



ORIGINAL RESEARCH ARTICLE

ANGULATION AND DISTANCE OF SUPERIOR MESENTERIC ARTERY ACCORDING TO BODY MASS INDEX ON PATIENTS BASED ON COMPUTED TOMOGRAPHY SCAN STUDY AT CHITWAN MEDICAL COLLEGE

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ABSTRACT

Background: Superior mesenteric artery syndrome is a rare but vital cause of upper gastrointestinal obstruction which occurs when the third portion of the duodenum is trapped between aorta and superior mesenteric artery. The significant decrease of the angle and distance between the superior mesenteric artery and aorta is the etiology of Superior mesenteric artery syndrome. The study aimed to identify the angulations and distance of superior mesenteric artery from aorta and their correlation with body mass index in patients referred for contrast enhanced computed tomography of abdomen examination in Chitwan Medical College.

Methods: The angle between the aorta and superior mesenteric artery was measured in arterial phase of the abdominal scan in the multiplanar reconstructed image in sagittal plane. The distance between the superior mesenteric artery and aorta was measured in axial plane at the level of 3rd part of duodenum.

Results: The aortomesenteric distance was obtained to be 13.30 ± 4.75 mm and the aortomesenteric angle was obtained to be 54.7 ± 16.91 degree for a total of 210 patients. There was a positive correlation between body mass index and aortomesenteric distance ($p=0.086$) and significant positive correlation between body mass index and aortomesenteric angle ($p=0.122$). Additionally, it showed there was significant positive correlation between aortomesenteric angle and aortomesenteric distance.

Conclusions: The distance and angle between the superior mesenteric artery and the aorta correlates significantly with the body mass index which indicates that the decrease in body mass index can be used as a risk factor of superior mesenteric artery syndrome.

INTRODUCTION

Superior mesenteric artery (SMA) syndrome is a rare but vital cause of upper gastrointestinal obstruction which occurs when the third portion of the duodenum is trapped between aorta and superior mesenteric artery. It is more frequent in woman and young adults. There are some debates about this syndrome as the relationship between anatomical findings and clinical symptoms is not well established. But the risk factor includes rapid weight loss due to decrease in retroperitoneal fat between SMA and aorta, corrective scoliosis surgery, which causes decrease in length of spine and hip that apply pressure to

abdomen.^{1, 2} The reduction of the retroperitoneal fat is related to the compression of the third part of duodenum by superior mesenteric artery. The loss of retroperitoneal fat causes the decreased angulations of SMA, thus result in constriction at the location where the duodenum crosses and thus start the syndrome.³ The significant decrease of the angle and distance between the SMA and aorta is the etiology of Superior mesenteric artery syndrome.³⁻⁵ The angle and distance between the SMA and aorta is also influence by the amount the retroperitoneal fat.³⁻⁶ Body mass index provides a direct measure of the weight and can be used as a parameter for

measurement of body fat.⁷ In Computed Tomography (CT), the measurement of aortomesenteric angle (AMA) and aortomesenteric distance (AMD) can be done which is appropriate for diagnosis of Superior mesenteric artery syndrome (SMAS). As in SMAS, both AMA and AMD are reduced to value of 6-20 degree and 2-8 mm respectively.⁸ Other relative finding may include a dilated stomach and duodenum upto AMA followed by abrupt narrowing as the duodenum passes underneath the SMA.⁹ Normally, the SMA is encased in the retroperitoneal and mesenteric fat and lymphatic tissue at its origin, which is responsible for maintaining a wide aortomesenteric angle and distance. The loss of the peritoneal fat may result in the reduction of the angle leading into SMAS.¹⁰ Various investigations such as Barium studies, endoscopy prove useful in the diagnosis of SMA syndrome. However contrast enhanced computed tomography (CECT) presents the advantage of providing overall assessment of the abdominal cavity. Recently multidetector computed tomography (MDCT) with multiplanar reformation (MPR) and CT angiography have become valuable, non invasive diagnostic tools.

