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Original Article

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The relationship of inferior mesenteric artery occlusion with abdominal aortic aneurysm diameter and intramural thrombus thickness

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ABSTRACT

Objectives: In this study, we aimed to investigate the relationship between the diameter of the abdominal aorta with inferior mesenteric artery (IMA) occlusion and intraluminal thrombus (ILT) thickness, as well as the relationship between IMA occlusion and ILT diameter in patients with an abdominal aortic aneurysm (AAA).

Patients and methods: This retrospective study was conducted with 599 AAA patients (515 males, 84 females; mean age: 70.4±9.7 years; range, 26 to 96 years) between January 2015 and December 2020. The patients were grouped according to IMA occlusion. There were 169 (28.2%) patients with an occluded IMA (Group A) and 430 (71.8%) patients with a patent IMA (Group B).

Results: No correlation was found between aneurysm diameter and IMA occlusion. Intraluminal thrombus was more frequent in patients with IMA occlusion than in those without an occlusion (p=0.002). The ILT diameter was found to be extended in Group A (p<0.001). There was a significant positive correlation between AAA diameter and ILT diameter (τb=0.389; p<0.001).

Conclusion: Inferior mesenteric artery occlusion was not related to AAA diameter but was more frequently detected with increased ILT thickness/AAA diameter ratio. The increase in the aneurysm diameter is not associated with IMA occlusion. Future studies on ILT progression can better reveal the role of ILT on the pathogenesis of IMA occlusion.

Keywords: Abdominal aortic aneurysm, computed tomography angiography, inferior mesenteric artery.

An abdominal aortic aneurysm (AAA) is the permanent dilation of more than 50% of the abdominal aortic diameter, and it is a life-threatening clinical condition.[1] The prevalence of AAA in males over 65 years of age is estimated to be 5 to 7%.[2] It requires close monitoring and treatment depending on the size or symptomatology of the aneurysm. Enlargement of the aneurysm may be gradual or rapid, with its size remaining constant for a period or expanding within months. The expansion rate is expected to be 0.2 to 0.3 cm/year for small AAAs (3-5 cm) and 0.3 to 0.5 cm/year for aneurysms of >5 cm diameter.[3]

Intervention is indicated when the aneurysm diameter is ≥5.5 cm in males and >5 cm in females with acceptable surgical risk, presence of symptoms, and an annual growth rate of >1 cm.[4] However, decision-making solely based on the aneurysm diameter has its limitations due to the risk of rupture associated with a significant number of small-diameter aneurysms.[5] Other factors such as intraluminal thrombus (ILT), aneurysm wall inflammation, and biomechanical vessel wall stress have been investigated as potential causes of rapid AAA growth and rupture.[6] Of these possible mechanisms, ILT is commonly present in AAAs.[6]

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The impact of ILT on AAA growth and the risk of rupture is still poorly understood. Several studies have shown ILT to reduce the mechanical stress to which the vessel wall is exposed.[6-8] Nonetheless, ILT can induce hypoxia and mediate inflammatory processes that weaken the arterial wall.[9] It has also been reported that the presence of ILT is associated with the rupture of the AAAs.[10]

In patients for whom an intervention for the AAA is indicated, the inferior mesenteric artery (IMA) may be occluded. There is a paucity of data on the rate of IMA patency in AAAs in the literature. Similarly, although the presence or thickness of ILT in AAA has been associated with aneurysm enlargement,[11] there is insufficient data in the literature regarding the relationship of ILT with IMA occlusion.

The occlusion of the IMA may be related to the extent of aortic enlargement and intramural thrombus in AAA patients. In this study, we aimed to investigate the relationship between the diameter of the abdominal aorta and IMA occlusion and ILT thickness, as well as the relationship between IMA occlusion and ILT diameter in patients with AAA using computed tomography (CT).

PATIENTS AND METHODS

Data of a total of 986 patients were analyzed who underwent contrast-enhanced abdominal or thoracoabdominal CT scans at the Dr. Siyami Ersek Research and Training Hospital between January 2015 and December 2020 were investigated in this retrospective observational study. Five hundred ninety-nine patients (515 males, 84 females; mean age: 70.4±9.7 years; range, 26 to 96 years) whose widest diameter of the abdominal aorta was >3 cm in transverse (anteroposterior) 1 mm sections were diagnosed with an AAA and included in the study. The excluded patients had previously undergone open surgery or endovascular procedures for the abdominal aorta, but their preoperative CT image could not be obtained, or they were diagnosed with a ruptured AAA or concomitant thoracic aortic aneurysm. The age and sex were recorded from the demographic data of the patients, and the patients were divided into two age-and sex-matched groups: Group A, which included 169 patients with an occluded IMA, and Group B, which consisted of 430 patients with a patent IMA. The primary endpoint was the presence and thickness of the ILT in patients with and without IMA occlusion.

