

## ORIGINAL RESEARCH

# Diagnostic value of tearing pain alone in aortic dissection

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**Abstract**

Severe and sudden chest or back pain that feels like tearing is the most common symptom of aortic dissection. This study aimed to investigate if chest or abdominal pain alone is a marker of aortic dissection and to determine its patient characteristics. This was a retrospective, single-center observational study. It was conducted in the emergency department (ED) of a tertiary university hospital in Turkey. During three years, patients admitted to the ED and underwent contrast-enhanced thoracic and abdominal computed tomography angiography (CTA) were detected through the hospital computer system. Patients with tearing chest or abdominal pain at admission were identified. Patients with and without aortic dissection were compared based on gender, triage code, comorbidity, aortic aneurysm, and one-month mortality. 76.3% (n = 730) out of 957 CTAs were performed due to complaints of tearing chest or abdominal pain. Aortic dissection was detected in 4.5% (n = 33) of patients with tearing pain. Pre-existing aortic aneurysm was statistically significantly higher in the dissection group ( $p < 0.001$ ). When the chest or abdominal pain and CTA findings regarding the presence of aortic dissection were compared, the sensitivity of tearing pain was 84.62%, and the specificity was 24.07%. The positive predictive value of tearing pain was 4.52%, and the negative predictive value was 97.36%. In conclusion, the negative predictive value of tearing pain for aortic dissection was approximately 97%. This severe pain raises the possibility of aortic dissection. However, aortic dissection is only detected in a small percentage of cases in CTAs performed immediately to confirm the diagnosis.

**Keywords**

Aortic dissection; Tearing pain; Computed tomography angiography; Emergency department

## 1. Introduction

Aortic dissection is a rare but life-threatening condition that requires urgent diagnosis and treatment. Only in the USA 10,000 people are diagnosed with aortic dissection annually. Studies have shown that 20% of dissection patients die before reaching the hospital [1]. Aortic dissection is a challenging clinical condition with high mortality. It is characterized by the separation of the layers forming the aortic wall and blood filling between the intima and media layers. Although the precipitating cause of rupture is unknown, most patients have underlying systemic hypertension or a connective tissue disease that causes a structural abnormality of the aortic wall. Enlargement in the diameter of the aorta, *i.e.*, aortic aneurysm, is also a risk factor for aortic dissection [2]. The most common presenting symptom is pain, observed in more than 90% of patients. 85% of patients say the pain starts suddenly [3–6]. Pain due to aortic dissection is severe, and there is no relief. The pain is a stabbing, cutting, or tearing sensation [5]. Patients present to the emergency department (ED) with an extremely

noisy clinical picture. Care should be taken regarding aortic dissection if the patient is diagnosed with aortic aneurysm, connective tissue disease such as Marfan syndrome, or a family history of aortic dissection. The diagnosis is confirmed by computed tomography angiography (CTA) in patients with characteristic pain and risk factors [7–9].

Patients' complaints of tearing chest or abdominal pain put physicians on high alert for aortic dissection and CTA is often performed rapidly without further investigations. This study aimed to determine whether the complaint of tearing chest or abdominal pain can be used as a predictor of aortic dissection. The secondary aim was to describe the characteristics of patients with tearing chest or abdominal pain.

## 2. Materials and methods

### 2.1 Study design and setting

This is a retrospective, single-center observational study. It was conducted in the emergency department of a tertiary academic university hospital in Turkey with approximately 90,000

admissions per year. All patients ( $n = 957$ ) who presented to the ED between 01 January 2020, and 31 December 2022, and underwent contrast-enhanced thorax or abdomen CTA were identified through the hospital computer system. Among the patients, 730 patients who were admitted to the ED with complaints of tearing and severe chest or abdominal pain were detected. Data for the study were obtained from the hospital computer system and archive records.

Age, gender, triage code, comorbidities, presence of dissection, type of dissection and 1-month mortality outcome were recorded on the study forms. As a triage code, a 3-color scale was used to indicate patient severity: red (emergent), yellow (urgent) and green (non-urgent).

Aortic dissections are classified according to the level of the dissected aorta. De Bakey classification is one of the most commonly used classifications. Patients with dissection were divided into groups according to the De Bakey classification. Cases in which ascending and descending aorta were dissected together were classified as type 1, cases in which only ascending aorta was dissected were classified as type 2, and cases in which only descending aorta was dissected were classified as type 3 [10].

