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IMAGING ESSAY

Limited Aortic Intimal Tears: CT Imaging Features and Clinical Characteristics

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Limited aortic intimal tear is an uncommon lesion of the dissection spectrum. The lesion has several imaging features that are not well known, including asymmetric aortic contour abnormalities, filling defects, and various morphologic patterns, such as linear, L-shaped, T-shaped, and stellate configurations. Hemorrhage of the aortic wall may also be present in patients with this rare entity. This imaging essay reviews the CT imaging findings and clinical characteristics of patients with limited intimal tears.

Limited intimal tear (LIT) of the thoracic aorta is an uncommon aortic lesion that represents a type of acute aortic syndrome. In 1973, this lesion was characterized in an autopsy series as incomplete dissection or laceration of the intima and subjacent media without substantial dissection of blood into the media (1). Medial tissue at the base of the bare area that forms after edge retraction can exhibit focal bulging. A limited number of case reports were published thereafter, often characterized as "spontaneous" or "nontraumatic aortic tear" (2–5).

Discussion of this lesion reemerged in the literature in 1999 after Svensson and colleagues (6) reported nine of 181 patients who underwent multimodality imaging prior to ascending or aortic arch repair with subtle aortic tears. The authors proposed intimal tear without hematoma as a variant of aortic dissection (6). Subsequently, this lesion has been classified as a class 3 intimal tear (subtle or discrete aortic dissection) by the Task Force on Aortic Dissection of the European Society of Cardiology in 2001 (7) and as a class 3 intimal tear or limited dissection by the multidisciplinary American College of Cardiology Foundation and American Heart Association Task Force in 2010 (8). However, many clinicians remain unaware of this entity.

The purpose of this imaging essay is to provide an updated and focused review of this rare aortic lesion, with emphasis on its CT imaging and clinical characteristics.

Patients and Clinical History

This imaging essay is based on a retrospective single-institution study at Stanford University of patients with limited thoracic aortic tears. The study was approved by the institutional review board, and written informed consent was waived because of the retrospective nature of the study and anonymized data analysis. We expanded a prior study spanning from 2003 to 2012 in 24 patients (9), which now spans the years 2003 to 2020 and includes an additional 18 patients. The current study also reports the prevalence of presenting clinical symptoms and describes new tear morphologic patterns.

Forty-two patients with acute limited intimal thoracic aortic tears were identified between January 2003 and November 2020 at Stanford University. Patients with limited intimal aortic tears were identified via either retrospective review of images from CT angiography (CTA) in the picture archiving and communication system by a cardiovascular radiologist or review of clinical radiology reports predominately dictated by cardiovascular radiologists. CTA images corresponding with LITs identified from radiology reports were directly rereviewed by a cardiovascular radiologist (M.H.M., with 7 years of experience in radiology) to confirm the presence of LIT. Patients with LITs comprised approximately 4% of the total patient population with acute aortic syndromes during this period at the institution; this prevalence was derived from registries containing patients with classic aortic dissection, penetrating atherosclerotic ulcer (PAU), intramural hematoma (IMH), iatrogenic aortic dissection, and rupturing thoracic aortic aneurysm, which were previously collected at the institution via imaging and electronic medical record review.

Table 1 shows characteristics of the included patients. The majority of patients with LITs (36 of 42, 86%) had an underlying medical history of hypertension. A history of documented atherosclerosis defined as coronary artery disease, stroke, or peripheral artery disease was noted in 17 of 42 patients. Presenting clinical symptoms in the 42 patients were chest pain or discomfort (n = 28), abdominal pain (n = 1), back pain (n = 4), dyspnea or shortness of breath (n = 2), chest pain or discomfort with abdominal or back pain (n = 4), jaw pain (n = 1), and hemoptysis (n = 1), and one patient was asymptomatic. Two patients had a history of Marfan syndrome, and four additional patients had another connective tissue disease or vasculopathy (*ACTA* genetic aortopathy, IgG4 aortitis, Behcet disease, connective tissue disease not specified).

Abbreviations

CTA = CT angiography, IMH = intramural hematoma, LIT = limited intimal tear, PAU = penetrating atherosclerotic ulcer

Summary

This imaging essay reviews the clinical and CT angiographic imaging findings in patients with limited aortic intimal tears to improve awareness and understanding of this rare aortic lesion.

Key Points

- Acute limited intimal tear (LIT) of the aorta is a rare entity that manifests as an acute aortic syndrome.
- LITs demonstrate subtle asymmetric bulging, filling defects, distinctive tear configurations, and associated vascular findings at imaging.
- Prognosis of patients with LITs appears to resemble that of other acute aortic syndrome types, excluding rupturing thoracic aortic aneurysm.

Keywords

Aorta, CT

Imaging Features

Morphologic patterns of the LITs at CTA were classified into several categories: linear, stellate, T-shaped, or L-shaped (Fig 1). Orientation of the tears was categorized as circumferential if located perpendicular to the long axis of the aorta or longitudinal if parallel. When there was more than a single tear in one direction, circumferential versus longitudinal tear was determined using the more dominant tear component. An intimal tear involving the ascending thoracic aorta was defined as a type A lesion, while a lesion not involving the ascending thoracic aorta was defined as type B. LIT was considered distinct from pseudoaneurysm, as pseudoaneurysm reflects a breach of most of the aortic wall, is contained by adventitia or periadventitial tissue only, can have a narrow neck, and typically has a more prominent saccular outpouching compared with limited aortic intimal tear, whose eccentric bulging can be more subtle.

