EC EMERGENCY MEDICINE AND CRITICAL CARE
Case Report

# Aortic Dissection: Diagnostic Imaging Findings from Acute to Chronic Longitudinal Progression

**S Habib Chorfa*, N Amsiguine, B Dghoughi, B Bequali, L Jroundi and FZ Laamrani**

*Emergency Radiology Department, Ibn SINA University Hospital of Rabat, Morocco*

***Corresponding Author:** S Habib Chorfa, Emergency Radiology Department, Ibn SINA University Hospital of Rabat, Morocco.

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## Abstract

Aortic dissection is the most frequent and most dreaded aortic emergency, including intra-mural hematoma and penetrating aortic ulcer. An acute dissection is one in which the individual presents within the first two weeks. The diagnosis is suspected based on symptoms with a sudden onset of severe chest or back pain. Medical imaging such as CT scan, MRI, or ultrasound used to confirm and further evaluate the dissection, for the selection of patients to be operated on, for the preparation of the operation and for post-treatment follow-up. Two main types are Stanford type A, which involves the first part of the aorta, and type B, which does not. Organ mal perfusion is the most frequent acute complication, confirmed by imaging and/or biology as the first case we deal with. Aneurysmal dilatation of the false channel is the most frequent chronic complication.

Prevention is by blood pressure control and smoking cessation and for type A dissections, urgent surgical treatment is indicated. For uncomplicated type B dissections, medical treatment gives better results.

***Keywords:*** *Multidetector-Computed-Tomography (CT); Magnetic Resonance Imaging (MRI); Thoracic Aorta; Type A and B Dissection;*

## Introduction

Aortic dissection is part of a broader semiological framework of acute aortic syndrome (AAS) characterized by sudden and intense chest pain due to an organic lesion of the aortic wall outside a traumatic context. The etiologies of AAS are dominated by "classic" acute aortic dissection (with intimal rupture and false circulation channel) and intra parietal hematoma (related to rupture of the vasa vasorum without intimal tear on imaging). Other causes are rarer penetrating atheromatous ulcer, localized intimal ruptures and iatrogenic dissections. However, it constitutes a vital emergency whose unpredictable evolution is marked by aortic rupture and extension of the dissection.

The clinical picture is protean, the cardinal sign being the thoracic pain, important and classically migrating, which can be accompanied by variable visceral attacks: infarction, cerebral vascular accident, abdominal pain, paresis/paraplegia or ischemia of the limbs.

For many years, aortography was the only effective diagnostic method in patients with suspected aortic dissections (AD). Currently, computed tomography (CT) represents the gold standard for diagnosis, other examinations; echocardiography, in particular performed by transesophageal approach (TEE) and magnetic resonance imaging (MRI) have been proposed as relevant imaging techniques for the diagnosis of aortic dissection.

The objectives of this review are therefore to present cases of type A and B aortic dissection, to illustrate the acquisition modalities and post-processing used in the imaging of dissections, to specify the radiological criteria defining a complicated dissection, to explain the useful measurements and reconstructions before endovascular treatment and to present the post-therapeutic radiological follow-up of these pathologies.

## Medical Observation

A 48-year-old female patient, hypertensive on triple therapy with poor compliance, was admitted to the emergency department for anterior localized angina-like chest pain evolving for 5 days. No notion of trauma or surgery of the aortic junction was reported. On admission, the patient was conscious, pale, with incidental hypertension (200/100 mmHg on the right limb and 180/80 mmHg on the left limb), normocardial at 70 bpm, polypneic at 26 cycles/min and apyretic. Room air $SaO_2$ was 97%. Non-fasting capillary blood glucose was 1.6 g/L preserved diuresis, cardiovascular examination revealed normal cardiac auscultation with no perceived murmurs or rales. Vascular examination of the upper, lower and abdominal extremities was unremarkable. The electrocardiogram showed a regular sinus rhythm with electrical ventricular hypertrophy, which ruled out the diagnosis of coronary syndrome and pericarditis. In front of this picture of acute chest pain of sudden onset, with poorly controlled arterial hypertension, an aortic dissection was strongly suspected. The patient underwent a standard chest X-ray revealing mediastinal enlargement (Figure 1A). A thoracic-abdominal angiogram was performed urgently and showed a dissection of the ascending aorta extending to the coronary and inter ventricular arteries and up to the iliac bifurcation (Figure 1B-1D) classified as Stanford type A and DEBAKEY Type I complicated with hemopericardium.