Superior mesenteric artery syndrome is one of the rare causes of small bowel obstruction. The exact incidence is still not known. It is caused by extrinsic compression of the third part of the duodenum at an angle between SMA and abdominal aorta. The decrease in fatty pouch between SMA and aorta is the main cause of decreased AMA and AMD. Thus this study is conducted to know the angle and distance of SMA and aorta with respect to body mass index in normal population using MDCT. The main objective of this study was to identify the angulations and distance of SMA from aorta and their correlation with BMI in patients referred for CECT abdomen examination in a tertiary healthcare center in the country.

METHODS

This study was descriptive cross-sectional study performed in Department of Radiology and Imaging, Chitwan Medical College. The study population consisted of patients of age group 10-80 years, referred for contrast enhanced (CECT) abdomen or CT urogram. Simple random sampling procedure was chosen during the time period of 6 months from April to September 2018. A total number of 210 valid cases were taken as samples. However, patients who un-

derwent recent abdominal surgery or patients with previously diagnosed SMA syndrome, were excluded. Ethical approval was taken from Institutional Review Board of the institution.

The angle between the aorta and SMA was measured in arterial phase of the abdominal scan in the MPR reconstructed image in sagittal plane. The distance between the SMA and aorta was measured in axial plane at the level of 3rd part of duodenum. Appropriate measures were taken to ensure that position of the patients remain unchanged during the scan in all the phases. Weighing machine and height measuring tape was used for calculation of weight and height respectively for calculation of BMI. Data analysis was done using appropriate statistical software (Figure 1).

RESULTS

Out of 210 patients, 49.5% (n=104) were male and 50.5 % (106) were female, which were divided into four age groups; less than 20 years, 20-40 years, 40-60 years and 60-80 years. The mean age of the patients was 44.69 ± 16.23 years with minimum age 10 years and maximum age 79 years. Likewise for BMI calculation also, the patients were divided into four groups; underweight ($<18.5 \text{ kg/m}^2$), normal ($18.5\text{-}24.99 \text{ kg/m}^2$), overweight ($25\text{-}29.99 \text{ kg/m}^2$) and obese ($>30 \text{ kg/m}^2$). The mean BMI was $24.68 \pm 4.63 \text{ kg/m}^2$, maximum BMI was 41.86 kg/m^2 and minimum BMI was 15.88 kg/m^2 . The mean value of aortomesenteric distance of 210 patients was found to be 13.30 ± 4.75 with the minimum value being 5 mm and maximum value being 27mm. The mean value of aortomesenteric angle of 210 patients was found to be 54.7 ± 16.91 degree with the minimum value being 21 degree and maximum value being 110 degree.

For BMI category of less than 18.5 kg/m^2 (i.e. underweight) there were 8 male patients with the mean aortomesenteric distance of 12 ± 4.84 mm and mean aortomesenteric angle of 54.75 ± 16.09 degree; 12 female patients with a mean aortomesenteric distance of 9.33 ± 2.38 mm and mean aortomesenteric angle of 40.33 ± 10.54 degree. For BMI category of $18.5\text{-}24.99 \text{ kg/m}^2$ (i.e. normal) there were 64 male patients with the mean aortomesenteric distance of 14.53 ± 4.54 mm and mean aortomesenteric angle of 56.84 ± 18.13 degree; 32 female patients with a