Most configurations were linear (19 of 42, 45%), followed by stellate (10 of 42, 24%), T-shaped (nine of 42, 21%), and L-shaped (three of 42, 7%); CT examples (Figs 2–5), additional representative LITs (Figs 6, 7), and ancillary imaging findings (Fig 8) are provided. Roughly half of the tears were circumferential, and the remainder were longitudinal. LITs were predominately type A lesions (31 of 42, 74%) versus type B (11 of 42, 26%). Median length of the focal linear filling defect associated with tears measured 25 mm. All patients had an aortic bulge or outpouching of the residual aortic wall at the base of the intimal defect. Median length and width of the tears measured 38.5 mm and 19.0 mm, respectively. The median aortic diameter at the site of intimal tear was 52.0 mm (range, 42.0–58.3 mm).

Of the 42 patients with LITs, 32 had an associated vascular finding defined as classic aortic dissection, IMH, or PAU. IMH was the most common, present in 29 of 42 (69%) patients (Table 2). Patients with associated vascular findings were older, had greater prevalence of atherosclerosis, and had shorter intimal tears. Pleural and pericardial effusions were the most common additional imaging findings, occurring in 18 of 42 (43%) and 15 of 42 (36%) patients, respectively. Hemopericardium occurred in 12 of the 42 patients, and mediastinal or periaortic hematoma occurred in eight patients. Branch vessel malperfusion and aortic rupture were rare, occurring in only one and three patients, respectively.

LITs were detected in nine of 26 patients (35%) who underwent echocardiography at presentation; eight had type A tears, and one had a type B tear.

Management and Outcomes

Eleven of the 42 total patients (26%) underwent medical or nonoperative management. Seven of these patients had type A tears, and four had type B tears. Twenty-nine of 42 patients underwent interventional procedures comprising surgical (n = 22), endovascular (n = 4), or hybrid surgical-endovascular (n = 3) approaches. Most of these patients (23 of 29) had type A LITs, and six patients had type B tears. For the remaining two patients from the study sample, one underwent medical management in addition to subxiphoid pericardial window for evacuation of hemopericardium. The other patient was evaluated for potential endovascular treatment but decided to receive close follow-up at an outside medical facility; however, information regarding this follow-up was not available in the electronic medical record.

Medial degeneration was found in most patients (18 of 20) who had aortic specimens sent for pathologic evaluation. Seven of 42 patients had postoperative complications, which included anastomotic pseudoaneurysms (n = 2), iatrogenic transection of the innominate artery from the aorta during aortic arch repair (n = 1), mild pericardial para-anastomotic oozing (n = 1), type 3 endoleaks (n = 2), and large mediastinal air-containing fluid collection (n = 1).

Three of 42 patients (7%) had repeat acute aortic syndrome or propagation of dissection. Specifically, one patient with prior type A LIT had extension of IMH with dissection into the left common carotid artery origin, another patient with prior type A LIT had a new LIT in the proximal descending thoracic aorta, and a patient with prior type B LIT had a new type A dissection in the distal ascending thoracic aorta and proximal arch. The events occurred 10, 16, and 1991 days, respectively, following the initial presentation.

Seven of 42 patients with LITs died, with a median interval time from initial presentation of 367 days (range, 1 to 1998 days). This cohort comprised individuals with type A LIT and associated type A IMH (n = 5), type A LIT with associated type B IMH (n = 1), and type B LIT with associated classic type A aortic dissection (n = 1). Causes of death included septic shock resulting in renal failure and respiratory failure related to pneumonia (n = 1), pulseless electrical activity arrest following iatrogenic innominate artery transection from the aorta during arch repair for LIT (n = 1), respiratory failure with stroke and myocardial infarction in the setting of a type A LIT (n = 1), and unknown cause (n = 4) on account of insufficient information in the electronic medical record. Kaplan-Meier survival analysis was performed to evaluate 30-day and 5-year survival for patients with LITs compared with patients with other acute aortic syndromes from a previous cohort (9). Overall patients

Table 1: Characteristics of Total LIT Cohort and LIT with and without Additional Vascular Findings