## 2.2 Selection of participants and study protocol

During three years, all patients aged 18 years and older who presented to the ED and underwent thoracic and abdominal CTA were identified by using the hospital computer system. Among these patients, those who presented to the ED with tearing chest or abdominal pain were included in the study. In addition to the pain complaint, the results of the Numerical Rating Scale (NRS) [11], an 11-point ordinal scale ranging from 0 (no pain) to 10 (worst pain imaginable), marked in the patient files, were also evaluated. Those with NRS scores  $>7$  were considered severe pain and included in the study. NRS was  $>7$  points in all patients complaining of tearing pain. We excluded patients with recurrent aortic dissections and those transferred from outside centers for aortic dissection imaging. The characteristics of patients admitted to the ED with stabbing chest or abdominal pain were analyzed. The group with aortic dissection was compared with those without aortic dissection in terms of triage code, gender, presence of comorbid disease and presence of aortic aneurysm.

## 2.3 Statistical analysis

Quantitative data were summarised with mean and standard deviation, and categorical data were summarised with frequency and percentage. Pearson's Chi-square test or Fisher's exact test analyzed the relationship between two categorical variables. The strength of association was evaluated using Cramer's V statistics. Statistical software SPSS version 23 (SPSS Inc., Armonk, NY, USA) was used for these analyses. The significance level was considered as  $p < 0.05$ .

## 3. Results

This study was performed on 957 patients who presented to the ED and underwent contrast-enhanced thoracic and abdom-

inal CTA over a 3-year. Two hundred twenty-seven patients without complaints of tearing chest or abdominal pain were identified. Aortic dissection was detected in 2.64% ( $n = 6$ ) of these patients. It was found that 76.3% ( $n = 730$ ) of the patients who underwent CTA complained of tearing chest or abdominal pain.

Aortic dissection was detected in 4.5% ( $n = 33$ ) of patients admitted with tearing chest or abdominal pain. The sensitivity and specificity of tearing chest or abdominal pain for aortic dissection were 84.62% and 24.07%, respectively. The positive predictive value of tearing pain was 4.52%, and the negative predictive value was 97.36%.

When 730 patients with tearing pain were evaluated, the mean age of the patients was  $58.79 \pm 15.95$  years, and 54.5% ( $n = 398$ ) were male. When the triage codes were analyzed, it was found that 76.3% ( $n = 557$ ) of the patients had a yellow triage code, and 23.7% ( $n = 173$ ) had a red triage code. Aortic dissection was detected in 4.5% ( $n = 33$ ) of the patients in CTA reports. When the patients with dissection were analyzed according to the De Bakey classification, 27.3% ( $n = 9$ ) were type 1, 12.1% ( $n = 4$ ) were type 2 and 60.6% ( $n = 20$ ) were type 3. When CTA reports of patients presenting with tearing chest or abdominal pain were analyzed in terms of aortic aneurysm, 6.4% ( $n = 47$ ) of the patients had a previous diagnosis of aortic aneurysm. At least one comorbid disease was observed in 76.6% ( $n = 559$ ) of patients with severe chest or abdominal pain. The most common comorbid disease was hypertension, with 60.7% (Table 1).

When the patient group was analyzed regarding the diagnoses made at the ED admission, it was observed that 66% ( $n = 482$ ) of the patients did not get any diagnosis. Acute coronary syndromes were the most common diagnosis made as a result of ED presentation with tearing chest or abdominal pain with 10.3% ( $n = 75$ ). 2nd most common diagnosis was pneumonia with 5.2% ( $n = 38$ ), and 3rd most common diagnosis was aortic dissection with 4.5% ( $n = 33$ ) (Table 2).

Patient groups with and without aortic dissection were compared in terms of gender, triage code, comorbidity, and aortic aneurysm presence. No statistically significant difference was found between the groups regarding triage code, gender, or presence of comorbidity. Pre-existing aortic aneurysm was statistically significantly higher in the dissection group, and the strength of association was strong ( $p < 0.001$ , Cramer's V: 0.35) (Table 3).

## 4. Discussion

Rapid diagnosis of aortic dissection is critical to reduce the high mortality rates associated with this condition. However, this is still challenging in the ED due to its rarity and sometimes nonspecific clinical manifestations. Despite advances in technology and surgical techniques, mortality rates are quite high [6, 12–14]. In dissections involving the ascending aorta, 40% of patients die within the first hours. After 48 hours, mortality increases to over 50% [15]. With appropriate surgical methods, mortality in dissections involving the ascending aorta decreases to around 20%. In medically followed-up patients, mortality rates are still about 60%. In 90% of patients with type 1 and type 2 dissections, surgical treatment is performed.

