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Original Article

Detection of unexpected aortic aneurysms by using computed tomography in emergency department: A retrospective analysis of more than 10.000 patients

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Abstract

Aim: This study aims to determine the prevalence of aortic aneurysms (AA) on computed tomography (CT) in the emergency department.
Material and Methods: A total of 10219 CT images were retrospectively analyzed (7610 thoracic, 6148 abdominal CT). A thoracic aortic diameter greater than 50 mm, an abdominal aortic diameter greater than 30 mm, or an aortic diameter greater than 50% of normal were considered AA. The baseline demographic and clinical characteristics of patients with thoracic AA (TAA) and abdominal AA (AAA) were compared to those without AA.
Results: TAA was found in 990 (13%) of 7610 patients who had thoracic CT, while AAA was found in 66 (1.07%) of 6148 patients who had abdominal CT. In aneurysm groups, advanced age ($p<0.001$), male gender ($p<0.001$), aortic calcification ($p<0.001$), hyperlipidemia ($p<0.001$), coronary artery disease ($p<0.001$), hypertension ($p<0.001$), and diabetes mellitus ($p<0.001$) were more common and significantly different. Smoking was observed more frequently in the group with aneurysms ($p<0.001$). Among the groups, hospital mortality was higher in the aneurysm group ($p<0.001$). Surgery was recommended in 30 (3%) of TAA patients whose aortic diameter was greater than 55 mm; however, surgery could be performed in 20 (2%) of these patients. Surgery was recommended for 16 (24%) of AAA patients, but surgery could be performed only in 12 of them (18%).
Conclusion: Attention to aortic pathologies, particularly AA, in patients undergoing radiological imaging in the emergency department for various reasons allows for the early detection of asymptomatic but potentially fatal aneurysms.

Keywords: Aortic aneurysms, computed tomography, diagnosis, endovascular treatment

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INTRODUCTION

Diagnosis is difficult because thoracic aortic aneurysms (TAA) and abdominal aortic aneurysms (AAA) are asymptomatic, which can be fatal if ruptured [1,2]. Therefore, screening methods for TAA and AAA are lifesaving [3,4]. For various reasons, radiologic imaging is conducted in the emergency department, and computed tomography (CT) is one of the most commonly used methods. With early diagnosis and treatment, these patients can be followed up or treated with surgical methods to reduce mortality and morbidity [5,6].

This study aimed to determine the prevalence of TAA and AAA in patients who presented to the emergency department and underwent thoracic and abdominal CT for various reasons and to discuss risk factors and the results of these patients' follow-up.

MATERIAL AND METHODS

The study protocol adhered to the guidelines stipulated in the Declaration of Helsinki and was approved as an electronic medical record-based retrospective study by the Institutional Review Board of Afyonkarahisar Health Sciences University Hospital (05.05.2020/2011-KAEK-2); therefore, the requirement for obtaining informed consent from the patients prior to study participation was waived.

The hospital information system was used to review the medical files, and tomography images of patients presented to the emergency department and underwent thoracic and abdominal CT for various reasons between January 2020 and May 2021. Age, gender, medical history, course, and treatment processes of patients with AA were obtained and recorded. The study excluded patients under 18 years of age and those previously diagnosed with AA, undergoing AA intervention, and previously diagnosed with vascular disease. A thoracic aortic diameter greater than 50 mm, an abdominal aortic diameter greater than 30 mm, or an aortic diameter greater than 50% of normal were all considered aneurysms [1,2]. The section with the largest aortic diameter was magnified three times, and the electronic caliper was used to take axial and sagittal anteroposterior aortic measurements. Measurements were taken from the outer aortic adventitia to the opposite outer adventitia, the line passing through the center of the aorta. Patients with TAA and AAA were compared to those without AA for age, gender, concomitant diseases, aortic diameter, and hospital mortality. The surgical method was chosen based on the patient's demographics, the characteristics of the aneurysm, the accessible vascular structure, concomitant diseases, and the patient's general condition. Patients were followed up with 6-month controls after surgical treatment. Patients with AA, but not extending beyond the surgical margin, were treated with medication and followed up for six months.