Parameter	Total (n = 42)	LIT without Additional Vascular Findings (n = 10)	LIT with Additional Vascular Findings (n = 32)	P Value
Demographics				
Age (y)	69 (53–80)	50 (39–58)	75 (60–81)	.003*
Men	25 (60)	6 (60)	19 (59)	>.99†
Race and ethnicity				.22†
African American, non-Hispanic	1 (2)	0 (0)	1 (3)	
Asian, non-Hispanic	8 (19)	3 (30)	5 (16)	
Native Hawaiian or Pacific Islander, non-Hispanic	1 (2)	0 (0)	1 (3)	
White, Hispanic or Latino	3 (7)	2 (20)	1 (3)	
White, non-Hispanic	29 (69)	5 (50)	24 (75)	
Risk factors				
Hypertension	36 (86)	7 (70)	29 (91)	.14†
Hypercholesterolemia	18 (43)	3 (30)	15 (47)	.47†
Atherosclerosis	17 (40)	1 (10)	16 (50)	.03†
Active tobacco use	18 (43)	5 (50)	13 (41)	.72†
Connective tissue disease (CTD)	5 (12)	2 (20)	3 (9)	.58†
Marfan syndrome	1/5 (20)	0/2 (0)	1/3 (33)	
Other CTD or vasculopathy	4/5 (80)	2/2 (100)	2/3 (67)	
Redissection	10 (24)	2 (20)	8 (25)	>.99†
Tear and LIT characteristics				
Type				.25†
Type A	31 (74)	9 (90)	22 (69)	
Type B	11 (26)	1 (10)	10 (31)	
Shape of tear				.06†
Linear	19 (45)	7 (70)	12 (38)	
L-shaped	3 (7)	1 (10)	3 (9)	
T-shaped	9 (21)	0 (0)	8 (25)	
Stellate	10 (24)	1 (10)	9 (28)	
Linear and T-shaped	1 (2)	1 (10)	0 (0)	
Tear length (mm)	38.5 (22.0–65.3)	80.0 (33.8–109.8)	34.5 (21.3–54.3)	.02*
Tear width (mm)	19.0 (8.8–26.3)	22.5 (5.8–37.3)	18.5 (9.0–24.3)	.44*
Tear orientation				.72†
Longitudinal	20 (48)	4 (40)	16 (50)	
Circumferential	22 (52)	6 (60)	16 (50)	
Focal linear filling defect (mm)	25.0 (11.5–33.5)	29.0 (19.3–37.0)	17.0 (11.0–33.0)	.33*
Aortic diameter at site of LIT (mm)	52.0 (42.0–58.3)	48.0 (43.0–55.0)	52.0 (40.0–59.8)	.53*
Other imaging findings				
Pleural effusion	18 (43)	4 (40)	14 (44)	>.99†
Pericardial effusion	15 (36)	4 (40)	11 (34)	>.99†
Mediastinal or periaortic hematoma	8 (19)	1 (10)	7 (22)	.66†
Hemothorax	4 (10)	2 (20)	2 (6)	.24†
Hemopericardium	12 (29)	3 (30)	9 (28)	>.99†
PA subadventitial hematoma	7 (17)	0 (0)	7 (22)	.17†
Aortic rupture	3 (7)	1 (10)	2 (6)	>.99†
Branch vessel malperfusion	1 (2)	0 (1)	1 (3)	>.99†

(Table 1 *continues*)

Table 1 (*continued*): Characteristics of Total LIT Cohort and LIT with and without Additional Vascular Findings

Parameter	Total (n = 42)	LIT without Additional Vascular Findings (n = 10)	LIT with Additional Vascular Findings (n = 32)	P Value
Follow-up				
Follow-up (d)	488.0 (54.0–1748.3)	935.0 (28.3–1868.8)	441.5 (67.5–1629.5)	.61*
Death, total	9 (21)	0 (0)	9 (28)	.09†
Death, 30 days	2 (5)	0 (0)	2 (6)	>.99†
Death, 3 months	3 (7)	0 (0)	3 (9)	>.99†
Death, 1 year	4 (10)	0 (0)	4 (13)	.56†
Death, 5 years	7 (17)	0 (0)	4 (13)	.56†

Note.—Values are medians with interquartile ranges in parentheses, numbers with percentages in parentheses, or ratios with percentages in parentheses. The source of the race and ethnicity classification was the electronic health record. Branch vessel malperfusion is defined as left lower extremity arterial ischemia (occlusion of the left common iliac artery) and superior mesenteric artery false lumen thrombosis. LIT = limited intimal tear, PA = pulmonary artery.
*Comparison of continuous variables was performed using Mann-Whitney U test ($P < .05$ considered significant).
†Comparison of proportions was performed using the Fisher-Freeman-Halton exact test ($P < .05$ considered significant).

with LITs appeared to have similar 30-day and 5-year survival compared with patients with classic aortic dissection, IMH, and PAU, with ruptured aortic aneurysm having the worst prognosis of all groups (Fig 9).

Summary

LITs are rare lesions representing subtle aortic tears that can show aortic bulges and filling defects with different tear configurations. We describe new morphologic patterns of limited aortic tears, consisting of L-shaped and T-shaped tears in addition to the previously published linear and stellate forms (6,10). LITs may occur at various sites within the thoracic aorta and may be associated with hemorrhage involving the aortic wall. Chest pain or discomfort is the most common presenting symptom in these patients, with hypertension and possibly connective tissue disease or other vasculopathy as risk factors. Thirty-day and 5-year survival of patients with LIT in our study appeared similar to rates of other acute aortic syndromes, specifically classic dissection, IMH, and PAU, supporting that this lesion belongs within the dissection spectrum. Most patients who died in our study had type A limited tears and associated IMHs at presentation. We also found that three patients developed repeat acute aortic syndrome or dissection propagation, a complication that has not yet been fully recognized.

