

# Putative computed tomography scan-negative type A dissection



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## ABSTRACT

**Objectives:** Computed tomography angiography (CTA) is the imaging modality most frequently used to diagnosis type A aortic dissection for chest pain with a high degree of sensitivity and specificity. False negative and positive errors in diagnosis are infrequent. Despite initial negative imaging studies for dissection, surgeons must consider early operation in patients with recent onset chest pain in the presence of an ascending aortic aneurysm.

**Methods:** We report 4 cases (2004-2021) of patients with a mean age of 51.25 years (male:female = 3:1) who presented with chest pain. Two had a history of syncope. On computed tomography angiography, all had an ascending aortic aneurysm and no dissection flap. Three had thickening of the ascending aorta and 1 had a chronic type B dissection. On echocardiography, aortic regurgitation was moderate-severe in 2 patients, 2 had a pericardial effusion, and none had a definitive dissection flap. All were operated on because of the surgeon's concern for the association of chest pain and an ascending aortic aneurysm. The Institutional Review Board at George Washington University Committee on Human Research has determined that the research is exempt from review under Department of Health and Human Services regulatory category 4 (#FWA00005945). The project as described in the application may proceed without further oversight by the Office of Human Resources on September 9, 2022.

**Results:** The diagnosis of type A aortic dissection was made at operation (3 on median sternotomy and 1 after aortotomy). All patients did well. One patient who had peripheral cannulation (no malperfusion) and severe coagulopathy developed a compartment syndrome and postoperatively required a below-knee amputation.

**Conclusions:** Surgeons must maintain a high index of suspicion for aortic dissection when patients present with chest pain and are found to have an ascending aortic aneurysm even in the absence of initial, classic features of dissection on computed tomography angiography. Improvements in imaging techniques and analysis are required. (JTCVS Open 2022;12:30-6)



**Intraoperative finding:** Deep intimal-medial tear in the wall of the ascending aorta.

## CENTRAL MESSAGE

Despite a negative CT scan for a type A dissection, in patients with chest pain and an ascending aortic aneurysm, early surgical intervention should be considered.

## PERSPECTIVE

CTA is most frequently used in diagnosing type A aortic dissection. Although CTA has a high degree of sensitivity and specificity, false negative errors in diagnosis can still occur. Our series emphasizes a need for a high index of suspicion and early operative intervention in patients presenting with chest pain and an ascending aortic aneurysm despite a negative CT scan for classical dissection.

Video clip is available online.

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The diagnosis of acute ascending thoracic aortic dissection is associated with a high mortality of 1% to 2% per hour for the first 24 hours<sup>1</sup> without surgical intervention, which mandates urgent and accurate diagnosis.<sup>2,3</sup> Improvements in imaging technology have resulted in highly sensitive and specific tools for making a diagnosis.<sup>4</sup> Even in patients undergoing operation, mortality is between 9% and 25%.<sup>5</sup> The widespread use of computed tomography angiography (CTA) in evaluating patients with suspected thoracic aortic dissection has also increased the propensity for false positive results and unnecessary surgery.<sup>6,7</sup> On the other hand,

**Abbreviations and Acronyms**

AI	= aortic incompetence
CT	= computed tomography
CTA	= computed tomography angiography
ECHO	= echocardiograph
EKG	= electrocardiograph
TEE	= transesophageal echocardiography
TTE	= transthoracic echocardiography

less well reported are patients who have a false negative computed tomography (CT) scan leading to inappropriate delay in management with potential dire outcomes.<sup>8,9</sup>

We describe our experience with 4 patients (Table 1) who presented with chest pain who on CTA had an ascending aortic aneurysm but no features of aortic dissection. Additional echocardiography (ECHO) also did not identify the aortic dissection. The patients were taken to the operating room because of chest pain in a patient with an ascending aortic aneurysm. The diagnosis of a type A dissection was made after sternotomy in 3 and after aortotomy in 1 patient. All underwent successful replacement of the ascending aorta or a Bentall procedure.