Statistical Analysis

Continuous variables were expressed as mean or median, while categorical variables were expressed as percent as appropriate. Continuous variables were assessed with T test or Mann Whitney U test, while categorical variables were assessed using the X2 test. Pearson correlation was used in the correlation of aortic dilatation with age and other parameters and was expressed with 'r'. All statistical analyses were performed using the R statistical software version 3.2.2 (R Foundation for Statistical Computing, Vienna, Austria). A p-value of less than 0.05 was considered to indicate a statistical significance.

RESULTS

AA was found in 990 (13%) of 7610 patients who underwent thoracic CT and 66 (1.07%) of 6148 patients who underwent abdominal CT. The mean age of patients with TAA was 71.16±11.2 years and was significantly higher than the mean age of patients without AA ($p<0.001$). Similarly, the mean age of patients with AAA was 81.3±8 years, and it was significantly higher than the mean age of patients without AA ($p<0.001$). There was a significant difference between the groups, with 534 (53.9%) of TAA patients and 45 (68.2%) of AAA patients being male. ($p<0.001$).

The most common reason for admission in TAA patients was respiratory distress 409 (41.3%), while 219 (22.1%) underwent CT for abdominal pain and 187 (18.9%) for trauma. The most common reason for admission of patients with AAA was general condition disorder in 30 (45.6%) patients, while CT was performed in 20 (30.4%) patients due to abdominal pain (Table 1). Table 1 compares the demographic and clinical features of the groups.

In-hospital mortality was detected in 112 (11.3%) of the patients with TAA and 357 (5.4%) of the patients without AA ($p<0.001$). Similarly, in-hospital mortality was observed in 21 (31.8%) patients in the group with AAA, while it was observed in 243 (4%) patients in the group without AAA ($p<0.001$). In none of the patients, the cause of death was related to AA. Table 1 shows the baseline characteristics and demographic characteristics of the patients.

Screening of the entire aorta for AA was performed, particularly in patients over 65 and in males found to have TAA or AAA. Other aortic regions were dilated in patients with TAA or AAA, and the association increased with age (Table 1 and Table 2).

Table 1. Demographic characteristics of patients

Variables	Patients without thoracic aortic aneurysm (n=6620)	Patients with thoracic aortic aneurysm (n=990)	P value	Patients without abdominal aortic aneurysm (n=6082)	Patients with abdominal aortic aneurysm (n=66)	P value
Age (year)	52.37±20	71.16±11.2	<0.001	49±19	81.3±8	<0.001
Gender (male)	3105 (46.9%)	534 (53.9%)	<0.001	3193 (52.5%)	45 (68.2%)	<0.001
Reason for admission						
Respiratory distress	3441 (52%)	409 (41.3%)	<0.001	406 (6.7%)	1 (1.5%)	N/A
Traffic accident	1243 (18.8%)	22 (2.2%)	<0.001	1203 (19.8%)	2 (3%)	N/A
Abdominal pain	833 (12.5%)	219 (22.1%)	<0.001	3368 (55.4%)	20 (30.4%)	<0.001
General condition disorder	158 (2.4%)	68 (6.9%)	<0.001	115 (1.9%)	30 (45.6%)	<0.001
Malignancy	204 (3.1%)	69 (7%)	<0.001	249 (4.1%)	1 (1.5%)	N/A
Trauma	649 (9.8%)	187 (18.9%)	0.046	535 (8.7%)	3 (4.5%)	N/A
Others	46 (0.7%)	14 (1.4%)	N/A	85 (1.4%)	4 (6%)	N/A
Fever	20 (0.3%)	1 (0.1%)	N/A	6 (0.1%)	3 (4.5%)	<0.001
Renal disfonctions	26 (0.4%)	1 (0.1%)	N/A	115 (1.9%)	2 (3%)	N/A
Comorbidities						
Hyperlipidemia	854 (12.9%)	199 (20.1%)	<0.001	718 (11.8%)	22 (33.3%)	<0.001
Coronary artery disease	682 (10.3%)	206 (20.8%)	<0.001	364 (6%)	66 (100%)	<0.001
Hypertension	1390 (21%)	338 (34.1%)	<0.001	772 (12.7%)	66 (100%)	<0.001
Diyabetes mellitus	1467 (21.4%)	285 (38.9%)	<0.001	1295 (21.3%)	22 (33.3%)	0.018
Chronic obstructive pulmonary disease	655 (9.9%)	68 (6.9%)	0.002	116 (1.9%)	0	0.257
Creatinine	1.01±0.36	0.81±0.29	<0.001	0.90±0.71	0.88±0.13	<0.001
Use of statins	477 (7.2%)	91 (9.2%)	0.025	334 (5.5%)	66 (100%)	0.05
Smoke						
Current	894 (13.5%)	179 (18.1%)	0.033	341 (5.6%)	22 (33.3%)	0.001
Ex	688 (10.4%)	45 (4.6%)		584 (9.6%)	0	
Never	5031 (76%)	765 (77.3%)		5157 (84.8%)	44 (66.7%)	
Mortality	357 (5.4%)	112 (11.3%)	<0.001	243 (4%)	21 (31.8%)	<0.001