This lesion can be challenging to diagnose, thus requiring attentiveness on behalf of the imager. A subtle asymmetric contour abnormality of the aorta may be a clue to aid lesion detection. High-quality CT acquisition, as well as postprocessed three-dimensional volume rendering or endoluminal aortic views will also help to solidify diagnosis. We suspect that this lesion may reflect underlying cystic medial degeneration, as this finding is frequently observed following pathologic analysis of surgical specimens from our patients. In conclusion, it is important to strengthen understanding of the clinical and imaging findings associated with this rare, yet potentially life-threatening aortic lesion to improve diagnosis and treatment.

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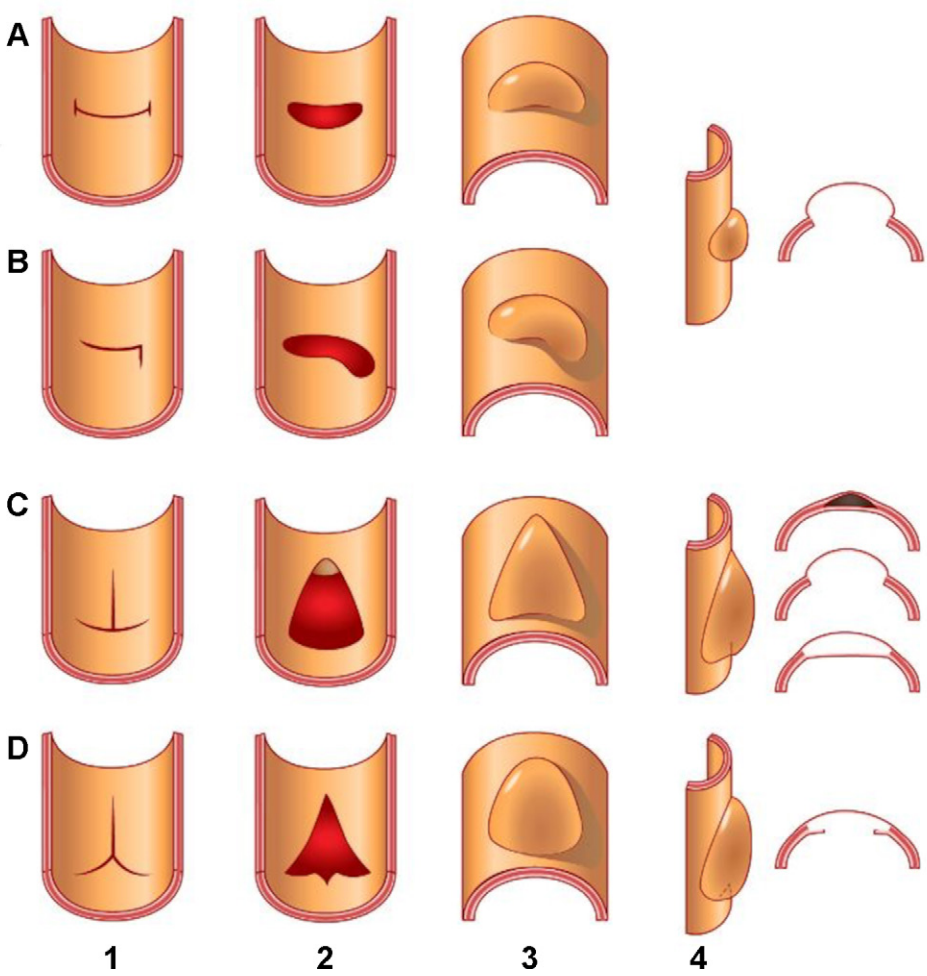

Figure 1: Drawings of limited aortic intimal tear configurations. **(A)** Linear, **(B)** L-shaped, **(C)** T-shaped, and **(D)** stellate tear configurations within endoluminal (1–2) and external surface (3–4) views of the aorta. Linear tear represented a tear in a single plane or orientation. L-shaped tear reflected a linear tear with an additional tear plane oriented at the end and perpendicular to the linear tear. T-shaped tear had an additional tear plane oriented at the mid segment and perpendicular to a linear tear plane. Stellate tear represented a star-shaped configuration.