**MATERIALS AND METHODS****Case 1**

The patient was a 49-year-old-man with no significant past medical history. He presented to an outside hospital with central chest pain and a tentative diagnosis of acute coronary syndrome was made. There was no electrocardiograph (EKG) or enzyme evidence of myocardial infarction and he was treated as a patient with unstable angina. A CT scan was done and this showed an enlarged ascending aorta (5.6 cm) and the ECHO showed moderate-to-severe aortic incompetence (AI). He was treated with clopidogrel and antihypertensive agents. He was seen at an outside hospital and transferred to our facility for further evaluation. The chest pain continued and the patient was taken to the catheterization laboratory for a coronary angiogram, which did not show an aortic dissection, but there was severe AI. Because of the constellation of findings, the patient was taken to the operating room. The transesophageal ECHO (TEE) showed moderate-severe aortic regurgitation and an enlarged root but no dissection. At median sternotomy, a classical type A ascending aorta was

noted that extended down to the annulus. A Bentall operation using a St Jude valve conduit (St Jude Medical) and additional coronary artery bypass grafting was performed. Because of the prior use of clopidogrel, there was a coagulopathy requiring delayed closure of the sternum. Postoperatively, he developed a compartment syndrome that required a below-knee amputation. The patient remains alive 18 years later.

**Case 2**

A 43-year-old African American man had severe chest pain and syncope and was brought to an outside hospital. He was severely hypertensive on admission and awake with no residual neurological sequelae. A CT scan showed the presence of an enlarged ascending aorta, no dissection, and a pericardial effusion. He was transferred to our hospital for drainage of the pericardial effusion. ECHO confirmed a pericardial effusion but no dissection was seen. Despite the absence of a dissection, the surgeon was suspicious because of the presence of an enlarged ascending aorta, severe chest pain, and a pericardial effusion in the presence of an ascending aortic aneurysm.

Again in the operating room, TEE did not show an aortic dissection. With full capability for cardiopulmonary bypass on standby in the operating room, a median sternotomy approach was used. On immediately opening the sternum, the presence of a hemopericardium was obvious. On opening the pericardium, a classical type A dissection was present. This patient underwent a successful bio-Bentall procedure and is alive 8 years later.

**Case 3**

A 43-year-old African American man presented with moderate-to-severe bouts of increasing chest pain. The CT scan showed evidence of a chronic type B dissection and in addition he had an ascending aortic aneurysm (5.5 cm) and associated moderate aortic regurgitation. Cardiac catheterization was done and he had no evidence of significant coronary artery disease. Intraoperative TEE confirmed moderate AI and an ascending aortic aneurysm. An unexpected finding on making the aortotomy in the aneurysmal ascending aorta was the presence of a linear tear above the sinotubular junction near the left coronary cusp. He underwent a Bentall procedure and he had a benign postoperative course. He underwent a further operation to manage his iliac artery aneurysm and he is alive 6 years after his Bentall procedure.