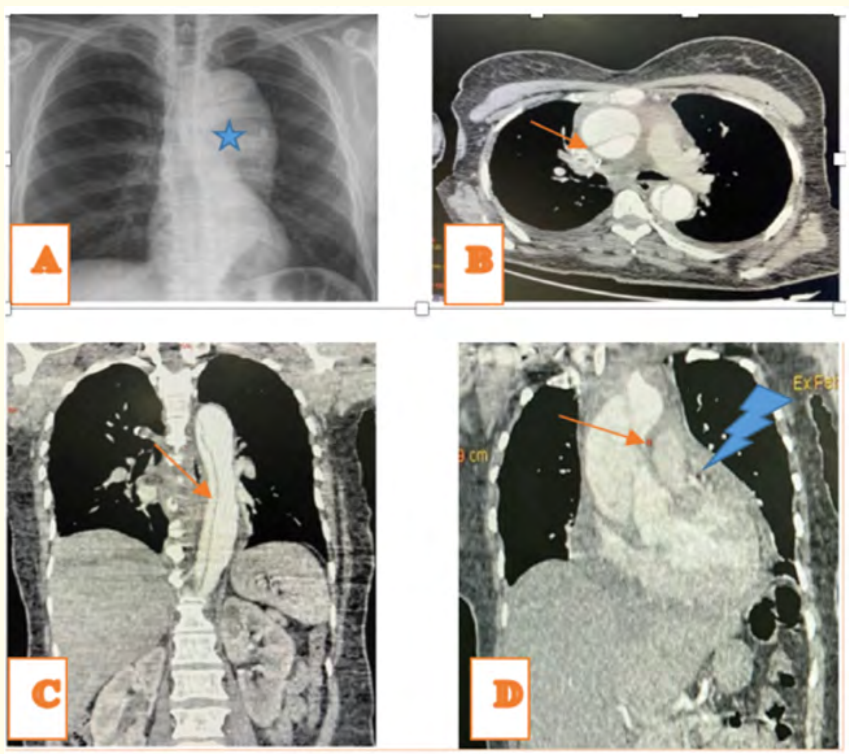


***Figure 1:*** *A: Standard radiograph showing mediastinal enlargement. B: Axial CT section showing an intimal flap at the level of the ascending and descending thoracic aorta. C and D: Reconstruction figures taking the appearance of a flat and linear addition image © with hemopericardium (D) graded Stanford A and DEBAKEY I.*

The ascending thoracic aorta at this level measured 40 mm in maximum axial diameter and 38 mm at the descending thoracic aorta.

The supra-aortic trunks were free, the celiac trunk, the superior artery mesenteric (AMS) and the left renal artery arose from the false channel without intimal flap at their level, the right renal artery arose from the true channel without anomaly.

In order to eliminate other differential diagnoses and as part of the workup for aortic dissection, biological tests were performed. These included a blood form count, a blood ionogram, and a hemostasis and renal workup, which were normal. Troponin, C reactive protein (CRP), and D-dimer measurements were negative. The patient also underwent a C- brain scan which returned normal.

At the end of this clinical and paraclinical workup, the diagnosis of an acute dissection complicated by hemopericardium was retained, the most probable etiology of which is a poorly controlled senile hypertension. The patient was treated by endovascular stent grafting after obtaining a stent graft of the ascending aorta made according to the measurements calculated on the angioscan.