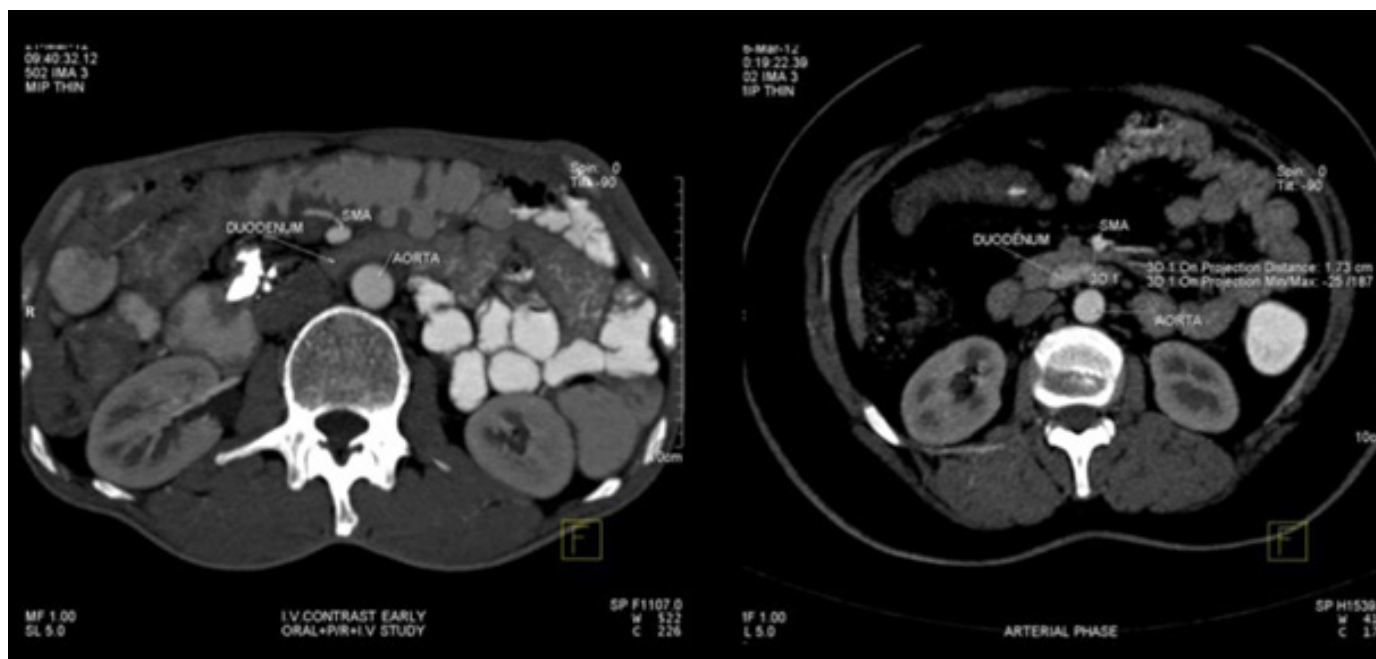


Figure 1: Cross-sectional CT scan image of abdomen showing measurement techniques.

mean aortomesenteric distance of 11.47 ± 4.10 mm and a mean aortomesenteric angle of 50.06 ± 16.25 degree. For BMI category of 25 – 29.99 kg/m² (i.e. overweight) there were 28 male patients with the mean aortomesenteric distance of 13.86 ± 4.88 mm and a mean aortomesenteric angle of 56.29 ± 13.47 degree; 40 female patients with a mean aortomesenteric distance of 13.25 ± 4.61 mm and a mean aor-

tomesenteric angle of 55.20 ± 15.19 degree. For BMI category of greater than 30 kg/m² (i.e. obese) there were 4 male patients with the mean aortomesenteric distance of 24 ± 3.46 mm and a mean aortomesenteric angle of 99.00 ± 12.70 degree; 22 female patients with a mean aortomesenteric distance of 12.45 ± 3.60 mm and a mean aortomesenteric angle of 52.00 ± 9.50 degree (Table 1).

Table 1: Distribution of Mean AMA and AMD with various BMI categories and gender.