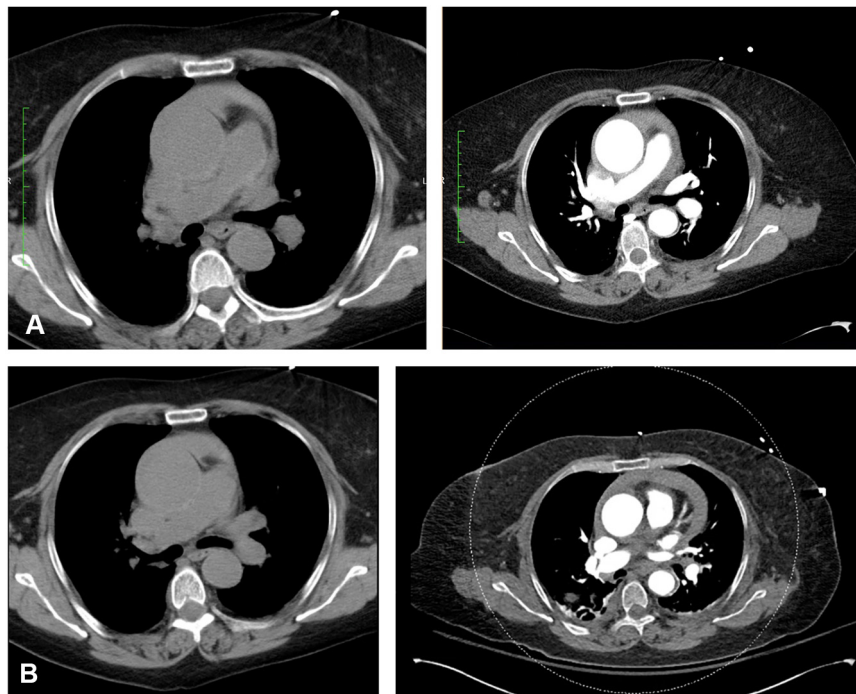
**Case 4**

A 70-year-old Hispanic woman developed severe chest pain and collapsed whilst shopping. She had no prior cardiac history. Emergency medical services found her hypotensive and she had recovered from her syncopal episode. She was given fluids and taken to another hospital. Now the patient was hypertensive and tachycardic. She has an elevated

**TABLE 1. In all cases, a standard computed tomography angiography (CTA) was performed. The preoperative CT scan, intra-operative transesophageal echocardiography, operative photographs, and an image of the deep tear in the ascending aorta that was not seen on the CTA, and postoperative CT scan are shown in Figures 1 through 3 and Videos 1 through 4. The same surgeon was involved in the care and operative procedures of all 4 patients**

Case No.	Age (y)/sex	Type A dissection	Ascending aortic aneurysm? (cm)	Pericardial effusion	Chest pain	Syncope	Aortic insufficiency	Ascending aortic tear	Operation	Alive
1	49/M	No	Yes: 5.6	No	Yes	No	Moderate-severe	No	Bentall acute type A	Yes
2	43/M	No	Yes: 5.7	Yes: Bloody	Yes	Yes	No	No	Bentall acute type A	Yes
3	43/M	No* chronic type B	Yes: 5.5	No	Yes	No	Moderate	No	Bentall acute type A	Yes
4	70/F	No	Yes: 5.2	Yes: Bloody	Yes	Yes	Mild	No	Hemi-arch/tube graft acute type A	Yes

M, Male; F, female. \*No type A dissection, chronic type B dissection.



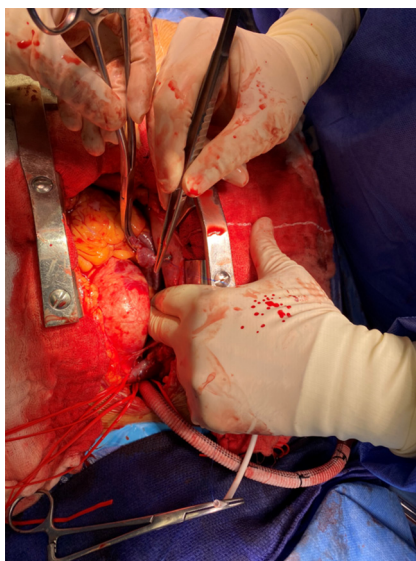
**FIGURE 1.** A, Computed tomography (CT) (case 4) with and without contrast. This shows an aneurysmal ascending aorta (5.18-cm diameter). There were no features of an aortic dissection and an intramural hematoma was not seen on the noncontrast images. B, Repeat CT of case 4 with and without contrast 11.5 hours after first. CT. There were no features of aortic dissection. However, now there is some thickness of the ascending aorta near the pulmonary artery.

white count at 21 k suggestive of infection. A CT scan showed an enlarged ascending aorta (5.2 cm) but no evidence of aortic dissection and a pericardial effusion (35 HU) (Figure 1, A). She was treated with antibiotics and transferred to our intensive care unit for drainage of her pericardial effusion. There was no evidence of myocardial infarction. The transthoracic echocardiography confirmed the presence of a moderate pericardial effusion, an enlarged ascending aorta, and mild AI. We planned to a median sternotomy

instead of a pericardial window because of the presence of an aneurysm and chest pain.

A repeat CTA was done 11.5 hours after the first study. Again, no dissection flap was seen and presence of some aortic wall thickening was noted between the ascending aorta and the pulmonary artery (Figure 1, B). Transthoracic echocardiography (TTE) did not show a dissection flap (Videos 1 and 2). However, some thickening of ascending aortic wall was noted.