Two days later, because of the incessant pain, a recurrence of stent dissection was suspected. The angiographic control was satisfactory with stent material in place and absence of intimal flap at this level within creased left pleural effusion. No intraoperative incident or immediate post-therapeutic complication had been deplored. Given the good post-operative evolution, the patient was declared discharged. Follow-up at one month revealed a healthy patient, hemodynamically stable on oral antihypertensive drugs and without any symptomatology. The follow-up angioscan at 1 month showed a correctly positioned and patent stent without complications (Figure 2E-2H). A few day later control, the patient presented an abolition of the left popliteal pulses and CT angiography of the lower limbs: complete yellow thrombosis of the left popliteal artery (Figure 3).

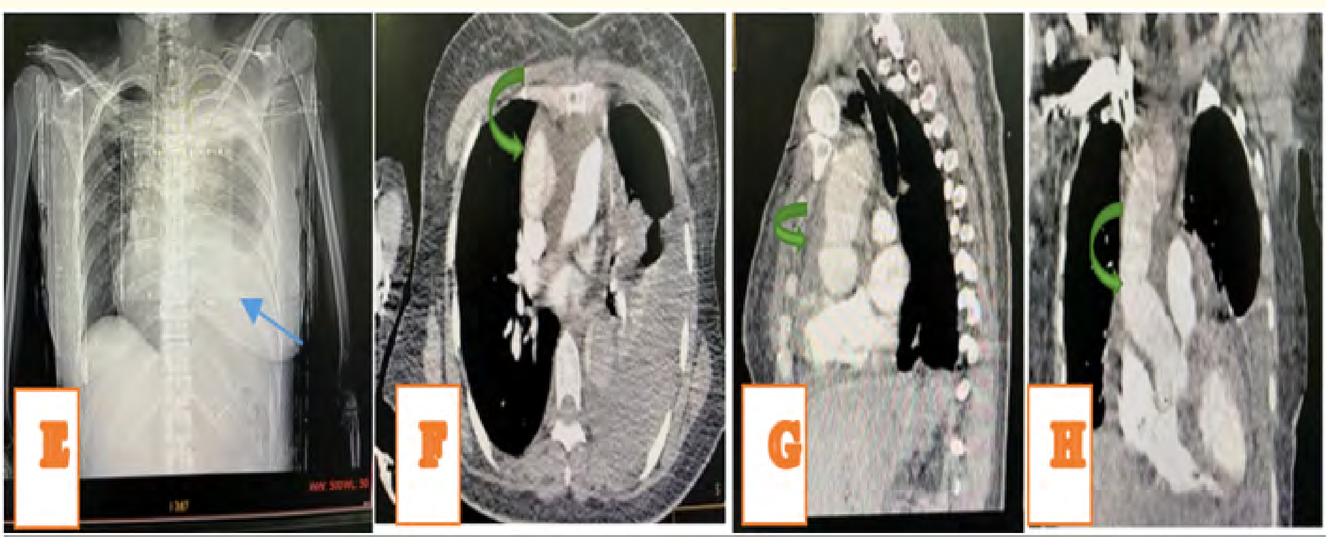


***Figure 2:*** *E: Standard postoperative control radiograph showing increased pleural effusion. F-H: Axial section with sagittal and coronal reconstruction showing a stent in place without intimal flap.*

