologies, congenital anomalies, and anatomical variations of abdominal blood vessels, all of which could be detected during the interpretation of the images for exclusion criteria.

Each patient image was measured using CT-scan DICOM images and radiant DICOM viewer software. The superior mesenteric artery and aorta angle was measured using a sagittal section in MIP reconstruction (Figure1).

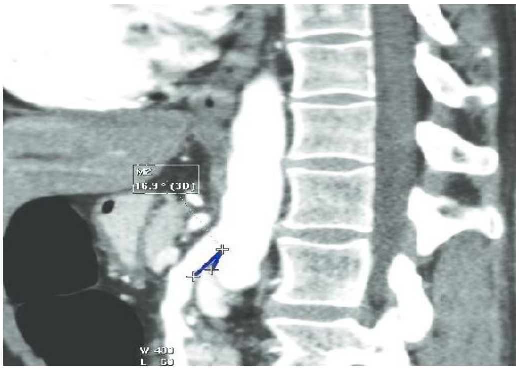

Fig-1: CT Parasagittal view showing the angle between the superior mesenteric artery and aorta.

The maximum length of the superior mesenteric artery was measured in MIP parasagittal, and VR views from the origin of SMA in the abdominal aorta at the level of the L1 vertebrae to the bifurcation of SMA to an ileocolic artery (Figure 2).

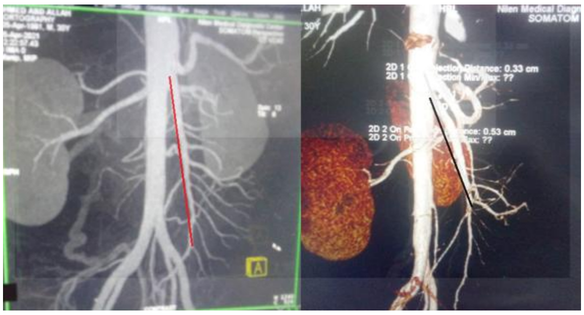

Fig-2: CT parasagittal and a 3D view showing the length of SMA.

The maximum diameter of SMA was also measured as the most largest dimension on MIP parasagittal images (Figure 3-A). The distance between SMA and celiac trunk was measured in parasagittal views using MIP reconstruction (Figure 3-B). All measurements were recorded maximum appreciated in sections for better accuracy.

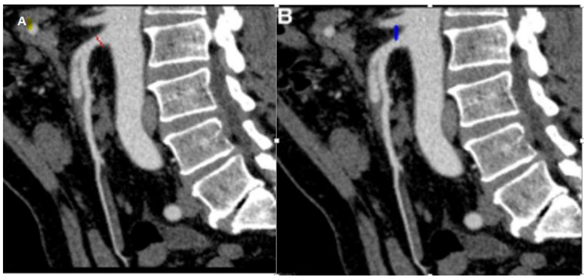

Fig- 3: CT parasagittal showing SMA diameter (A) and distance between SMA and Celiac trunk (B).

RESULT

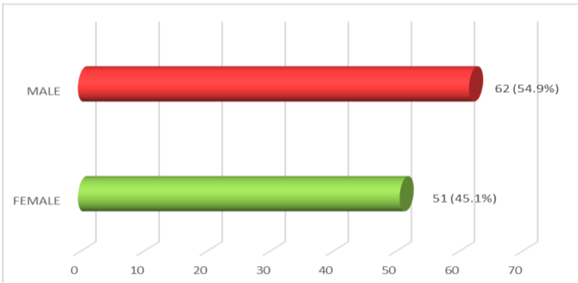

Fig-4: Shows gender distribution

Table-1: Demonstrate the mean, standard deviation, minimum and maximum value for study variables.

	Age	Height	Weight	BMI	SMA length	SMA diameter	Distance between celiac & SMA	Angle between A.A & SMA
Mean	41.9	163.7	68.7	25.5	101.1	5.2	4.6	66.1
Std. Deviation	12.7	6.78	7.6	3.3	24.6	1.5	1.4	29.5

Table-2: Demonstrate the SMA length, SMA diameter, distances between celiac and SMA, the angle between abdominal aorta, SMA, and No. SMA branches according to age.