Upon opening the sternum, hemopericardium was present. Some adventitial hemorrhage was noted on the anterolateral aspect of the ascending aorta on draining the pericardial blood. (Figure 2). This was not in the region of the thickening noted on the CT scan. After aortotomy, a deep tear was noted posteriorly, around the sinotubular junction (Figure 3, Videos 3 and 4, and Video Abstract). She underwent an ascending aorta and hemi-arch repair using circulatory arrest via a graft to the innominate artery. Her postoperative course was benign and she is doing well at 10 months postintervention.



**FIGURE 2.** Ascending aorta with adventitial hemorrhage after drainage of bloody pericardial effusion

## DISCUSSION

Improvement in surgical techniques and cerebral protection for managing type A aortic dissection have resulted in a decrease in morbidity and mortality even in patients without associated malperfusion.<sup>10</sup> To improve survival, it is mandatory to make an early correct diagnosis. In this regard, the most common modality used to confirm the clinical suspicion is CTA due to its availability, speed of imaging of the entire aorta, and ability to detect alternative diagnoses. The sensitivity and specificity of CTA for aortic dissection range from 94% to 100% and 77% to 100%, respectively.<sup>3,4</sup> Other imaging modalities include magnetic



**FIGURE 3.** A deep intimal-medial tear is seen in the wall of the ascending aorta.

resonance imaging and TEE and they offer comparable sensitivities and specificities for making the diagnosis of aortic dissection and can be used as secondary tests when the diagnosis is uncertain.<sup>11</sup>

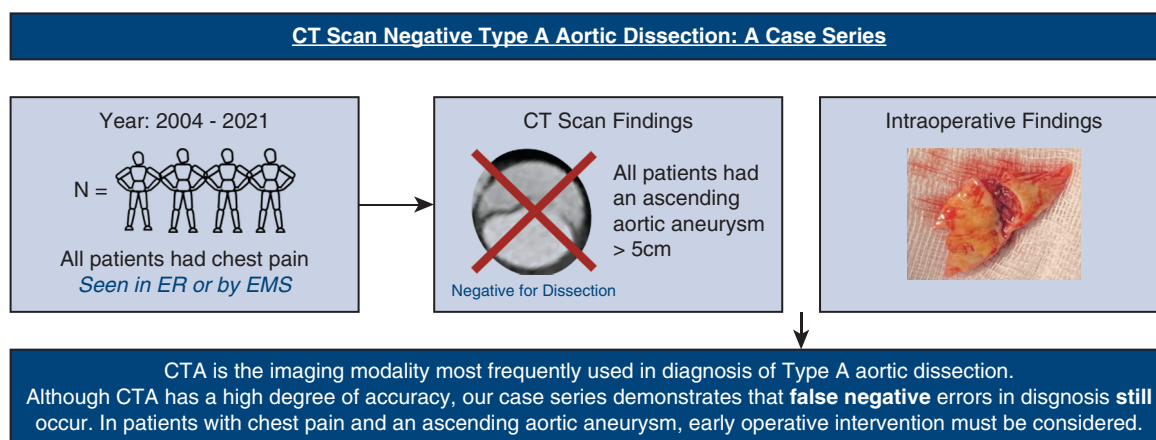
Diagnostic features of aortic dissection on CTA include the presence of an intimal flap, presence of a true and false double lumen, and dilatation of the ascending aorta. An added advantage of CT scanning is that it assists the surgeon with operative planning because it can visualize the extent of the dissection flap, including valve or branch vessel involvement or other distal complications. Disadvantages of CTA include radiation exposure and use of iodinated contrast. In the series presented, on preoperative CTA, all cases had an ascending aortic aneurysm but no dissection flap. In our series of patients, dissection flap was not seen on ECHO. In 2 patients, there was moderate-to-severe aortic regurgitation, in 2 patients there was evidence of pericardial effusion, and in 2 patients there was aortic wall thickening. Although CTA, TTE, and magnetic resonance imaging are all highly accurate, false negative and positive studies do occur.<sup>6-9</sup> False-negative CTA studies for aortic dissection can be

due to inadequate contrast opacification or where the presence of peripheral calcification in a chronic dissection simulates an atherosclerotic aneurysm. However, CTA is generally a very sensitive test and false-negative findings are rare. There were 2 case reports from Yale of ascending aortic aneurysm with pain who were operated on despite CTA negative for aortic dissection. Intraoperatively, aortic dissection was detected. They emphasized that the size criteria for replacing ascending aortic aneurysms pertain to asymptomatic patients, and symptomatic patients with aneurysm require resection regardless of size.<sup>8,9,12</sup>