Table 2. Differences of groups according to aortic characteristics

Variables	Patients without thoracic aortic aneurysm (n=6620)	Patients with thoracic aortic aneurysm (n=990)	P value	Patients without abdominal aortic aneurysm (n=6082)	Patients with abdominal aortic aneurysm (n=66)	P value
Ascending thoracic aortic diameter (mm)	31.7±4.1	42.4±2.3	<0.001	33±5.9	35.1±3	0.006
Descending thoracic aortic diameter (mm)	23.78±3.8	29.01±2.6	<0.001	24±3.8	24±0.5	
Abdominal aortic diameter(mm)	16.2±2.9	19.04±2.7	0.006	16.12±2.5	3.4±7.8	<0.001
Calcification	1747 (26.4%)	629 (63.5%)	<0.001	1709 (28.1%)	66 (100%)	<0.001
Stenosis						
No stenosis	6421 (97%)	968 (97.8%)	0.718	5924 (97.4%)	43 (65.2%)	
İnfrarenal aortic stenosis (over than 50%)	20 (0.3%)	0		24 (0.4%)	23 (34.8%)	<0.001
Abdominal aortic stenosis (%30-50)	112 (1.7%)	22 (2.2%)		134 (2.2%)	0	

It was found that 30 (3%) patients with TAA were recommended surgery because the aortic diameter was more than 55 mm, but surgery could be performed in 20 (2%) patients. Surgery was recommended in 16 (24%) patients with AAA, but surgery could be performed in 12 (18%). Surgery could not be performed on patients whose general condition put them at high risk for surgery and who refused it. Figure 1 depicts the distribution of patients based on surgical and medical treatment. Surgical treatment of aneurysm diameter and morphology was performed with endovascular methods in suitable patients.

In contrast, open surgery was performed in patients unsuitable for endovascular treatment (Figure 2). Hybrid surgery and endovascular intervention were performed in two patients for TAA, and graft interposition was performed with open surgical methods in the other patients. Endovascular intervention was performed in 4 patients (6%) with AAA, while open surgery was conducted in the other eight patients (12%). No mortality was observed in the six-month and 1-year follow-ups after surgery.