	SMA Length	SMA Diameter	Distance between celiac & SMA	Angle between A.A & SMA	No. SMA branches
≥20	110.6±27.6	5.9±	3.3±0.2	98.6±56	6.6±1
21-30	111.7±28.8	5.7±1.7	4.6±1	61.8±31.4	9.78±2.1
31-40	97.3±23	5.28±1.4	4.8±1.7	61.75±25	10±1.6
41-50	96.5±18	5±1.3	4.49±1.3	70.85±29	8.6±2.4
51-60	99.42±24	5.3±1.7	4.66±1.6	66.87±28	8.07±2.3

Table-3: Demonstrate the SMA length, SMA diameter, distances between celiac and SMA, angle between abdominal aorta, SMA, and No. SMA branches according to gender.

	SMA Length	SMA Diameter	Distance between celiac & SMA	Angle between A.A & SMA	No. SMA branches
Male	101.5±24	5.3±1.49	4.6±1.43	62.1±28.3	9.3±2.40
Female	100.7±25.5	5.3±1.66	4.6±1.59	70.9±30.5	8.50±2.1

Table-4: Demonstrate the correlation between patient's age, height, weight, BMI, and the angle between A.A and SMA, SMA length, diameter, distance between celiac trunk and SMA.

		AGE	HEIGHT	WEIGHT	BMI
Angle between A.A & SMA	Pearson Correlation	-.010	-.034	-.092	-.101
	Sig. (2-tailed)	.917	.720	.331	.289
	N	113	113	113	113
SMA Length	Pearson Correlation	-.130	.207*	-.052	-.174
	Sig. (2-tailed)	.170	.027	.582	.065
	N	113	113	113	113
SMA Diameter	Pearson Correlation	-.092	.235*	.167	.002
	Sig. (2-tailed)	.332	.012	.077	.985
	N	113	113	113	113
Distance between celiac & SMA	Pearson Correlation	.064	.098	.133	.070
	Sig. (2-tailed)	.500	.301	.161	.458
	N	113	113	113	113
****. Correlation is significant at the 0.01 level (2-tailed).**					
***. Correlation is significant at the 0.05 level (2-tailed).**					

Table-5: Demonstrate the number of SMA branches

		Frequency	Percent
Number of SMA branches	4.0	2	1.8%
	5.0	11	9.7%
	6.0	3	2.7%
	7.0	15	13.3%
	8.0	14	12.4%
	9.0	21	18.6%
	10.0	14	12.4%
	11.0	16	14.2%
	12.0	11	9.7%
	13.0	6	5.3%
	Total	113	100%

Table-5: Demonstrate the number of SMA branches according to gender.

		No. SMA branches										
		Four	Five	Six	Seven	Eight	Nine	Ten	Elven	Twelve	Thirteen	Total
Female	Count	0	8	1	7	7	10	10	4	3	1	51
	% within Gender	0.0%	15.7 %	2.0%	13.7 %	13.7 %	19.6 %	19.6 %	7.8%	5.9%	2.0%	100%
	% within No.SMA branches	0.0%	72.7 %	33.3 %	46.7 %	50.0 %	47.6 %	71.4 %	25.0 %	27.3%	16.7%	45.1 %
Male	Count	2	3	2	8	7	11	4	12	8	5	62
	% within Gender	3.2%	4.8%	3.2%	12.9 %	11.3 %	17.7 %	6.5 %	19.4 %	12.9%	8.1%	100%
	% within No.SMA branches	100%	27.3 %	66.7 %	53.3 %	50.0 %	52.4 %	28.6 %	75.0 %	72.7%	83.3%	54.9 %
Total	Count	2	11	3	15	14	21	14	16	11	6	113
	% within Gender	1.8%	9.7%	2.7%	13.3 %	12.4 %	18.6 %	12.4 %	14.2 %	9.7%	5.3%	100%
	% within No.SMA branches	100%	100 %	100%	100%	100 %	100 %	100 %	100 %	100%	100%	100%

DISCUSSION

The abdominal vessels, especially the celiac trunk computed tomography and the superior mesenteric artery (SMA), frequently show various anomalies in their origin and course; thus, these arteries are studied with great interest. Several anatomic and radiologic descriptions of variation in the origin of the ventral branches of the abdominal aorta had been reported in the literature [3]. In this retrospective study, a total of 113 patients, 62 (54.9%) males, and 51 (45.1%) females, as shown in figure 41, were examined via CT abdominal with contrast and presented with clinically suspected abdominal diseases.

The number and percentage of patients based on age groups were 2.7%, 20.4%, 24.8%, 17.7%, and 34.5% for age range 10-20 years, 21-30 years, 31-40 years, 41-50 years, and 51-60 years, respectively. Milnerowicz S *et al.*[4] measured superior mesenteric artery in 114 patients who underwent arteriograms for various reasons. They reported superior mesenteric artery diameter and length in Poland population about 0.4 cm and 5.7 cm, respectively.

