Diagnosis with ECG-gated MDCT of floating thrombus in aortic arch in a patient with type-A dissection

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Abstract: Multidetector computed tomography has been shown to be accurate in noninvasive assessment of chest vascular disease. The motion artifacts of the thoracic aorta and the supra-aortic vessels were significantly reduced in the electrocardiogram (ECG)-gated data acquisition. This positive effect of ECG synchronization is more pronounced in the region of the ascending aorta, aortic arch, and proximal descending aorta.

Keywords: ECG-gated, MDCT 64-slice, chest vascular disease

Introduction

A variety of atypical imaging features, pitfalls, and artifact can occur during with computed tomography (CT) examination, which is a commonly used noninvasive imaging technique for the diagnosis of aortic dissection (Fisher et al 1994; Batra et al 2000; Raptopoulos et al 2006).

Motion artifacts caused by transmitted cardiac pulsation can frequently degrade thoracic CT studies. Some of these artifacts (eg, motion artifacts that mimic aortic dissection) are recognized as important sources of potential diagnostic errors (Loubeyre et al 1997; Rubin 1997).

A typical diagnostic pitfall caused by such transmitted cardiac pulsation is an artifactual intimal flap, resembling dissection in the ascending aorta (Loubeyre et al 1997).

Synchronization of the CT acquisition with the patient's electrocardiogram (ECG) reduces cardiac motion artifacts and enables noninvasive visualization of the coronary arteries (Achenbach et al 1998; Nieman et al 2001) and other cardiac anatomy (ascending aorta) (Willmann et al 2002; Morgan-Hughes et al 2003).

It has been shown that retrospective ECG gating can be beneficially employed for reducing transmitted cardiac pulsation also in more extensive scanning volumes in the thorax (Flohr et al 2002; Roos et al 2002). Retrospective ECG gating (Ohnesorge et al 2000) is the most commonly used strategy for ECG synchronization at multidetector row CT. Substantial effort has been invested in defining suitable time points during the cardiac cycle for reconstruction of CT data to provide optimal depiction of the coronary arteries (Hong et al 2001; Kopp et al 2001; Giesler et al 2002).

Case report

A 69-year-old female with thoracic pain, left superior arm parestesia and radial pulse absence was referred to the emergency department of our institution. She had a medical history with several episodes of thoracic pain spontaneously resolved, hypertension treated with calcium blockers and hyperlipidemia with statin. Her paste medical history was free of cardiologic disease.

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An ECG (Figure 1) was performed and it revealed normal findings for the heart and ascending aorta but considering clinical symptoms, a thoracic angio-CT was ordered.

An angiographic CT-scan with 64-multislice spiral scanners (Aquilion, Toshiba Europa Medical System) was performed before contrast media injection and after contrast media intravenous administration. Ninety-five milliliters (400 mg I/ml; flow 4 ml/s) (Iomeron, Bracco, Milan, Italy) were administred followed by a chaser bolus of 50 ml saline (flow 4 ml/s) using automatic dual-head injector (Stellant® D, MedRad, Indianola, Pennsylvania, USA).

Bolus chaser helps to flush the contrast bolus from the arm veins. A bolus tracking technique was used to synchronize the arrival of the contrast bolus in thoracic aorta. This technique consists of positioning a region of interest (ROI) in the ascending aorta; the scan will start when the attenuation value recorded in the ROI is higher than 100 HU, the attenuation value seen at baseline. When the attenuation value inside the ROI reaches a given threshold, the scan begins.

Cranio-caudal spiral scanning of the heart was performed after mild hyperventilation within a single breathhold at end-inspiratory suspension. CT angiography suspected an intimal flap of ascending aorta, involving aorta valve and with possible involvement coronary artery ostium (Figure 2 a-c); also a possible thrombosed intimal tear of aorta arch was considered (Figure 2 b). CT findings were conflicting with ecocardiography so a thoracic CT ECG-gated was considered and performed using the current protocol in our Institution (criteria in Table 1).

ECG-gated examination excluded intimal flap in the ascending aorta and showed the presence of a aorta arch dissection with a thrombus extending to innominate trunck, left common carotid artery and left subclavian artery and the presence of floating thrombus in aorta arch (Figures 3, 4).