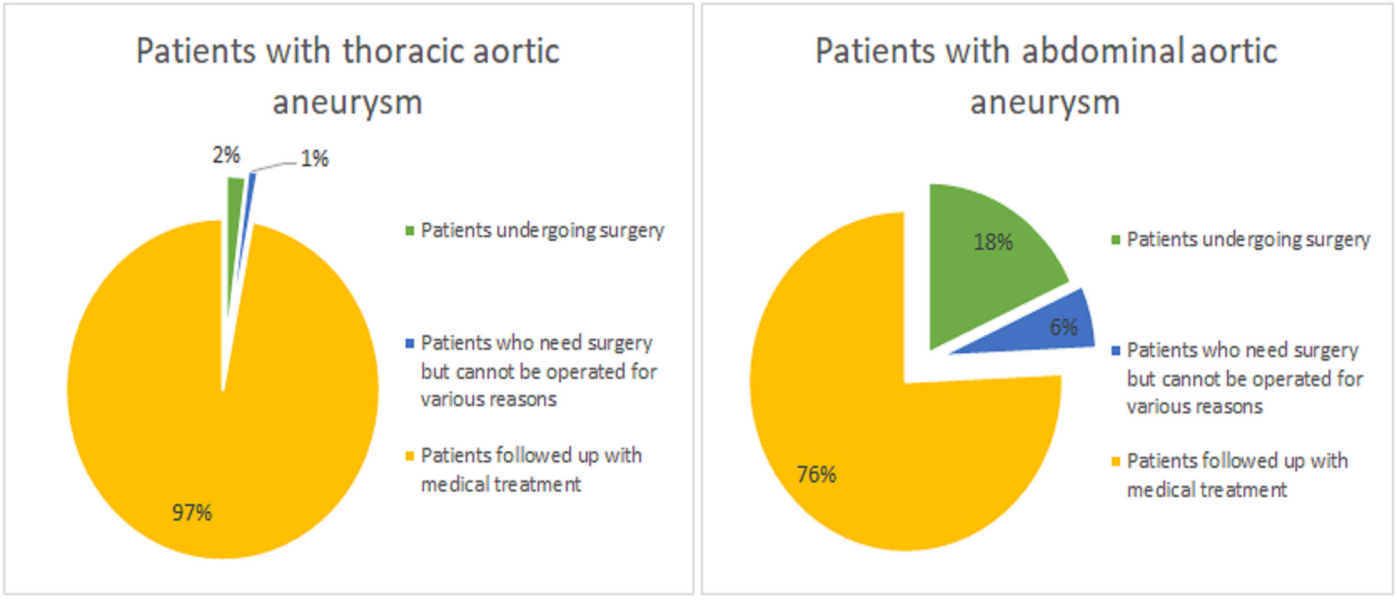

Figure 1. The distribution of patients based on surgical and medical treatment

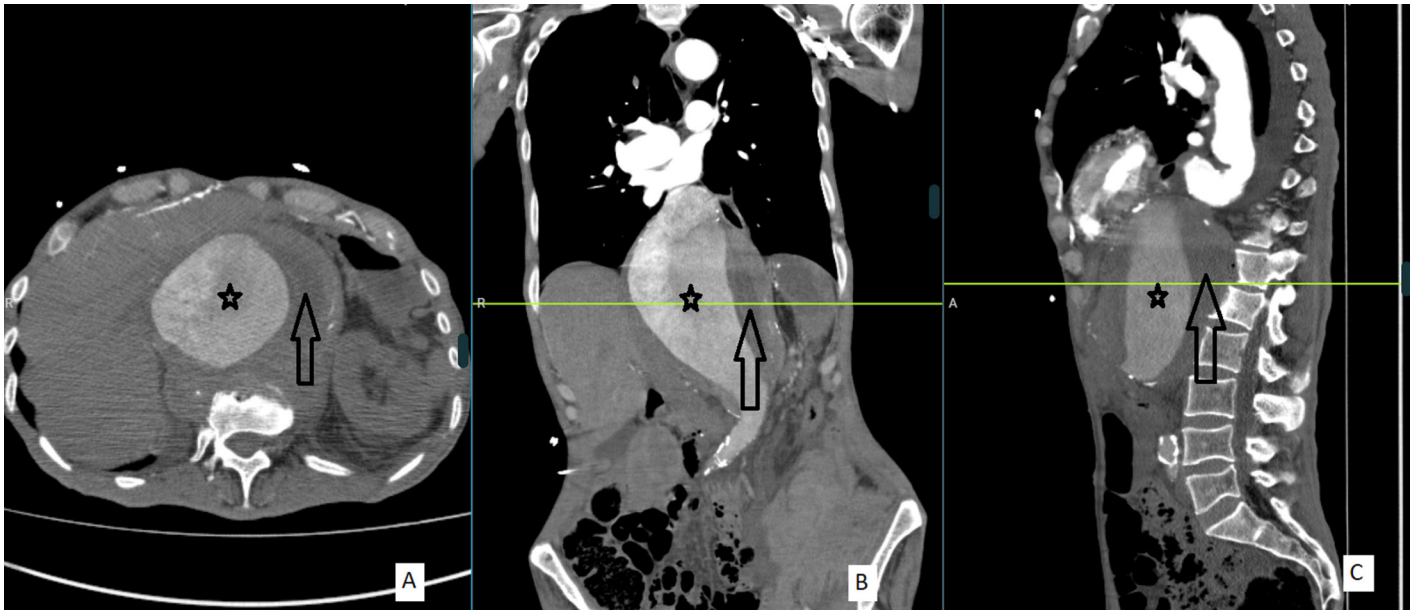

Figure 2. Computed tomography images of an abdominal aortic aneurysm diagnosed as resting in the emergency department. This patient was unsuitable for endovascular intervention and was treated with open surgery. " * " indicates the true lumen, while "→" indicates the thrombosis of aneurysmatic wall.

DISCUSSION

This study investigated the incidental discovery of aortic aneurysms in the emergency department and patients' demographic and clinical characteristics with aneurysms. According to our research findings, the incidence of aortic aneurysms is high in all groups of patients admitted to the emergency department. This increase is also observed in patients presenting with non-traditional risk factors such as malignancy and traffic accidents.

One of the leading causes of cardiovascular mortality and morbidity is aortic aneurysms. Although the treatment is surgical, percutaneous interventional methods have been used, resulting in a dramatic decrease in mortality. The absence of specific symptoms and signs makes diagnosis difficult. It is often detected incidentally. It is, however, one of the most feared and life-threatening situations among the causes of both abdominal and chest pain. Cardiovascular mortality and morbidity are very high in dissection from the aneurysm sac. In this context, an aortic aneurysm belongs to a group of diseases that should not be delayed in both diagnosis and treatment.