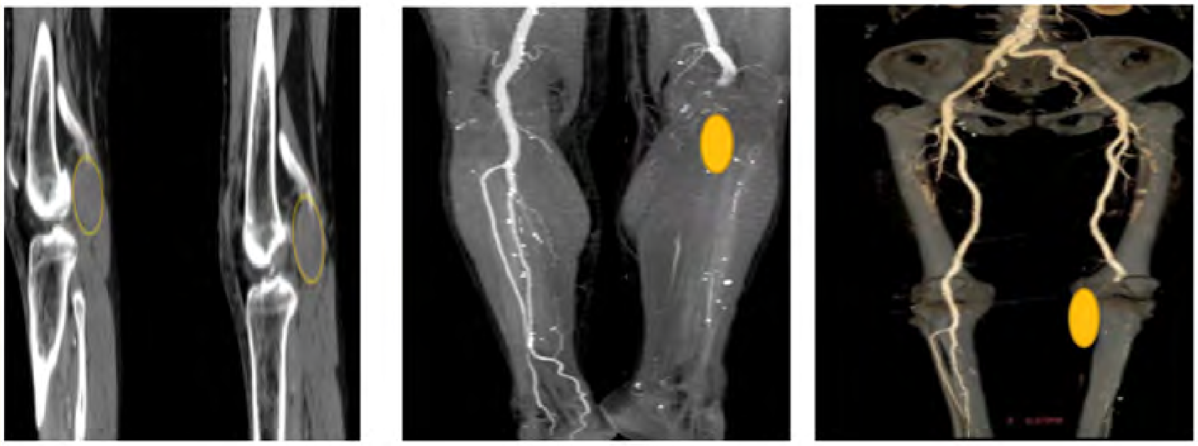

***Figure 3:*** *CT angiography of the MI: complete yellow thrombosis of the left popliteal artery (yellow circle).*

## Discussion

Aortic dissection is a potentially fatal condition. In its classical form, itis the main etiology of AAS, encountered in 90% of cases, followed by intra-parietal hematoma (IPH) (5 - 10%) [1]. AAS is a life-threatening medical and radiosurgical emergency (vascular rupture and ischemic syndrome) most often due to chronic arterial hypertension, atheroma or congenital anomalies (Marfan's disease, Ehlers-Danlos syndrome,) or acquired (trauma). It is a longitudinal cleavage of the media, by irruption of pulsatile luminal blood through an initial intimal breach called "portal of entry" or by rupture of a wall hematoma under tension towards the lumen, with usually anterograde progression of this cleavage, thus creating a false channel separated from the true lumen by the intimal flap.

Several classifications have been proposed according to the location and extension of the dissection: the Debakey classification (Type I involves the ascending aorta, aortic arch, and descending aorta. Type II is confined to the ascending aorta. Type III is confined to the descending aorta distal to the left subclavian artery [2]). historically the oldest, and the Stanford classification [3], the most widely used in therapeutic reasoning, which is based solely on the extension of the dissection, and not on the location of the entry point. Any dissection extending up stream of the ostium of the brachio-cephalic-arterial trunk is classified as A, the others being classified as B, with or without involvement of the aortic arch depending on whether or not they extend up stream of the ostium of the left subclavian. In addition to its prognostic value, this classification has a value of therapeutic orientation: This classification has a fundamental importance in the management of patients. Indeed, type A presents a risk of rupture of the ascending portion of the aorta, revealing 1% per hour of evolution, with as a consequence the death of the patient [1]. Type B, on the other hand, presents only a minimal risk of rupture, a difference that has not been explained to date. In both cases, however, organ malperfusion syndromes can occur, sometimes resulting in death.

Towards the end of the 20$^{th}$ century, Svensson [4] was able to individualize three other causal types of acute aortic dissection These are localized dissection, penetrating atheromatous ulcer (PAU) and iatrogenic dissection. Clinically, all etiologies of AAS present with similar symptoms. It is commonly a sudden, violent, migratory chest pain associated with chronic hypertension or of incidental discovery.

Aortic dissection appears to be of interest to middle-aged men (40 - 45 ans) [5]. Its natural history is unpredictable and controversial, transmural rupture and extension seem to be formidable complications and difficult to evaluate.

Radiologically, spiral angiography with good resolution 3D reconstruction allows to distinguish between the different etiologies of AAS with an estimated sensitivity of 93.4% and specificity of 87.1% [6]. It is the reference examination in emergency with an acquisition taking from the supra aortic trunk to common artery femoral with synchronization to the heart rate to eliminate cardiac motion artifacts on the ascending thoracic aorta. Carried out in two stages: without injection of iodinated contrast product, which is imperative for the diagnosis of intramural hematoma, and with injection of 120 ml of iodinated contrast product at the arterial stage at an injection rate of between 3 and 4 ml/s, which allows a positive diagnosis. The parenchymal venous time can confirm the suspicion of complications when it finds signs of visceral ischemia (renal cortex, splenic parenchyma, digestive walls). These maybe acute limb ischemia, abdominal pain and/or nausea in the case of mesenteric ischemia, or renal insufficiency ± arterial hypertension in the case of renal suffering. Two other radiological criteria. Thein crease of a peri-aortic hematoma or the increase of a hemothorax on early CT scan, also allow to classify an acute aortic dissection as complicated [7].