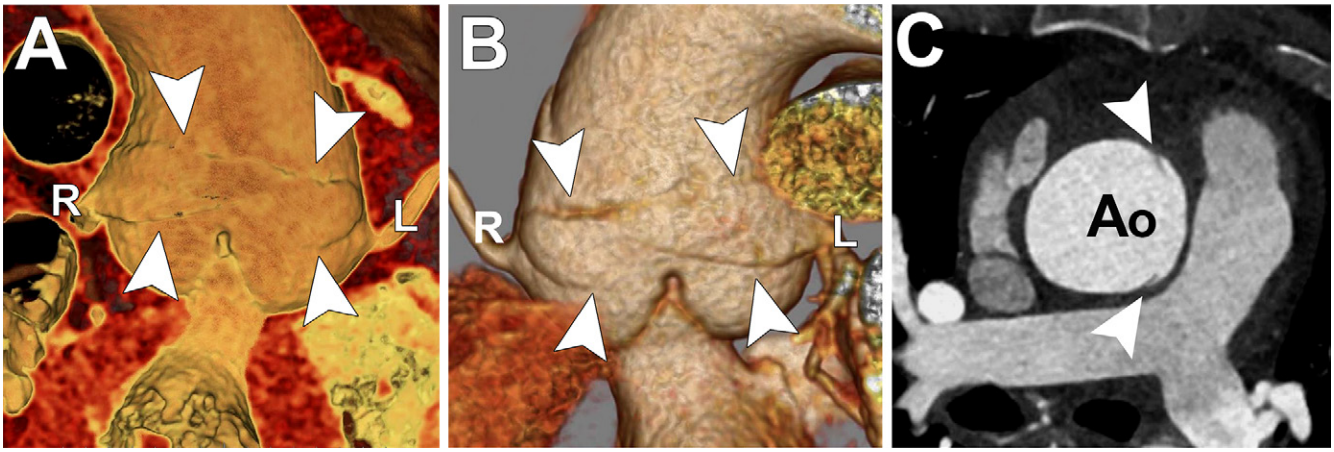

Figure 2: Linear-shaped limited intimal tear (LIT). **(A)** Blood-pool inversion volume-rendered endoluminal CT image shows ovoid, linear type A LIT in the aortic root (arrowheads). Note proximity to the left (L) and right (R) coronary arteries. **(B)** Volume-rendered CT image of external surface of the aortic root demonstrates linear defect (arrowheads) spanning the distance between the left (L) and right (R) coronary arteries. **(C)** Axial contrast-enhanced CT angiographic image of the ascending thoracic aorta (Ao) shows focal linear filling defects (arrowheads) representing the undermined edges of the tear.

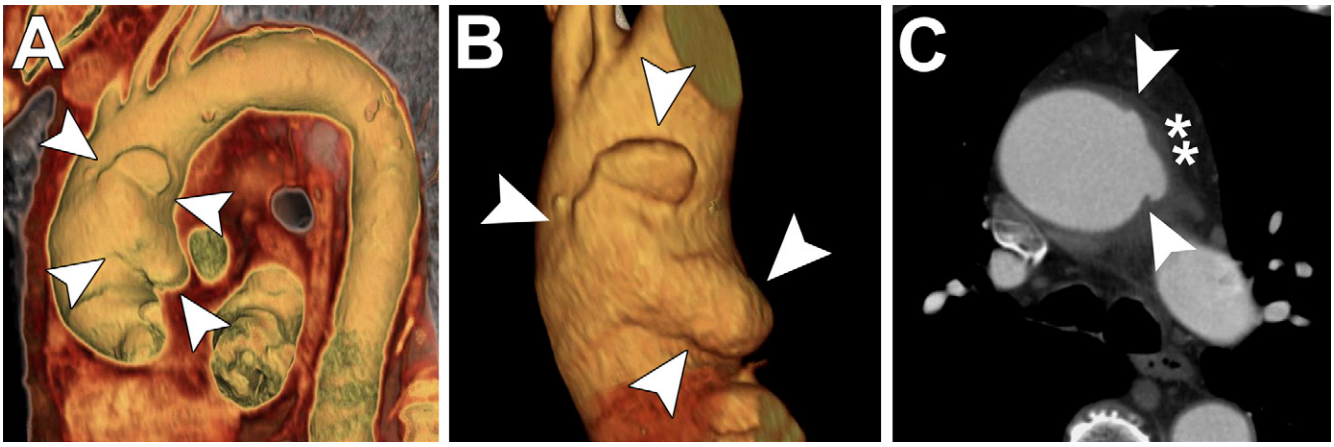

Figure 3: L-shaped limited intimal tear (LIT). **(A)** Blood-pool inversion volume-rendered endoluminal CT image shows type A LIT with L-shaped configuration in the ascending thoracic aorta (arrowheads). **(B)** Volume-rendered CT image of external surface of ascending aorta shows the tear (arrowheads). **(C)** Axial contrast-enhanced CT angiographic image demonstrates undermined edges of the tear (arrowheads), with focal outpouching of the remaining aortic wall (**).