In the evaluation of the CT images, measurements were made using transverse 1 mm contrast-enhanced thoracoabdominal or abdominal CT slices. The diameter of the widest abdominal aortic segment, ILT thickness at the origin of the IMA, and the presence of IMA occlusion at the IMA origin were recorded. In addition, the ratio of maximum ILT thickness at the level of IMA to maximum aortic diameter was calculated.

Statistical analysis

The data were analyzed with the IBM SPSS version 25.0 software (IBM Corp, Armonk, NY, USA). Categorical data were expressed as numbers and percentages, and normally distributed continuous data were presented as means and standard deviation. The Pearson chi-square test was used to compare categorical data, and Student's t test was used to compare normally distributed continuous data. Kendall's ordinal correlation was applied to continuous data. Analyses with receiver operating characteristic (ROC) curves were performed for the classification performance of the parameters in outcome variables. The Youden's index method was used to identify the best cut-off point in the ROC analysis. A p value of <0.05 was considered statistically significant.

RESULTS

The mean aneurysm diameter was 57.4±14.1 mm (median: 55; range, 30 to 153). All aneurysms in the study were fusiform aneurysms with a mean aneurysm length of 5.2±1.5 cm. There were 169 (28.2%) patients with an occluded IMA and 430 (71.8%) patients with a patent IMA. The SMA was patent in all patients, and four (0.7%) patients, all of whom had occluded IMAs, presented with mesenteric ischemia at the time of their CT scans. Intraluminal thrombus was present in 511 (85.3%) patients. The mean thickness of ILT was 21.6±9.9 mm (median: 20; range, 2 to 75) in these 511 patients. The mean mural thrombus/aortic diameter ratio was 0.3±0.2 in patients with ILT (Table 1).

Groups were not different in terms of mean aneurysm diameter. No correlation was found between aneurysm diameter and IMA occlusion. When the relationship between IMA patency and the presence of ILT was examined, ILT was present in 156 (92.3%) of 169 patients in Group A. In Group B, 355 (82.6%) of 430 patients had ILT. The presence of ILT was significantly different between the two groups (p=0.002). While the mean ILT thickness

Table 1. Patient data and aneurysm parameters by IMA occlusion

	All patients (n=599)			Group A (IMA occluded, n=169)			Group B (IMA patent, n=430)			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			70.4± 9.7			70.0± 9.1			70.5±10.0	0.600
Sex										0.734
Female	84	14.0		25	14.8		59	13.7		
Male	515	85.9		144	85.2		371	86.3		
Aneurysm diameter (mm)			57.4±14.1			58.6±14.8			56.9±13.8	0.189
Aneurysm size										0.540
<4.5	90	15.0		21	12.5		69	16.0		
4.5-5.5	183	30.4		51	30.4		131	30.3		
>5.5	328	54.6		96	57.1		232	53.7		
Aneurysms with mural thrombus	511	85.3		156	92.3		355	82.6		**0.002**
Thrombus pattern										**<0.001**
No thrombus	88	14.7		13	7.7		75	17.4		
Annular	204	34.1		103	60.9		101	23.5		
Branch side	63	10.5		37	21.9		26	6.0		
Opposite side	244	40.7		16	9.5		228	53.0		
Mural thrombus thickness (mm)			21.6±9.9			21.7±11.5			17.4±11.8	**<0.001**
Mural thrombus/aortic diameter ratio			0.3±0.2			0.387±0.161			0.301±0.184	**<0.001**

IMA: Inferior mesenteric artery; SD: Standard deviation.

was 21.7±11.5 mm in Group A, this value was 17.4±11.8 mm in Group B, and the ILT diameter was extended in Group A (p<0.001). The thrombus pattern was also different between the groups (p<0.001). The patients with occluded IMAs most frequently had annular mural thrombus (60.9%), whereas patients with patent IMAs most commonly had a thrombus on the wall opposite to the IMA origin (53.0%). The ratio of the ILT diameter to AAA diameter was 0.387±0.161 in Group A, while it was less in Group B with 0.301±0.184 (p<0.001; Table 1).