**TABLE 1. Characteristics of patients who admit to emergency department with tearing chest or abdominal pain.**

Features	n (%)
Triage code	
Yellow	557 (76.3)
Red	173 (23.7)
Gender	
Male	398 (54.5)
Female	332 (45.5)
Age, years	
Mean ± standard deviation	58.79 ± 15.95
Aortic Dissection	
Yes	33 (4.5)
No	697 (95.5)
Dissection Type (De Bakey Classification)	
Type 1	9 (27.3)
Type 2	4 (12.1)
Type 3	20 (60.6)
Presence of Aortic Aneurism	
Yes	47 (6.4)
No	683 (93.6)
Having Comorbidity	
Yes	559 (76.6)
No	171 (23.4)
Comorbidities	
Hypertension	443 (60.7)
Diabetes Mellitus	197 (27.0)
Coronary Artery Diseases	277 (37.9)
Hearth Failure	75 (10.3)
Cronic Renal Failure	24 (3.3)
Malignities	59 (8.1)
Cronic Obstructive Lung Disease	101 (13.8)
Psychiatric Disases	78 (10.7)
Stroke	6 (0.8)
Hyperlipidemies	200 (27.4)
Mortality	
No	17 (51.5)
First 24 h	6 (18.2)
24 h–1 mon	5 (15.2)
>1 mon	5 (15.2)

**TABLE 2. Diagnosis of patients who admits to emergency department with tearing chest or abdominal pain after computed tomography angiography.**

Diagnosis	n (%)
Normal findings	482 (66.0)
Acute Cholecystitis	13 (1.8)
Ileus	4 (0.5)
Pneumothorax	1 (0.1)
Acute Pancreatitis	5 (0.7)
Appendicitis	7 (1.0)
Rib Fractures	1 (0.1)
Cholelithiasis	2 (0.3)
Acute Coronary Syndrome	75 (10.3)
Pulmonary Edema	26 (3.6)
Pneumonia	38 (5.2)
Aortic Aneurism	24 (3.3)
Mesenteric Ischaemia	4 (0.5)
Pulmonary Embolism	13 (1.8)
Aortic Dissection	33 (4.5)
Renal Infarction	2 (0.3)

**TABLE 3. Comparison of groups with and without aortic dissection in terms of triage code, gender, having comorbidity and presence of aortic aneurysm.**

Features	Aortic Dissection (n = 33)	No Dissection (n = 697)	p value
Triage code			
Yellow	27 (81.8%)	530 (76%)	0.446
Red	6 (18.2%)	167 (24%)	
Gender			
Male	20 (60.6%)	378 (54.2%)	0.472
Female	13 (39.3%)	319 (45.8%)	
Having Comorbidity			
Yes	28 (84.8%)	531 (76.2%)	0.251
No	5 (15.2%)	166 (23.8%)	
Presence of Aortic Aneurism			
Yes	15 (45.5%)	32 (4.6%)	<0.001
No	18 (54.5%)	665 (95.4%)	

*p value was calculated by Pearson Chi Square test. p < 0.05 indicates a significant statistical difference.*

In type 3 dissections in which the distal part of the aorta is affected, the mortality rate is around 10%. Medical and endovascular treatments are frequently preferred over surgery in type 3 dissections [6]. In our study, 41% ( $n = 16$ ) of the patients with aortic dissection died. Since dissection surgery cannot be performed in our hospital, patients with surgical indications are referred to appropriate hospitals. When it comes to saving lives, every moment counts. Delays in determining the proper hospital and transferring the patient can have devastating consequences. We must take every precaution to minimize this delay and ensure patients receive the care they need as quickly as possible.

In studies in the literature, the majority of patients with aortic dissection were found to be men [3, 6, 13, 16]. Our study obtained similar results to the literature regarding gender ratios. Hypertension, one of the most common causes of aortic dissection, is frequently observed in men [3, 6]. One of the critical reasons for the higher prevalence of aortic dissection in men is the higher prevalence of hypertension compared to women.

Studies indicate that pain is the most common symptom of aortic dissection. Studies have reported that approximately 90% of patients presenting with aortic dissection have tearing chest or abdominal pain [3, 6, 13]. In our study, 85% ( $n = 33$ ) of 39 patients with aortic dissection presented with tearing chest or abdominal pain. When tearing pain was compared with CTA as a diagnostic criterion, sensitivity and specificity were found to be 85% and 24%, respectively. The negative predictive value of tearing pain for dissection was about 97%. With this result, we can state that patients without tearing pain most probably do not have aortic dissection, but it is impossible to say that there is no dissection if there is no pain.