In the context of a potentially life-threatening emergency, the relative contra indications associated with iodinated contrast injection (severe renal insufficiency with creatinine clearance of less than 30 mL/min/1.73m$^2$, history of moderate anaphylactoid reaction) do not prevent its performance. Triggering uses the bolus-tracking method with a region of interest in the ascending aorta, under continuous visual control in the event of placement in a thrombosed false channel. Dual-energy scanners allow, due to the increased contrast of iodine on low-keV monochromatic reconstructions, to decrease the amount of iodine injected [8], which maybe useful in follow-up examinations in patients with impaired renal function. It is this arterial phase that will allow the positive diagnosis, the assessment of extension and the classification of the disease. The main semiological criterion is the visualization of the intimal flap, a linear hypodense endoluminal structure that corresponds to the torn intima, and separates the true from the false channel. It is its extension that will classify the dissection [19]. The true duct, corresponding to the normal aortic lumen directly supplied by the left cardiac chambers, is identified by following the path of the dissection by continuous linear scrolling from the chambers of expulsion; at the descending aortic level, certain semiological signs allow its recognition on an isolated section, as well as signs that allow identification of the false duct at the descending aortic level: the beak sign, with acute angle connection of the false duct to the wall, the presence of more or less extensive parietal thrombus, invagination of the intima flap and dilatation with delaved opacification at arterial time, It also allows visualization of the entry and re-entry ports of the dissection, the extension of the dissection to the supra-aortic trunks, the coronary arteries, the arteries of the abdominal viscera, and even the common femoral arteries. Hemomediastinum, hemopericardium or pleural effusion are secondary to a rupture, visceral malperfusion by a static mechanism (extension of the dissection) or dynamic mechanism (compression of the false channel the true channel) are the complications to be systematically looked for, thus allowing to orientate the management [9] (Figure 3).

Because of its limited accessibility, its complexity and its long acquisition time of between 20 and 45 minutes, magnetic resonance imaging (MRI) still a second-line examination, which has no place in the acute phase. This non-irradiating modality is thus mainly reserved for the follow-up of chronic dissections in young subjects [10]. It presents diagnostic performances similar to angioscanner, with a sensitivity of 98% and a specificity of 98%, its interest lies mainly in the study of valve dynamics, flow analysis and chronic pathologies [11].

The examination begins with the acquisition of T1-weighted morphological sequences in the axial ± sagittal plane. Optional ECG-synchronized cine sequences in the axial plane are very informative in chronic dissections to visualize intimal flap mobility during the cardiac cycle. The reference sequence is the injected angio-MRI sequence, in fast three-dimensional acquisition at arterial time after administration of 0.2 mmol/kg of bolus gadolinium, which offers excellent contrast and millimetric isotropic spatial resolution. Maximum coverage is limited by the antenna used (thoracic or cardiac) and usually does not exceed 45 cm caudocranially [12].

In case of contra indication to gadolinium injection (severe or end-stage renal failure) or failure of injected sequences, injection-free angio micrographic sequences based on free-breathing gradient echoacquisitions with ECG synchronization can be used (3D TrueFisp, Fiesta or Balanced FFE sequences). They offer very good image quality [11], provided that the patient remains immobile and has a regular heart and respiratory rhythm throughout the 10 - 15 minutes required for the acquisition.

Aortography is performed before the placement of an aortic stent, it allows the differential diagnosis of ACS during coronary angiography [9].

Other paraclinical means have proven their reliability in confirming the diagnosis of acute dissections. This is transesophageal ultrasound (TEE). Although TEE has a lower diagnostic sensitivity (80%) than CT and MRI, it is the second line of imaging modality to be performed in case of suspected AAS. TEE is known to be a rapid, more easily accessible examination that can be performed at the patient's bed. Doppler ultrasound of the supra-aortic trunks can, preoperatively, verify the absence of extension of the dissection, in particular to the carotid arteries. Arteriography has no place in the diagnosis of aortic dissection at present because of the loss of time it entails and its danger in this context. It is reserved for therapeutic purposes [20].