BMI categories	Sex	Frequency	Mean AMA \pm SD (degree)	Mean AMD \pm SD (mm)
Underweight	Male	8	54.75 ± 16.09	12 ± 4.84
	Female	12	40.33 ± 10.54	9.33 ± 2.38
Normal	Male	64	56.84 ± 18.13	14.53 ± 4.54
	Female	32	50.06 ± 16.25	11.47 ± 4.10
Overweight	Male	28	56.29 ± 13.47	13.86 ± 4.88
	Female	40	55.20 ± 15.19	13.25 ± 4.61

The Pearson correlation coefficient between AMA and BMI was found to be 0.122 which signifies positive correlation between BMI and AMA. The correlation was significant by one tailed test as the p value = 0.01 for 5% level of significance. Similarly, the Pearson correlation coefficient between aortomesenteric distance and body mass index was found to be

0.086 which signifies positive correlation between BMI and AMD. The Pearson correlation coefficient between AMA and AMD was $r = 0.668$ which signifies positive correlation between aortomesenteric distance and angle. The p value of AMA and AMD was 0.00 by one tailed test and 1% level of significance which means there was a significant correla-

tion between AMD and AMA (Table 2).

Table 2: Pearson correlation coefficient of AMA and AMD with BMI and with each other.

Pearson correlation coefficient (r)		AMA	AMD
	Body mass index	0.122 (p=0.01)	0.086 (p=0.12)
	AMA	1	0.668 (p=0.00)

DISCUSSION

SMA syndrome (also called as Willkie's syndrome) occurs due to reduced aortomesenteric angle and distance resulting in vessel compression of the third part of the duodenum.¹¹ Apart from these, other cases include duodenal malrotation due to peritoneal adhesion causing duodenal compression , anomalous low origin of SMA, and high insertion of the duodenum by the ligament of Treitz.¹² The SMA originates from the anterior aspect of the aorta ,at the level of L1and L2 levels of the vertebral body , just inferior to the origin of celiac trunk and descends downwards at an acute angle into the mesentery. Between the SMA in its ventral and caudal course and the aorta is running posterior and parallel to it, thus the aortomesenteric angle is formed.¹³ Normally SMA usually forms an angle of 45 degree with the aorta, normal range ranging from 25 degree to 60 degree¹⁴ and the aortomesenteric distance being 10-28 mm.¹⁵ The results of this study were consistent with the literature in terms of aortomesenteric angle and aortomesenteric distance. As this study showed that for 210 patients who were referred for CECT scan of abdomen with various different complains, the mean aortomesenteric distance was 13.30 ± 4.75 mm and the mean aortomesenteric angle was 54.7 ± 16.91 degree which is in the normal range of values i.e. 10-28 mm and 25-60 degree as noted by LB Cohen et. al.¹⁰

This study showed there was significant positive correlation between AMA and BMI ($r = 0.122$; $p=0.01$) which is in concordance with the finding of the study performed by Ozkurt et. al.¹³ who concluded that the AMA significantly correlate with BMI ($r= 0.29$;

$p<0.001$).

There was also positive correlation between AMD and BMI ($r=0.86$; $p=0.12$) which also is in concordance with the finding of the study performed by Ozkurt et al¹³ who concluded that the AMD correlate with BMI ($r=0.35$; $p<0.001$).Although the study by Ozkurt et al. showed significant positive correlation between AMD and BMI, our study shows that the correlation is insignificant. This variation of result may have occurred due to difference in sample size. A positive correlation was also observed between the aortomesenteric angle and aortomesenteric distance($r=0.668$) which also is in concordance with the finding of the study performed by A B Desai et al.¹⁶ who concluded that there was a strong correlation between the aortomesenteric distance and aortomesenteric angle ($r=0.9$). Additionally, it also shows the correlation is significant ($p=0.0001$).

The limitation of our study was that we were not able to include patients with clinically diagnosed SMAS in this study. Therefore, we were unable to compare the mean values of aortomesenteric distance and angle of patient with or without SMAS. Nevertheless, the main purpose of the study was to find the normal values.

CONCLUSIONS

This study concluded that the distance and angle between the SMA and the aorta correlated significantly with the body mass index. This signifies that with increase or decrease in body mass index, the distance and angle between the SMA and aorta also increases or decreases respectively. This further indicates that the decrease in body mass index could be used as a risk factor of SMA syndrome. Additionally, this study also showed that there was positive correlation between the distance and angle between the SMA and aorta.

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