In our study, all patients presenting with tearing pain were admitted to the ED with a yellow or red triage code. When the final diagnosis was analyzed at the end of the evaluation, 66% of the patients were discharged from the ED without any diagnosis. Pain, a symptom of many diseases, is a personal feeling. The threshold of feeling pain and the reaction to pain may differ. Pain scales are used to show the intensity of the pain felt [17, 18]. Pain scales help measure the increase or decrease in the pain felt. They can compare the pain of the person with the pain they felt a while ago. No method can objectively measure how much pain a person who says they have severe pain has. Patients presenting to the emergency department may exaggerate their complaints to be taken seriously or reach the physician quickly. Performing triage by experienced personnel, examining the patients' vital signs in detail during triage, and performing electrocardiogram examination at the triage stage may prevent crowding in the yellow and red areas. Further studies on this subject will contribute to the literature.

The presence of aortic aneurysm is considered as a risk factor for dissection. A study showed that 13% of patients diagnosed with aortic dissection had a known aortic aneurysm before dissection. In the study, the history of aneurysm increased up to 19% in dissection patients under the age of 40 years [19]. Another study showed that 20.7% of patients with descending aortic dissection and 12.7% with ascending aortic dissection had a known aortic aneurysm [3]. In our study, when

the groups with and without aortic dissection were compared in terms of aortic aneurysm, aortic aneurysm was found to be statistically significantly higher in the group with dissection.

In our study, 957 patients underwent contrast-enhanced thoracic and abdominal CTA for various reasons within three years, and 730 of these CTAs were performed because of tearing chest or abdominal pain. When the files were analyzed, it was observed that none of these 957 patients underwent transthoracic echocardiography (TTE) or ultrasonography (USG) before CTA. Studies have shown that TTE and USG examinations successfully diagnose aortic dissection. TTE is particularly successful in evaluating the aortic root and proximal ascending aorta. It is also adequate for assessing various aortic segments, including the arcus, proximal descending aorta, and abdominal aorta. USG can be used for bedside examination, is suitable for repeated examination and can directly and dynamically observe the movement of flaps within the aorta. Color Doppler ultrasound can visualize abnormal blood flow in the true and false lumen of the ruptured aorta. The flow in the true lumen is faster, while the flow in the false lumen is slower. When thrombosis occurs in the false lumen, the blood flow signal disappears. Color Doppler ultrasonography can also determine the location of partial aortic rupture, which is clinically meaningful [20–22]. Our study found aortic dissection in only 4.5% of patients with tearing chest or abdominal pain. Patients who describe tearing pain tend to have contrast-enhanced CTA performed rapidly by ED physicians because of a possible diagnosis of dissection. Contrast-enhanced CTA is not harmless because of the radiation exposure and the possibility of renal damage due to the contrast agent administered. Many CTAs increase the economic burden on the healthcare system and the damage caused to society by aortic dissections. The quality of care may improve if the physician prioritizes patient-centered care in ordering imaging and informs the patient about the benefits and harms of imaging [23]. After clinical evaluation, it would be more appropriate to evaluate patients with suspected dissection, primarily with TTE and USG. If dissection is still suspected, CTA imaging should be performed. Routine use of ultrasound in emergency departments, especially in critical diagnoses, is guiding the physician.

Our study had some limitations. The first was that it was retrospective. The second was that it was single-centred. Third, a documented chest pain score was not used in the files of patients presenting with severe tearing pain at the center where the study was conducted. Finally, different presenting parameters (blood pressure, heart rate, sensorium, *etc.*) and laboratory parameters were excluded from the scope of the study, and only the diagnostic value of symptom severity for aortic dissection was considered.

## 5. Conclusions

The most common symptom of aortic dissection is severe pain. The negative predictive value of tearing pain for dissection is 97.36%. In CTAs performed to rule out aortic dissection in patients complaining of tearing pain in the chest or abdomen, the incidence rate is less than 5%, considering that aortic dissection is already rare. Further studies, including parameters

such as vital signs and clinical features, are needed to reduce over-imaging and costs for the diagnosis of aortic dissection in patients with severe tearing pain.

## AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

## AUTHOR CONTRIBUTIONS

EŞ—designed the study, analyzed the data, wrote the original draft, reviewed and edited. KS—designed the study, collected and analyzed the data, wrote the original draft, and reviewed it. MCD—designed the study, analyzed the data, wrote the original draft, supervised, reviewed, and edited. HG—collected the data and reviewed it. All authors read and approved the final manuscript.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was initiated in the emergency department of a university hospital following the Duzce University Non-Invasive Health Research Ethics Committee approval with decision number 2023/92, Date: 05 June 2023. Informed consent was waived owing to the retrospective nature of the study. The study was conducted in compliance with the principles of the Declaration of Helsinki.

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## CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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