DeWeert and colleagues<sup>8</sup> describe a case of a patient on phencyclidine who presented with an acute aortic syndrome. There was no evidence of ascending aortic dissection on CTA, but a flap was seen on TEE and the patient underwent a root and aortic valve replacement.<sup>8</sup>

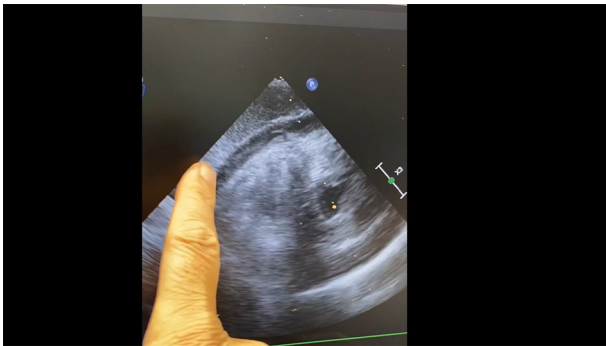
False-positive CTA results are more common and can result in unnecessary surgery. They can be due to curvilinear artifacts in the aortic root and proximal ascending aorta. These are often caused by aortic wall motion and can be reduced by using EKG gating.<sup>13</sup>

In our series, none of the patients had EKG-gated CT scans. This later modality improves visualization of the aortic root and helps correct for motion artefacts. However, EKG-gated CT scans requires the presence of trained technicians, an advanced-generation scanner, and radiologists who can read cardiac images. Most centers do not offer this service on a 24/7 basis. The other variants of the aortic syndrome complex, such as intramural hematomas are detected on noncontrast CT scans. In 3 patients (cases 1, 3, and 4) out of 4 where noncontrast scans were performed, intramural hematoma was not identified. In case 4 where a second CT scan study was performed 11.5 hours after the first scan, some thickness of the ascending aorta was noted (Figure 1, B).



CTA - Computed Tomography Angiography, CT - Computed Tomography

**FIGURE 4.** Overview of the case series of computed tomography (CT) scan-negative type A aortic dissection. ER, Emergency room; EMS, emergency medical services; CTA, computed tomography angiography.

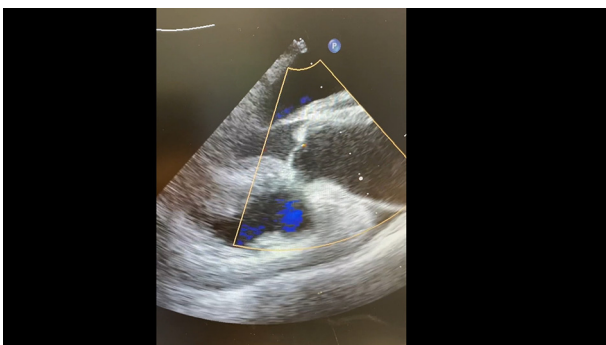


**VIDEO 1.** Intraoperative transesophageal echocardiography. There is a pericardial effusion present. Video available at: [https://www.jtcvs.org/article/S2666-2736\(22\)00369-2/fulltext](https://www.jtcvs.org/article/S2666-2736(22)00369-2/fulltext).