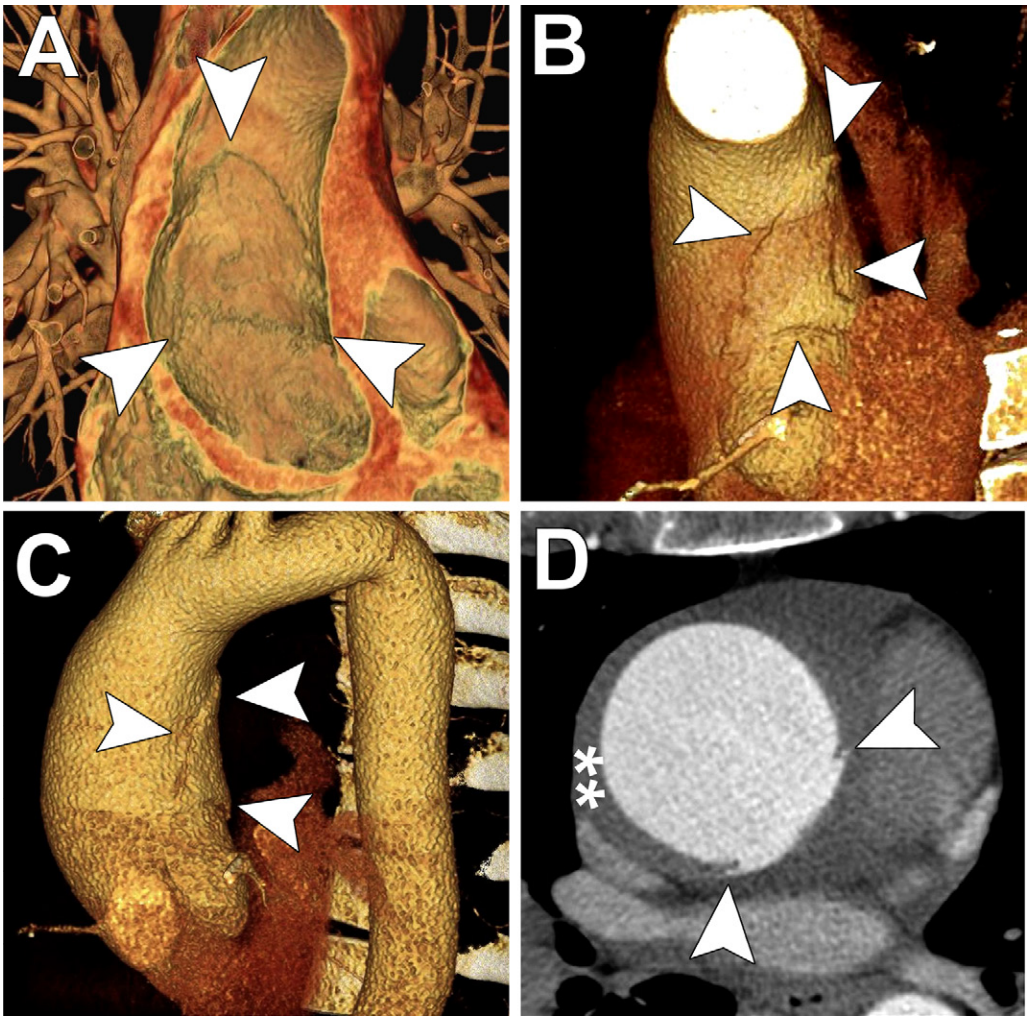

Figure 4: T-shaped limited intimal tear (LIT). **(A)** Blood-pool inversion volume-rendered endoluminal CT image shows type A LIT with T-shaped tear vector, resulting in a triangular tear pattern (arrowheads). **(B)** Volume-rendered CT image of external surface shows the tear (arrowheads). **(C)** Volume-rendered CT image shows focal outpouching between the undermined edges of the LIT (arrowheads). **(D)** Axial contrast-enhanced CT angiographic image demonstrates elongated undermined edges (arrowheads). A portion of an associated intramural hematoma is also demonstrated (**).

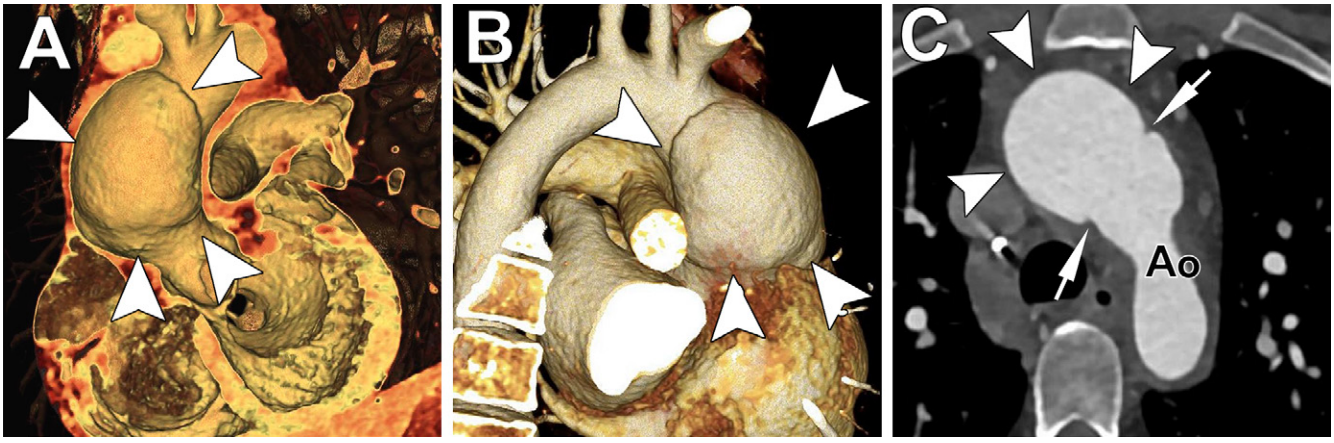

Figure 5: Stellate-shaped limited intimal tear (LIT). **(A)** Blood-pool inversion volume-rendered endoluminal CT image shows type A LIT with stellate tear vector, resulting in large ovoid defect (arrowheads). **(B)** Volume-rendered CT image of external surface shows large ovoid bulge (arrowheads) representing the remaining media and adventitia within the LIT. **(C)** Axial contrast-enhanced CT angiographic image demonstrates undermined edges (arrows) at the LIT in the proximal transverse aorta (Ao). Large bulge anteriorly between the edges represents the residual aortic wall (arrowheads).