In our study, the superior mesenteric artery diameter and length in our population were found to be 5.2±1.5 mm and 101±24 mm, respectively, as presented in Table 1.

This difference in our results compering to Milnerowicz S, Milnerowicz results may be due to the effect of imaging technique (e.g., CT and conventional arteriography) measurement environment (e.g., display settings on diagnostic workstations, often referred to as "windowing") or due to different populations or races. When exploring the effect of age on SMA length and diameter, we found that both length and diameter of the SMA were slightly decreased in the older population compeer with a younger population as shown in Table 2, the decreasing of length and diameter in older people may be due to the organ atrophy that occurs with age. Adenauer Marinho de Olveira Góes Junior *et al* (5). Studied the influence of age and sex on the anatomy of the abdominal aorta and its branches, it was found that in the older population, the SMA length and diameter were smaller than in the younger population. Our results in contrast with Adenauer Marinho de Olveira Góes Junior *et al.* [5].

Furthermore, the length and diameter of SMA in the male group were 101.5±24 mm and 5.37±1.49 mm, respectively. While the length and diameter of SMA in the female group were 100.7±25.5 mm and 5.35±1.66 mm, respectively, as presented in Table 3.

Some researchers found significant genetic differences at the cellular level and demonstrated how these differences impact organ growth independently of circulating hormones. These findings could justify why there is a difference in the length and diameter of SMA in men or women in our study.

When further exploring the distance between origins of the celiac trunk and superior mesenteric artery. In the studies conducted by Yadav *et al.* [7] and George *et al.* [6], the distance between the origins of the celiac trunk and the superior mesenteric artery was found to be 19.3 mm and 16± 5.0 mm, while the distance between the origins of the celiac trunk and superior mesenteric artery in our study was 4.62±1.43 mm ,as demonstrated in Table 1. The difference in our results could be due to the smaller sample size when compared to Yadav [7] and George [6] studies.

The distance between origins of the celiac trunk and superior mesenteric artery were similar in both genders, in which male patients had a distance of 4.6±1.43 mm. while female patients had a distance of 4.6±1.59 mm, as shown in Table 4. The distance between origins of the celiac trunk and superior mesenteric artery regarding the age is not significant statistically, with a p-value of 0.064 as presented in Table 5.Our findings found that the distance between origins of the celiac trunk and SMA regarding age compatible with the results of Yadav *et al*.[7], where they found no significant difference with a p-value of 0.15 when studied the distance between the origin of the celiac trunk from abdominal aorta and origin of its last branch.

To our knowledge, SMA usually forms an angle of 45° with the aorta, a normal angle ranging from 25° to 60°(8). In the current study, the angle between the abdominal aorta and SMA was found to be 66° as shown in Table 1. Our findings were higher when compared with the results of Huseyin Ozkurt *et al*. [9], where they found the angle ranged between 38° and 60°. The difference in results could be due to the smaller sample size when compared to the other study. Further, we noticed that the abdominal aorta and SMA angle decreases when age increase, as demonstrated in Table 2. This age-specific effect on the angle between the abdominal aorta and SMA is different from Huseyin Ozkurt *et al*. [10]. Furthermore, the angle was higher in the females' group when compared to the male group.

To our knowledge, the SMA divides into multiple jejunal and ileal branches. There are approximately 4 to 6 jejunal and 10 to 14 ileal arteries originating from the left side of the SMA that run within the mesentery to form a series of arcades before reaching the intestinal wall [11]. Our study observed different variations in the branching pattern of SMA, as presented in Table 5. Variations of the visceral arteries are common, but there are some more exceptional anatomical variations that may puzzle the surgeons or vascular radiologists dealing with intra-abdominal diseases [12]. In the present study, 85.8% of cases represented more than seven branching patterns of the superior mesenteric artery. This is in accordance with previous reports [13].

In addition, the branching pattern of SMA was more prevalent in men, as shown in table 6. Our findings on the branching pattern of SMA were completely different from the results of Yadav *et al*. [14].The SMA diameter had a strong significant correlation with BMI but had no significant correlation with weight, and height, respectively (Table 5). The SMA length had no significant correlation with weight and BMI but had had a significant correlation with height. There was no significant correlation between the angle between the abdominal aorta and SMA with patient height, weight, and BMI, respectively (Table 5).

