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COMPUTED TOMOGRAPHIC MEASUREMENT OF NORMAL AORTOMESENTERIC DISTANCE AND AORTOMESENTERIC ANGLE

[1]*Dr. Mukesh Kumar Gupta, [1]Dr. Ashok Raj Pant, [1]Dr. Nishant Mishra and [2]Dr. Suresh Prasad Sah

[1]Department of Radiology and [2]Department of Surgery, BPKIHS, Dharan.

***Corresponding Author: Dr. Mukesh Kumar Gupta**
Department of Radiology, BPKIHS, Dharan.

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ABSTRACT

Background: Abnormal narrowing of the aortomesenteric distance (AMD) and aortomesenteric angle (AMA) may result in compression of the important anatomical elements leading to various clinical manifestations. In order to label the AMD and AMA as abnormal, background knowledge of their normal standardized value is essential. The purpose of this study was to measure the normal AMD and AMA on computed tomography (CT) and determine their variation in relation to age, sex & body mass index. **Methods**: A cross-sectional study was conducted on 270 patients undergoing contrast enhanced CT scan of the abdomen. The AMD and AMA were measured on selected images by the electronic caliper. Body weight and height of the patients were taken to calculate BMI. Independent t-test was applied to compare the mean values of AMD and AMA in males and females. Pearson's correlation coefficient (r) was computed to assess correlation of AMD and AMA with age and BMI. P-value <0.05 was considered statistically significant with 95% confidence interval. **Results:** The mean AMD and AMA were 19.74±5.15 (range, 12.5-35) mm and 62.39±19.02 (range, 30.8-119) degree respectively. The mean AMD & AMA were 20.26 ±5.19 mm & 63.04±20.33 degree in male and 19.27±5.08 mm & 61.80±17.83 degree in female respectively. AMD had no correlation with age but AMA showed significant negative correlation with age. Both AMD and AMA showed significant positive correlation with BMI. **Conclusion:** The mean AMD and AMA were 19.74±5.15 (range, 12.5-35) mm and 62.39±19.02 (range, 30.8-119) degree respectively. There was no significant gender difference for mean values of AMD and AMA. AMD had no correlation with age but AMA showed significant negative correlation with age. Both AMD and AMA showed significant positive correlation with BMI.

KEYWORDS: Age, Aortomesenteric distance, Aortomesenteric angle, BMI, Computed tomography.

INTRODUCTION

The superior mesenteric artery runs inferiorly and anteriorly making an angle with the abdominal aorta at its origin called aortomesenteric angle. The left renal vein and third portion of the duodenum are the important anatomical elements located in the aortomesenteric angle space. Several factors may cause narrowing of the aortomesenteric distance and angle which may result in compression of the duodenum or the left renal vein between SMA and aorta.[1,2] Superior mesenteric artery syndrome (SMAS), also known as cast syndrome or arteriomesenteric duodenal compression syndrome or Wilkie syndrome, is a rare cause of upper gastrointestinal obstruction in which the third portion of the duodenum is compressed between the aorta and the superior mesenteric artery.[3,4]

Third portion of the duodenum is bounded by retroperitoneal fat which provides a cushion for the duodenum and helps maintain a wide AMD & AMA. Numerous previous studies have found the normal range of the AMA and AMD to be 28-65 degree and 10-34 mm respectively.[3]

The AMD and AMA are influenced by the amount of the retroperitoneal fat tissue. Depletion of the retroperitoneal fatty padding in various debilitating conditions results in narrowing of AMD and AMA leading to compression & obstruction of the duodenum.[4] Body mass index (BMI) provides a direct measure of underweight and overweight and acts as a proxy for fat mass.[5] Marked loss in the body weight and low BMI are the predisposing factors for development of SMA syndrome.[6]

SMA syndrome occurs more frequently in the females and two-thirds of the cases are 10 to 39 years of age. Contrast enhanced CT scan is an important diagnostic tool for SMA syndrome as it allows simultaneous evaluation of the mesoaortic vascular anatomy and transverse duodenal compression with proximal dilatation.[3]

Background knowledge of standardized values for the AMD and AMA is essential as it can facilitate in making diagnosis, deciding the management strategy and prognostication of the conditions arising due to compression by superior mesenteric artery. Several studies have reported the role of AMA and AMD in the development of SMA syndrome thus necessitating the importance of measuring and determining normal values of the angle and distance. The purpose of this study was to measure the normal AMD and AMA on computed tomography and determine their variation in relation to age, sex & body mass index.