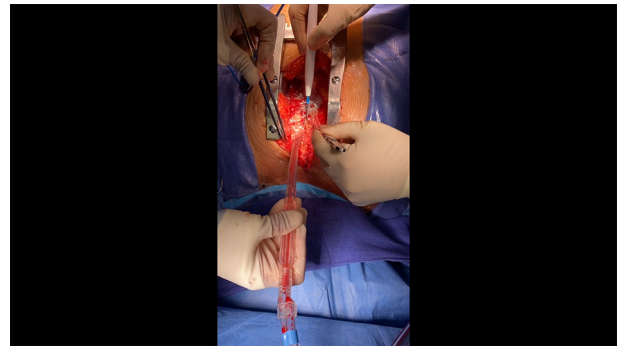
The true incidence of false negative CTA for aortic dissection will require autopsies to be performed in patients who die as a result of acute aortic syndrome and sudden death. In a Japanese study, 7% of patients with sudden death on postmortem CT autopsy had an aortic dissection.<sup>14</sup> Similarly, a Mayo Clinic report showed approximately 30% of cases of aortic dissection remained undiagnosed until postmortem examination.<sup>15</sup>

Although it is frequently performed, bedside, point-of-care TTE is not very accurate. The sensitivity and specificity of formal TTE for aortic dissection range from 77% to 80% and 93% to 96%, respectively, for the ascending aorta. It may detect a flap in the parasternal long axis view of the aortic root.<sup>16</sup> However, emergency department TTE does have value in evaluating patients who are hemodynamically unstable or have heart failure, pericardial tamponade, aortic insufficiency, or wall motion abnormality.

Much has been written about the early operation in patients with symptomatic ascending aortic aneurysms.<sup>17</sup> The surgical decision to operate in our case series was predicated on the presence of an ascending aortic aneurysm and



**VIDEO 2.** Intraoperative transesophageal echocardiography. There is no evidence of a dissection flap. There is some thickness noted of the aortic wall. Video available at: [https://www.jtcvs.org/article/S2666-2736\(22\)00369-2/fulltext](https://www.jtcvs.org/article/S2666-2736(22)00369-2/fulltext).



**VIDEO 3.** Intraoperative video: On opening the pericardium, bloody effusion and clot is seen. Video available at: [https://www.jtcvs.org/article/S2666-2736\(22\)00369-2/fulltext](https://www.jtcvs.org/article/S2666-2736(22)00369-2/fulltext).

recent onset of severe chest pain. All patients were hypertensive and there was no evidence of a myocardial infarct. Because of our favorable experience with urgent replacement of symptomatic ascending aortic aneurysms that had false negative CTA findings for aortic dissection, we would encourage other centers to use this approach as surgical delay increases morbidity and mortality. We have not used, nor suggest, this approach in the absence of an ascending aortic aneurysm.

## CONCLUSIONS

Our report suggests no single historical feature, physical examination finding, or laboratory test or imaging study can safely rule out aortic dissection. Although the CTA is usually the initial imaging test with a high sensitivity and specificity, false negative findings can occur (Figure 4). In patients with chest pain and an ascending aortic aneurysm on CTA, consideration must be given to early operative intervention, even in the absence of classic features of type A dissection (Video Abstract).



**VIDEO 4.** Intraoperative video: On aortotomy, a deep linear intimal-medial tear is seen posteriorly. Video available at: [https://www.jtcvs.org/article/S2666-2736\(22\)00369-2/fulltext](https://www.jtcvs.org/article/S2666-2736(22)00369-2/fulltext).

### Conflict of Interest Statement

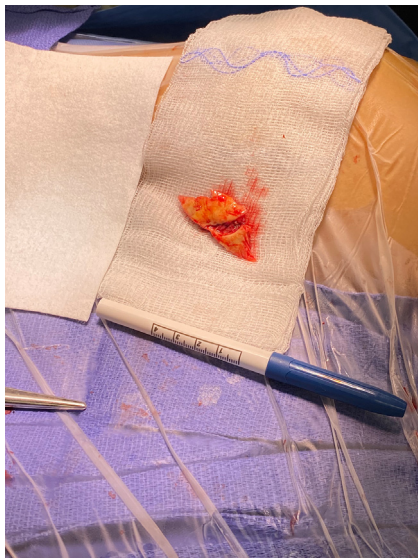
The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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**Key Words:** aortic dissection, aortic surgery, diagnostic imaging, computed tomography, angiography



**FIGURE E1.** Intraoperative finding: deep intimal-medial tear in the wall of the ascending aorta.