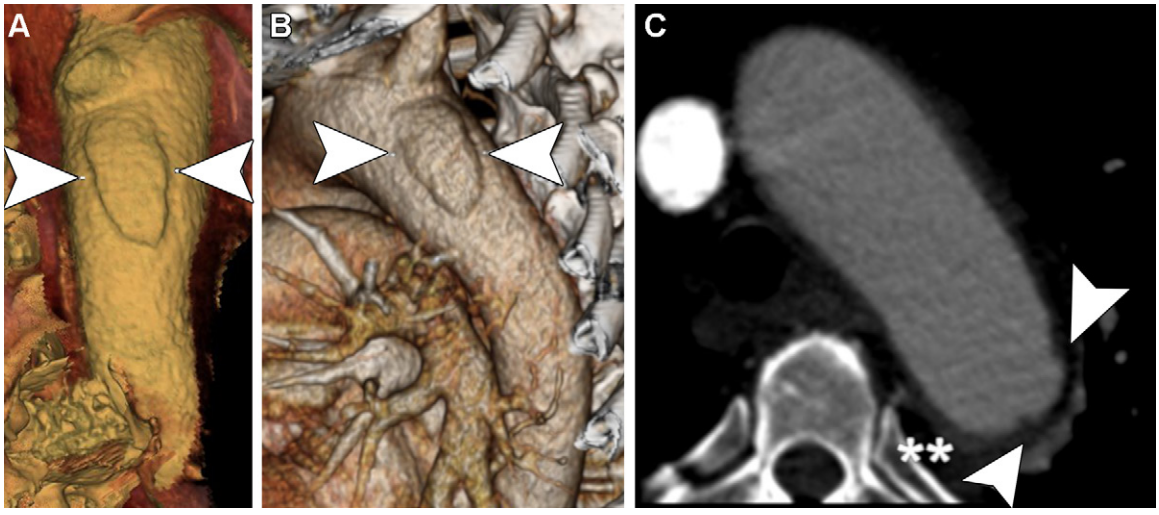

Figure 6: Limited intimal tear (LIT) of descending thoracic aorta with intramural hematoma. **(A)** Blood-pool inversion volume-rendered endoluminal CT image shows type B LIT (arrowheads) of the proximal descending thoracic aorta. **(B)** Volume-rendered CT image of external surface shows the tear (arrowheads). **(C)** Axial contrast-enhanced CT angiographic image of type B LIT (arrowheads) and intramural hematoma (**).

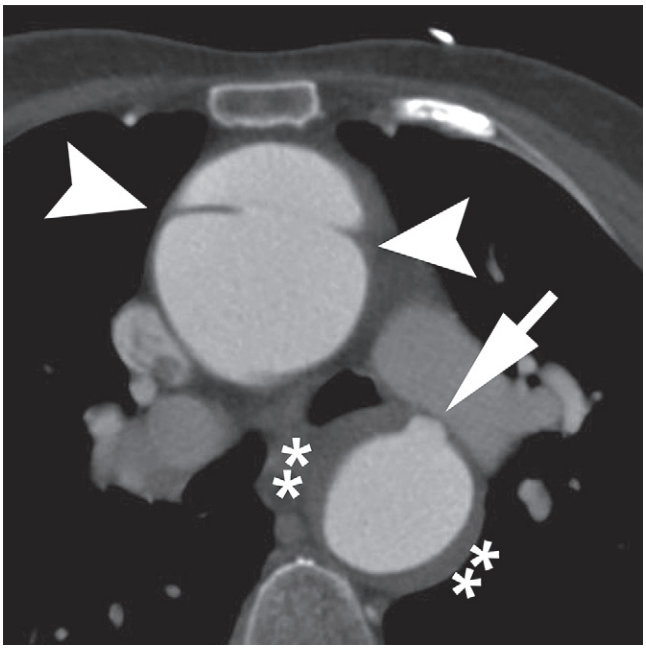

Figure 7: Limited intimal tears (LITs) and intramural hematoma (IMH). Axial contrast-enhanced image from CT angiography demonstrates LIT with focal bulge in the ascending thoracic aorta (arrowheads), as well as LIT (arrow) and IMH (**) in the descending thoracic aorta. IMH was hyperattenuated on noncontrast imaging (not shown).

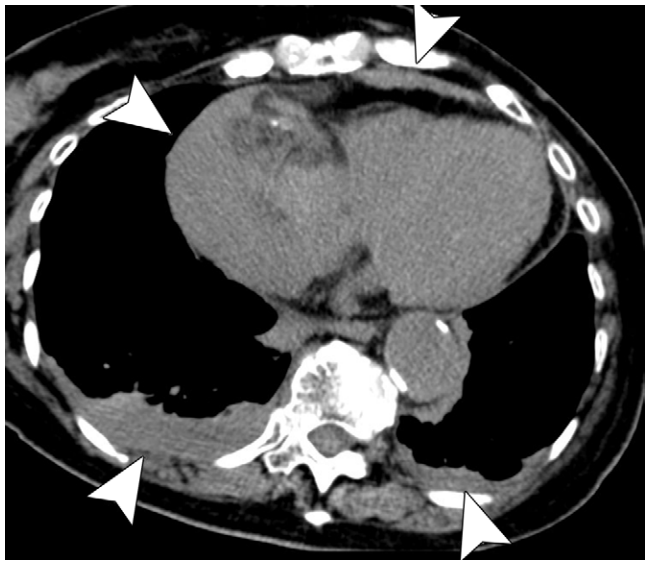

Figure 8: Ancillary findings of hemopericardium (mean attenuation, 46 HU) and bilateral hemothorax (mean attenuation, 28 HU) (arrowheads) on axial noncontrast CT image in a patient with limited intimal tear of the ascending thoracic aorta.