METHODS

A hospital based cross-sectional study was carried out on 270 consecutive patients at B.P. Koirala Institute of Health Sciences (BPKIHS), Dharan, Nepal over a period of 9 months from 25th February to 24th November, 2018. Informed consent was taken from all the participants. Approval of ethical clearance was obtained from the institutional review committee (IRC), BPKIHS, Dharan, Nepal. This study had no influence on the treatment of the patients or execution/ indication of the CT scan. The referred patients, irrespective of age and sex, undergoing contrast enhanced CT scan of the abdomen in the department of Radiodiagnosis and Imaging for various indications were included. Patients with history of previous abdominal surgery, clinical features supportive of superior mesenteric artery syndrome or nutcracker syndrome and abnormality on CT scan which could distort the normal anatomy of AMD & AMA were excluded from the study. Patients too ill to allow weighing and measuring height were also excluded. The scans were performed in supine position on a Hitachi 16-slice MDCT scanner. Multiplanar reformation was done on the console for assessment of the branching configuration of the SMA from the aorta.

The AMD was measured on selected axial image as distance between the anterior margin of the aorta and the posterior margin of the SMA at the level of crossing of duodenum (fig.1). The AMA was measured on selected reformatted sagittal–oblique/ sagittal image at the level of origin of SMA from the aorta (fig. 2). The AMD and AMA were measured by electronic calipers available on the working console. Body weight and height of the patients were taken to calculate BMI. All the measurements were recorded on the structured pro forma for the analysis of data.

Statistical analysis was performed using SPSS software. For descriptive statistics, mean ± SD was calculated and presented for age, AMD and AMA. Frequencies and percentages were computed for gender. Independent t-test was applied to compare the mean values of AMD & AMA in males and females. Pearson's correlation coefficient (r) was computed to assess correlation of AMD and AMA with age and BMI. P-value <0.05 was considered as statistically significant with 95% confidence interval.

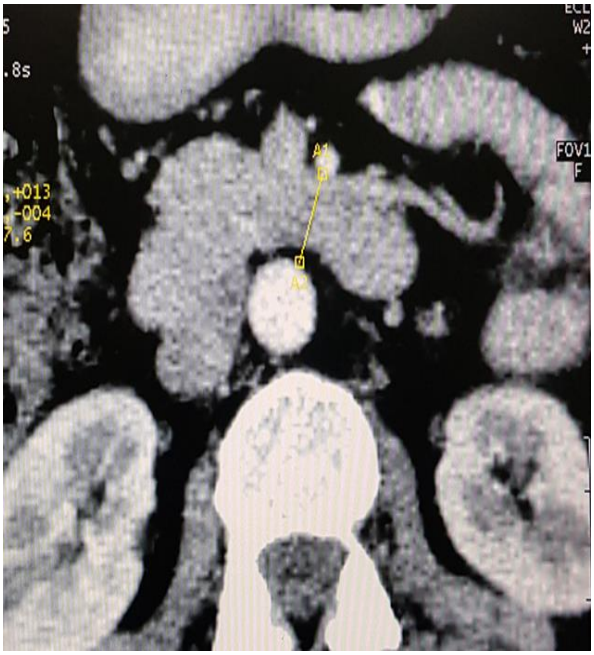

Fig. 1: Measurement of aortomesenteric distance.