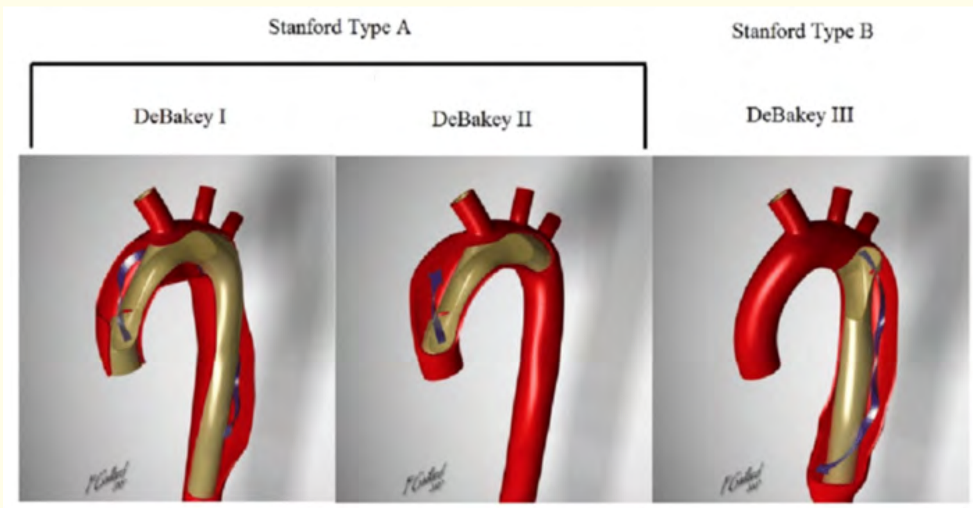


***Figure 4:*** *Debakey and Stanford classification radiopaedia.org/cases/aortic-dissection2016.*

Although not yet included in current recommendations, these new factors may identify high-risk patients who may benefit from early intervention based on cross-sectional imaging: maximum diameter of the false channel greater than 22 mm, total aortic diameter greater than 40 mm, initial portal of entry located in the concavity of the arch [13], initial portal of entry greater than 10 mm, partial thrombosis of the false channel [14], which is thought to be a risk factor for subsequent aneurysmal progression, by occlusion of the reentry portals and increased pressures in the false channel.

Over the past three decades, endovascular treatments of acute aortic dissections (AADs) have represented a major advance in the management of severe complications such as malperfusion syndromes. In type B AADs, endovascular approaches have become the first line of therapy, almost completely excluding open surgery from the therapeutic armamentarium. Type B being medical in the absence of complications, consisting of lowering blood pressure and relieving pain. However, high mortality rates have prompted practitioners to consider non-surgical approaches to avoid adding operative mortality to the natural mortality of AAD [15]. According to the IRAD (International Registry of Aortic Dissections), mortality of type A AADs ranges from 20% to 26% after surgery. It peaks at 46% in patients over 80 years of age (with a 5-year survival rate ranging from 0% to 55%) [16].

Follow-up aftertreatment of thoracic aortic pathologies is based on CT or MRI imaging, which looks for complications related to the treatment and the evolution of the treated pathology.

After treatment of an aortic dissection, there is very often a circulation of the false channel on a part of the native aorta [17]. It is necessary to look for the entry points, to monitor the caliber of the aorta at the different levels, to look for signs of visceral ischemia (static or dynamic) and of acute complication in case of painful recurrence [18].

## Conclusion

Angioscanner, with ECG synchronization is the best examination for the positive diagnosis and extension of an aortic dissection and the immediate post operative control of ascending aorta surgeries during type A dissections. It should include a combined exploration of the thoracic and abdominal-pelvic stage [20], like this case. MRI is validated in the monitoring of chronic type B dissections. In addition, treatment is based primarily on control of arterial hypertension and stenting. Clinical and radiological monitoring of patients is necessary to detect complications related to the pathology or endovascular treatment [15].

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