At this time, our patient underwent a surgical treatment. For the cardiopulmonary bypass, a retrograde femoral artery cannulation was used in combination with a two-stage venous cannula in the right atrium. Because of the total occlusion of the innominate artery, the right carotid artery was cannulated too. A standard median sternotomy was made. A pericardial tamponade had been found. Blood temperature was reduced to 20 °C and the circulation interrupted. The cerebral perfusion was maintained through the carotid cannula. The aortic arch was opened. No dissection was found into the ascending aorta. The intimal tear was in the transverse arch between the innominate and the subclavian artery. A red thrombus was present into the aortic arch and branched into the 3 supra-aortic vessels. The thrombus was removed and the aortic arch replaced with a 26 mm Dacron graft. The subclavian artery, the left carotid artery and the innominate artery were connected one by one to the graft (Figure 5 a-b).

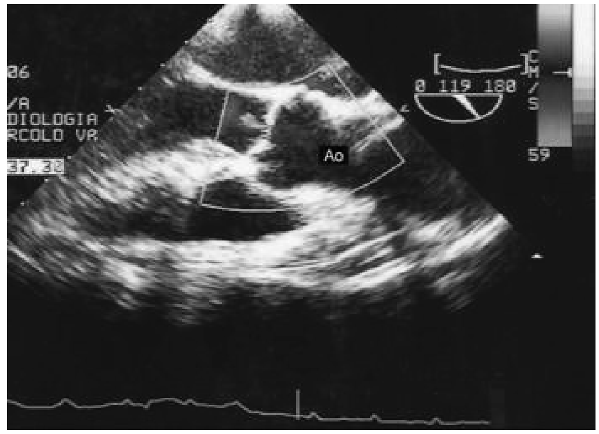

Figure 1 Echocardiogram: no intimal flap is present.

Discussion

CT is an important tool for the evaluation of acute aortic dissection, which requires prompt and accurate diagnosis to initiate appropriate surgical intervention or medical treatment

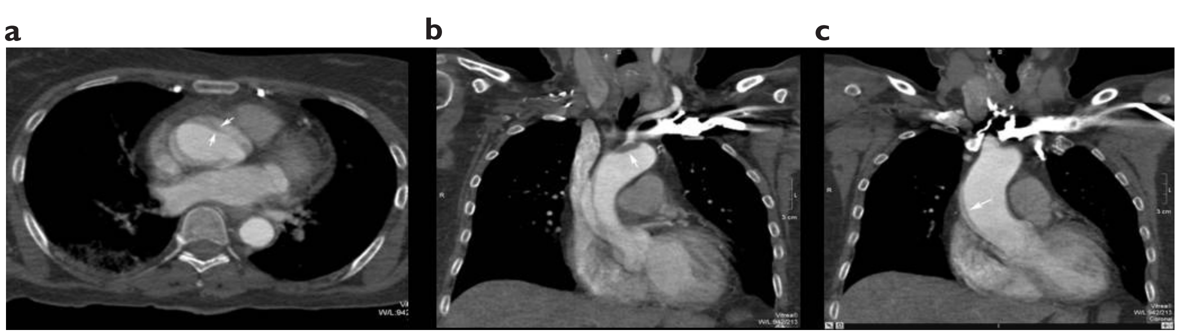

Figure 2 CT-Angio without gating. Pulsation artifacts misappared of aortic valve (**a-c**) and aortic arch thrombus (MPR: **b**); suspected ascending aorta intimal flap (MPR: c)

Table 1 Results of thoracic CT ECG-gated examination

Parameter	Angio-CT	ECG-Gated
Tube voltage	120 Kv	120 Kv
Tube current	100–270 mA (dose modulation)	250 mA
FOV	L-LL	M-L
Collimation	0.5 mm × 64	0.5 mm × 64
Pitch factor	0.64	0.22
Scan time	7–8 sec	14–15 sec
Synchronization technique	Bolus tracking	Bolus tracking
ROI	Ascending aorta	Ascending aorta
Cut-off	+100 HU	+100 HU
Volume contrast material	80–90 ml	90–100 ml
Flow rate contrast material	4 ml/sec	4/5 ml/sec
Concentration contrast material	370/400 mgl/ml	370/400 mgl/ml
Volume bolus chaser	40 ml	40 ml
Flow rate bolus chaser	4 ml/sec	4/5 ml/sec

Abbreviations: CT, computed tomography; ECG, electrocardiogram; FOV, field of view; ROI, region of interest.

(Fisher et al 1994; Batra et al 2000). A confident diagnosis of aortic dissection relies on the visualization of an intimal flap in the thoracic aorta and the presence of enhanced or thrombosed true and false lumens.

A variety of pitfalls were encountered that mimicked aortic dissection in CT examinations (Batra et al 2000). These pitfalls were attributable to technical factors (eg, improper contrast material timing); streak artifacts generated by high attenuation materials or high contrast interfaces; aortic variations, such as congenital ductus diverticulum and acquired aortic aneurysm with thrombus; peri-aortic structures (eg, aortic arch branches); and, finally, streaks caused by cardiac pulsation and aortic wall motion. Although several of these pitfalls are easy to recognize and unlikely to present a diagnostic problem, others are potentially confusing.