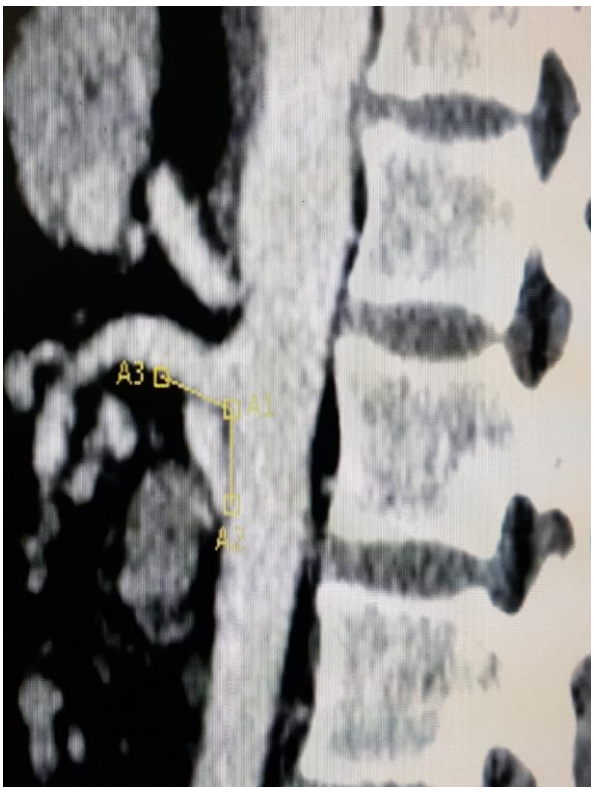

Fig. 2: Measurement of aortomesenteric angle.

RESULTS

Among total 270 participants, 127(47%) were male and 143(53%) were female with male to female ratio of 1:1.13. The age ranged from 12 to 81 years with mean age of 44.96±16.76 years. The body mass index (BMI) of the participants ranged from 16.40 to 32.46 kg/m^2 with a mean of 23.38±2.89 kg/m^2. [Table 1]

Table 1. BMI (Kg/m^2) of the participants				
Sex	**N**	**Range**	**Mean ± SD**	**P-Value**
Male	127	16.40 - 31.88	23.64±2.90	0.156 (Insignificant)
Female	143	16.42 - 32.46	23.14±2.86	
Total	270	16.40 - 32.46	23.38±2.89	

The AMD ranged from 12.5 to 35 mm with the mean of 19.74±5.15 mm and the AMA ranged from 30.8 to 119 degree with mean of 62.39±19.02 degree among total of 270 participants. The AMD ranged from 12.60 to 35.00 mm with mean of 20.26±5.19 mm and the AMA ranged from 34.00 to 109.00 degree with mean of 63.04±20.33 degree among 127 males. The AMD ranged from 12.50 to 34.00 mm with mean of 19.27±5.08 mm and the AMA ranged from 30.80 to 119.00 degree with mean of 61.80±17.83 degree among 143 females. [Table 2]

Table 2. Values of AMD and AMA according to gender					
Sex	**N**	**AMD (mm)**		**AMA (degree)**	
		Mean ±SD	**Range**	**Mean ±SD**	**Range**
Male	127	20.26±5.19	12.60 - 35.00	63.04±20.33	34.00 - 109.00
Female	143	19.27±5.08	12.50 - 34.00	61.80±17.83	30.80 - 119.00
Total	270	19.74±5.15	12.50 - 35.00	62.39±19.02	30.80 - 119.00

The mean values of both AMD & AMA were slightly higher in males than in females but the differences were statistically insignificant when compared with independent t-test which is shown in table 3.

Table 3: Gender comparison of AMD and AMA			
Variables	**Male**	**Female**	**P-value**
AMD (mm)	20.26 ±5.19	19.27±5.08	0.114
AMA (degree)	63.04±20.33	61.80±17.83	0.598

When AMD and AMA were correlated with age, it was found that AMD had no correlation with age while AMA showed statistically significant negative correlation with age which is shown in table 4. With increase in patient's BMI, a significant increase in both AMD and AMA was seen on Pearson's correlation indicating a statistically significant positive relationship of BMI with AMD and AMA which is shown in table 4.