Table 2: Patients with LIT and Associated Vascular Findings

Associated Vascular Finding	All Patients (n = 32)	Patients with Type A (n = 22)	Patients with Type B (n = 10)
Classic dissection	3	1	2
IMH	29*	21	8*
PAU	1*	0	1*

Note.—Values are numbers of patients. IMH = intramural hematoma, LIT = limited intimal tear, PAU = penetrating atherosclerotic ulcer.
*One patient with type B LIT presented with concomitant IMH and PAU.

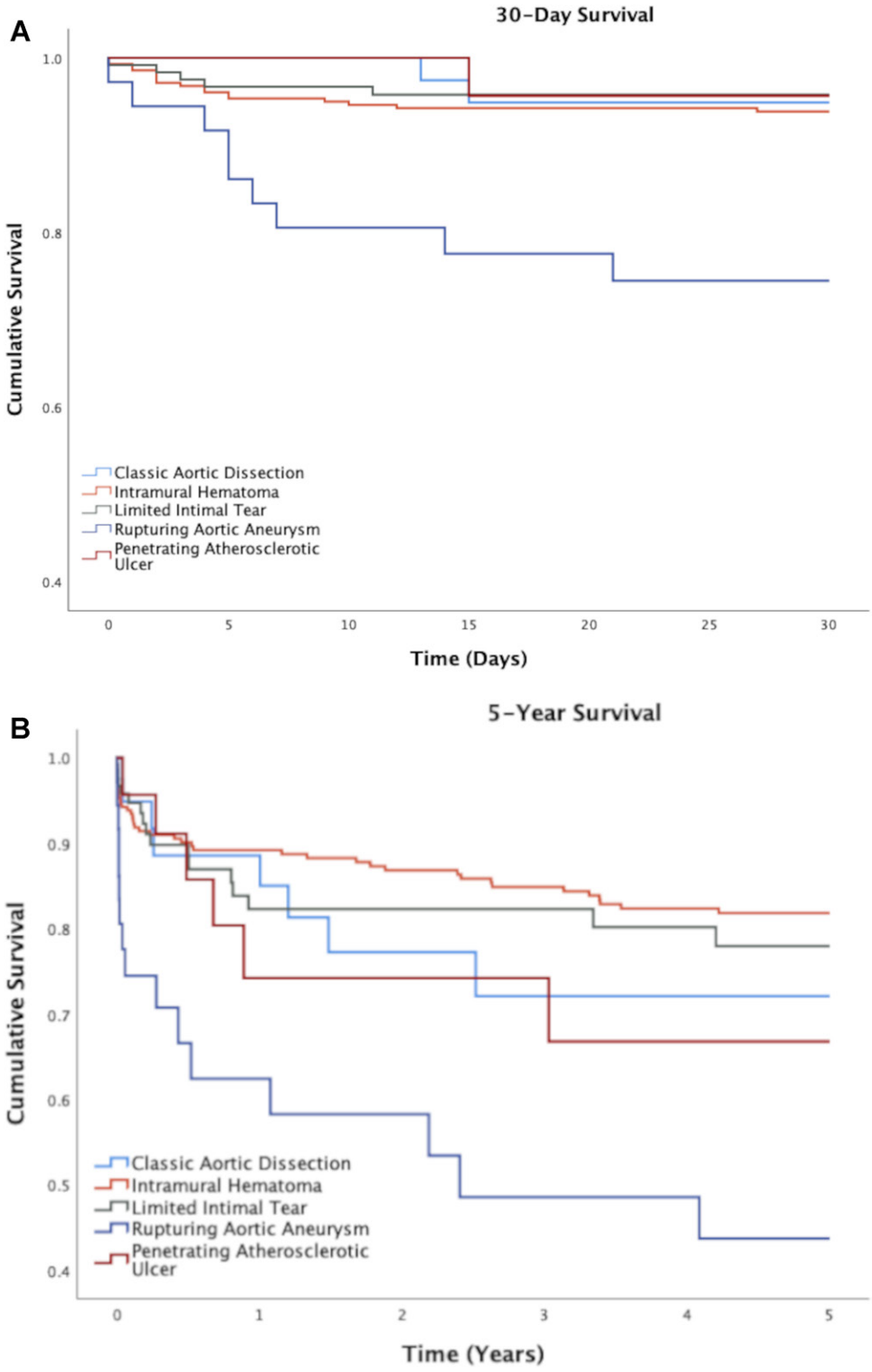

Figure 9: Thirty-day and 5-year survival rates in patients with acute aortic syndromes.