In our study, AA was found in 13% of patients who had no previous diagnosis of AA and underwent thoracic CT in the emergency department and in 1.07% of patients who underwent an abdominal examination CT. This rate was about 20% for the thoracic aorta and 1-4.3% for the abdominal aorta in previous publications [1,2,5]. Surgical intervention was performed in 2% of patients with TAA. In two of these patients, endovascular procedures were performed as hybrids, while the other patients were treated with open surgery. Endovascular surgery was performed in 6% of patients with AAA and open surgery in 12%. The operation, which we performed following the literature data, was performed with high success, and there was no hospital mortality or morbidity in either group [6,7].

The thoracic and abdominal aortic diameters have been found to increase with age. Previous research has shown that advanced age is a risk factor for AA [8]. Patients with TAA and AAA were older in our study than patients without AA. Figure 3 depicts the correlation between age and aortic diameters, and it has been demonstrated that advanced age has a significant effect on the change in aortic diameter.

Following the literature, in our study, there was a preponderance of the male gender in patients with an aneurysm. 53.9 of patients with TAA and 68.2% of patients with AAA were male, which was statistically significant (p<0.001) [9]. For this reason, we think that the incidence of AA is high in elderly male patients presenting to the emergency department and that patients in this high-risk group should be screened for aortic aneurysms on admission to the emergency department.