Furthermore, there is no significant correlation between the distance between celiac and SMA and patient height, weight, and BMI. Finally, the heterogeneity of the population limits this study because of the randomized selection process, which may influence the exactness of our outcomes and lessen the intensity of our conclusions since it makes other age groups have a lower factual validity if applied in future investigations. Other limitations of this study were: i) there was no second observer in measuring variables, meaning that the error in measuring inter-and intra-observer variability cannot be calculated; ii) there was a relatively small cohort sample size.

CONCLUSION

In conclusion, this study provides normative measurements that can use by the surgeons who can plan their line of treatments in cases like vascular aneurysm, celiac axis compression syndrome, mesenteric ischemia, etc. besides this, measurements can be important to determine the congenital abnormalities in abdominal vassals and should be included in the checklist when interpreting a CT scan in cases of vascular diseases.

REFERENCES

1. 1.Shaikh H, Wehrle CJ, Khorasani-Zadeh A. (2021).Anatomy, Abdomen and Pelvis, Superior Mesenteric Artery. StatPearls. Treasure Island (FL): StatPearls Publishing
2. Copyright © 2021, StatPearls Publishing LLC.; 2021.
3. 2.Firetto MC, Lemos AA, Marini A, Avesani EC, Biondetti PR. (2013). Acute bowel ischemia: analysis of diagnostic error by overlooked findings at MDCT angiography. Emergency radiology.;20(2):139-47.
4. Michels NA, Siddharth P, Kornblith PL, Parke WW. (1965). THE VARIANT BLOOD SUPPLY TO THE DESCENDING COLON, RECTOSIGMOID AND RECTUM BASED ON 400 DISSECTIONS. ITS IMPORTANCE IN REGIONAL RESECTIONS: A REVIEW OF MEDICAL LITERATURE. Diseases of the colon and rectum.;8:251-78.
5. Milnerowicz S, Milnerowicz A, Taboła R. (2012). A middle mesenteric artery. Surgical and radiologic anatomy : SRA.;34(10):973-5.
6. Goes Junior AMO, de Albuquerque FBA, Beckmann FA, Centeno FV, de Andrade MC, Vieira WB. (2020). Age and sex and their influence on the anatomy of the abdominal aorta and its branches. J Vasc Bras Jornal Vascular Brasileiro.;19:1-10.
7. George R. (1935). Topography of the Unpaired Visceral Branches of the Abdominal Aorta. J Anat.;69(Pt 2):196-205.

8. Sachin Phoolchand Yadav RSS, Tushar Patil. (2014). STUDY OF VARIATIONS OF CELIAC TRUNK IN WESTERN MAHARASHTRA POPULATION. International Journal of Current Research and Review.;6(23):36-43.
9. Pasumarthy LS, Ahlbrandt DE, Srour JW. (2010). Abdominal pain in a 20-year-old woman. Cleveland Clinic journal of medicine.;77(1):45-50.
10. Fitoz S, Ekim M, Ozcakar ZB, Elhan AH, Yalcinkaya F. (2007). Nutcracker syndrome in children: the role of upright position examination and superior mesenteric artery angle measurement in the diagnosis. Journal of ultrasound in medicine : official journal of the American Institute of Ultrasound in Medicine.;26(5):573-80.
11. zkurt H, Cenker MM, Bas N, Erturk SM, Basak M. (2007). Measurement of the distance and angle between the aorta and superior mesenteric artery: normal values in different BMI categories. Surgical and radiologic anatomy : SRA.;29(7):595-9.
12. Alaghmand M, Manzano MJ, Khati NJ, Venbrux AC. 25 - Anatomy of Alimentary Tract Vasculature. In: Mauro MA, Murphy KP, Thomson KR, Venbrux AC, Morgan RA, editors. (2020). Image-Guided Interventions (Third Edition). Boston: Elsevier, p. 212-21
13. Fuhrman BP, Zimmerman JJ. (2006). Pediatric critical care.
14. Igiri O, Ekong MB, Egemba GO, Asuquo OR. (2010). The Pattern of Arrangements and Distributions of the Superior Mesenteric Artery in a Nigerian Population. International Journal of Morphology, 28:33-6.
15. Sachin Phoolchand Yadav RSS, Tushar Patil. (2014). STUDY OF VARIATIONS OF CELIAC TRUNK IN WESTERN MAHARASHTRA POPULATION. International Journal of Current Research and Review, 6(23):36-43.