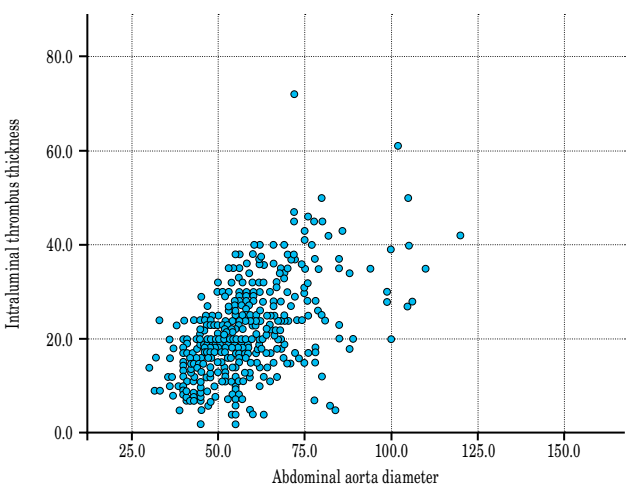

Figure 1. Intraluminal thrombus diameter/AAA diameter (τb=0.389, p<0.001).

There was a significant positive correlation between AAA diameter and ILT diameter (τb=0.389; p<0.001; Figure 1). The ROC analysis of the ILT diameter for the presence of IMA occlusion revealed an area under the curve of 60.2%. For an 11.5 mm ILT thickness, sensitivity was 87.6%, and specificity was 31.0%.

DISCUSSION

This study demonstrates that as the ILT thickness increases, the IMA occlusion is more frequent. In our study, no relationship was found between abdominal aortic diameter and IMA occlusion. To the best of our knowledge, the effect of ILT on IMA occlusion was not previously reported.

Autopsy studies have shown that the risk of rupture in aneurysms with smaller diameters (<5 cm) is higher, with a rate of 0.5 to 4%.[10] Based on this information, the diameter of the aneurysm may not be the only determinant of rupture risk, and patient-specific factors may play a role in the disease process leading to a rupture.[10]

One of the patient-specific risk factors for rupture may be the presence of ILT. Intraluminal thrombus is a structure with an accumulation of activated platelets, a small number of leukocytes (primarily neutrophils

known as polymorphonuclear cells), a thick fibrin network, and erythrocytes.[12] There are contradicting views on the role of ILT in the risk of rupture, with studies showing either an increase or a decrease in the risk.[13,14] While ILT may prevent aneurysm rupture as a mechanical barrier, there are also opinions that it reduces wall resistance due to the inflammatory cells in its existing structure.[15] It has also been reported that ILT causes aortic degeneration in some animal models, and platelet inhibitors prevent the growth of ILT and suppress aneurysm formation.[16]

In patients who develop an AAA, IMA occlusion with ILT is frequently encountered. Inferior mesenteric artery reimplantation is decided based on the preoperative CT evaluation, the assessment of the retrograde IMA flow during surgery, and the risk of perioperative bowel ischemia. Even if these conditions are taken into consideration, ischemic colitis may develop when IMA is not reimplanted due to insufficient collateral flow. Early colonoscopy is recommended when ischemic colitis is suspected.[17] The risk of developing ischemic colitis during AAA open surgery is reported to be between 0.6 and 3%.[18] Clinical indications for IMA reimplantation have not been established.[19]

The limitations of this study are its retrospective design and the measurements made on a single CT study for each patient. The rate of expansion of the aneurysm diameter and the time of IMA occlusion can be better evaluated by analyzing a series of CTs in a prospectively designed study. Our data did not allow analysis of the necessity of IMA reimplantation when IMA was occluded. Computed tomography measurements were made using two-dimensional sections, which may not be comparable to other studies that use three-dimensional methods. Three-dimensional volume studies can be performed for more precise measurements of ILT thickness.

In conclusion, IMA occlusion was not related to the AAA diameter but was more frequently observed with increased ILT thickness/AAA diameter ratio. The increase in aneurysm diameter is not associated with IMA occlusion. Future studies on ILT progression can better reveal the role of ILT on the pathogenesis of IMA occlusion.

Ethics Committee Approval: Dr. Siyami Ersek Research and Training Hospital (İstanbul) board (No: E-28001928-604.01.01) and Haydarpaşa Numune Research and Training Hospital Ethics Committee Approval (No: HNEAH-KAEK 2021/294-3401) were obtained for the study. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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