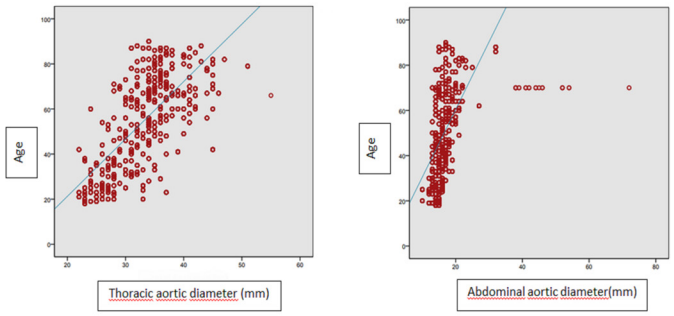

Figure 3. The correlation between age and aortic diameters. Abdominal and thoracic aorta diameters appear to increase with age. The age was higher in the group with aneurysms in the thoracic and abdominal aorta (p<0.001)

41.3% of patients with TAA were hospitalized for respiratory distress, and 45.6% of patients with AAA were hospitalized for poor general health. The main issue attracting attention here is the incidence of AA in patients admitted for reasons such as traffic accident, malignancy, trauma, which cannot be directly linked to aortic aneurysm. Previous studies have shown that AA is often not even considered in patients admitted to the emergency department or overlooked by the reporting unit and even neglected by the clinician if the aneurysm does not extend beyond specific dimensions. In this regard, regardless of the type of application, all patients who present to the emergency department should be evaluated for AA, and appropriate patients should be further investigated.

It was observed that abdominal aortic diameter in patients with TAA and thoracic aortic diameter in patients with AAA were higher than in other patients. This correlation is shown in Table 1. The findings of our investigation are consistent with the literature, which offers a link between TAA and AAA [10]. Therefore, an aneurysm of an aortic segment should be examined for aneurysms in other anatomical localizations.

Atherosclerosis plays the most effective role in the etiology of AA [11]. Diffuse calcifications in the aorta were observed in 63.5% of TAA patients and 100% of AAA patients in our study. (p<0.001). While 2.2% of patients with TAA had abdominal aortic stenosis of less than 30%, 34.8% of patients with AAA had abdominal aortic stenosis of 30-50%. Based on our findings, we believe that patients with aneurysms should receive atherosclerosis treatment and that the progression of atherosclerosis should be stopped. 9.2% of patients with TAA and all patients with AAA received statin therapy. In light of the studies, we recommend using statins to prevent the progression of atherosclerosis and protect against other cardiovascular risk factors in patients with AA [12-14].

The most common AA comorbidities in studies were hypertension, coronary artery disease, diabetes mellitus, chronic obstructive pulmonary disease, and smoking [15]. According to our findings, patients with TAA and AAA frequently have

hyperlipidemia, coronary artery disease, hypertension, diabetes mellitus, and chronic obstructive pulmonary disease, according to our results, which are consistent with the literature. Treatment of comorbidities is critical to reducing mortality and morbidity in these patients [13]. The hospital mortality rate for patients with TAA is 11.3%, which is statistically different from the hospital mortality rate (5.4%) for patients without AA, as shown in our study ($p<0.001$). Similarly, hospital mortality for patients with AAA was 31.8%, while hospital mortality for patients without AA was 4% and statistically different ($p<0.001$). Smoking history was present in 22.7% of patients with TAA and 33.3% of patients with AAA, proving to be statistically significant. Smoking is one of the preventable risk factors, and smoking cessation should be emphasized in these patients due to its effect on cardiovascular risk factors [16].

CONCLUSION

Attention to aortic pathology, especially AA, in the thorax or abdomen CT, in patients presenting to the emergency department allows early diagnosis of patients with aortic aneurysm, and mortality and morbidity can be reduced with necessary treatment in this patient population.

Limitations

Since the study is a retrospective study, other factors causing aortic aneurysm, such as atherosclerosis, need more extensive investigation. Since surgical margins may change in congenital tissue diseases and aortic valve diseases, further evaluation of patients such as cardiac evaluation may be added to the study in future prospective studies.

Ethics Committee Approval: The study protocol adhered to the guidelines stipulated in the Declaration of Helsinki and was approved as an electronic medical record-based retrospective study by the Institutional Review Board of Afyonkarahisar Health Sciences University Hospital (05.05.2020/2011-KAEK-2).

Patient Consent for Publication: Since the study was conducted with a retrospective file review,the requirement for obtaining informed consent from the patients prior to study participation was waived.

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

Author Contributions: All authors contributed equally to the article.

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