Table 4. Correlation of AMD and AMA with age and BMI (N=270)				
Parameters	**Age**		**BMI**	
	r	**p**	**r**	**p**
AMD	0	0.996	0.266**	<0.001
AMA	-0.198**	0.001	0.123*	0.043
**Correlation is significant at the 0.01 level (2-tailed) *Correlation is significant at the 0.05 level (2-tailed)				

DISCUSSION

The SMA originates from the abdominal aorta at L1-L2 level and forms an angle with the aorta called AMA as it courses anteriorly and inferiorly. Various conditions may cause decrease in AMD and AMA which may result in compression of important anatomical structures located in the angle.[3] Although several factors may predispose to the development of SMA syndrome, the AMA and the AMD at the level of duodenum are the critical elements.[4] In SMA syndrome, both AMD and AMA have been reported to be reduced, with values of 2-8 mm and 6-22 degree respectively.[3] However, SMA syndrome should not be diagnosed exclusively on the basis of reduced AMD and AMA on CT scan without of any signs or symptoms of duodenal obstruction.[3]

In order to label the angulation and the distance of SMA from aorta as abnormal, the normal values of AMD and AMA should be established first.

A wide variation in the normal values of aortomesenteric distance and aortomesenteric angle has been reported. In the present study, the mean values of AMD and AMA were 19.74±5.15 (12.5-35) mm and 62.39±19.02 (30.8-119) degree respectively among total of 270 participants. Previous studies have shown the normal range of the AMD and AMA to be 10-34 mm and 28-65 degree respectively.[3] Unal et al.[7] in a study found the normal values of SMA-Aorta distance and SMA-Aorta angle to be 16.0±5.6 (8.2-33.3) mm and 50.9±25.4 (15-112) degree respectively. Fu et al[8] found that the superior mesenteric artery had 90±10 degree angle with aorta in the control group. In a study by Konen et al.[9] the mean AMD and AMA were found to be 19.6 (range, 13.4-34.3) mm and 44.4 (range, 28-65) degree respectively in the control group.

In the present study, the mean values of AMD & AMA were 20.26±5.19 (range, 12.60-35.00) mm &

63.04±20.33 (range, 34.00-109.00) degree in males and 19.27±5.08 (range, 12.50-34.00) mm & 61.80±17.83 (range, 30.80-119.00) degree respectively in females. There was no statistically significant gender difference for mean values of AMD & AMA in this study. Arthurs et al.[1], in a study on 205 children, also found no significant gender difference for mean SMA angle or aortomesenteric distance. Unal et al.[7], on evaluation of total sample, found a significant effect of gender on the SMA-Aorta distance which was 13.4±5.7 mm for females and 16.3±6.5 mm for males (p=0.036). In the present study, AMA showed statistically significant negative correlation with age while AMD had no correlation with age. Arthurs et al.[1] found no significant correlation of aortomesenteric distance or SMA angle with age in a study on 205 children.

Rapid loss of body weight may result in depletion of retroperitoneal and mesenteric fat and subsequent reduction of the aortomesenteric distance.[2] In the present study, both AMD and AMA showed significant positive correlation with BMI which is in concordance with the finding of the study carried out by Ozkurt et al.[4] who also reported positive correlation of both AMD and AMA with BMI. Similarly, Desai et al.[10] reported positive correlation of both AMA & AMD with BMI indicating that the increase in value of AMD & AMA increases the value of BMI and vice versa. Likewise, Unal et al.[7] reported significant correlation of BMI with SMA-Aorta distance (r=0.616, p=0.004). Ozbulbul et al.[11] found positive correlation of BMI with AMD & AMA in females. In males, they reported positive correlation of BMI with AMD but found no statistically significant relationship between BMI and AMA.

The mean values of AMA and AMD in patients with and without SMA syndrome were not compared in this study as the prime aim was to find the normal values. Thus, further studies taking samples from patients with SMA syndrome and control subjects are needed to compare the mean values of angle and distance in symptomatic and asymptomatic individuals. The wide range of AMD and AMA, as seen in this study, suggests exercising caution while diagnosing SMA syndrome exclusively on the basis of AMD and AMA.

CONCLUSION

The mean AMD and AMA were 19.74±5.15 (range, 12.5-35) mm and 62.39±19.02 (range, 30.8-119) degree respectively which would be a useful reference. There was no significant gender difference for mean values of AMD and AMA. AMA showed significant negative correlation with age, however AMD had no correlation with age. Both AMD and AMA showed significant positive correlation with BMI.

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