In the study of Ko and colleagues (2005) aortic motion artifacts were frequently seen on thoracic MDCT, with an overall prevalence of 91.9%; thus, familiarity with these artifacts can help avoid false-positive interpretations, especially in patients with clinical presentations of severe chest pain.

Suppression of cardiac pulsation artifacts and aortic wall motion is not only important in the diagnosis or exclusion of aortic dissection, but also for the detection of pulmonary embolism (Schoepf et al 2002).

In addition to enabling noninvasive visualization of the coronary arteries, ECG synchronization has been shown to improve CT image quality in other thoracic structures (Schoepf et al 1999; Montaudon et al 2001). In principle, retrospective ECG-gating enables a reduction of transmitted cardiac pulsation in more extensive scanning volumes.

A pseudodissection spiral artifact of the ascending thoracic aorta has been previously described, and segmental reconstruction has been proposed to correct this (Qanadli et al 1999; Montaudon et al 2001). Retrospective gating eliminated this artifact on the axial images in our case, similar to the experience of Roos and colleagues (2002). In our case, we observed motion artifacts both the axial and multiplanar (coronal) images (Figure 2 a-b). Some authors observed more motion artifacts in multiplanar images than axial images. We ttributed these artifacts to segmental data collection during continuous table motion (Ohnesorge et al 2000; Jacobs et al 2002; Roos et al 2002; Schoepf et al 2004). These artifacts have been shown to be more pronounced with increasing heart rate and are also influenced by incorrect pitch or time reconstruction point in the R-R interval (Hong et al 2001; Choi et al 2004; Hofmann et al 2004). For decreasing cardiac pulsation motion

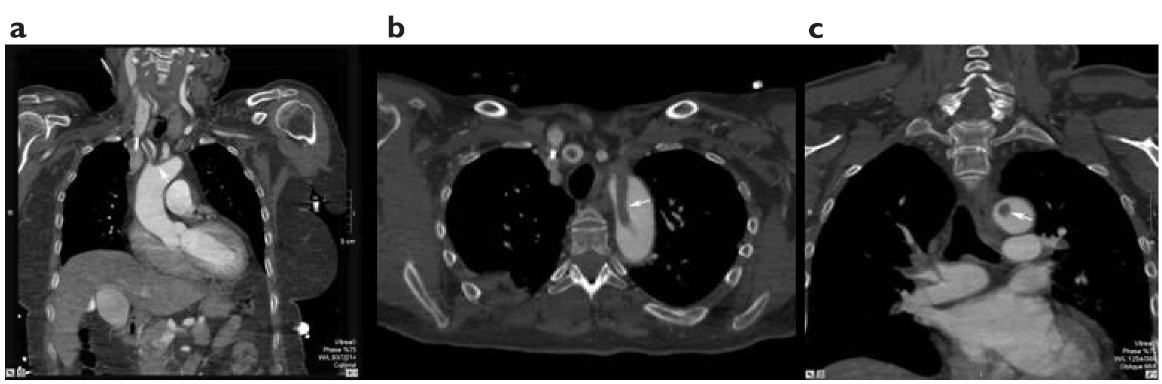

Figure 3 CT-Angio ECG-gated. Excluded aortic valve dissection (**a**), showed thrombus of innominate trunk, left common carotid artery and left subclavian artery (**b**-**c**).

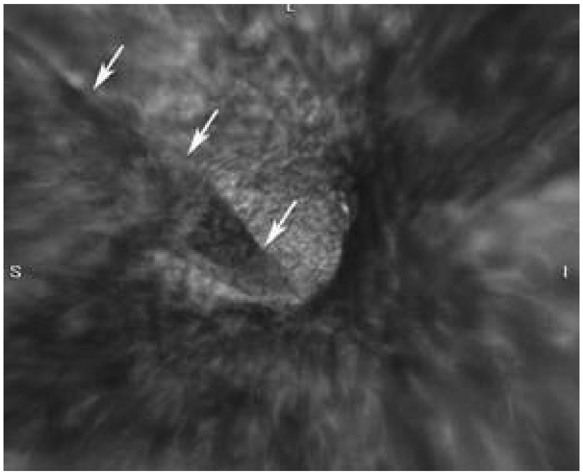

Figure 4 Virtual Endoscopy (3D EV): confirmed extension of aorta arch thrombus.

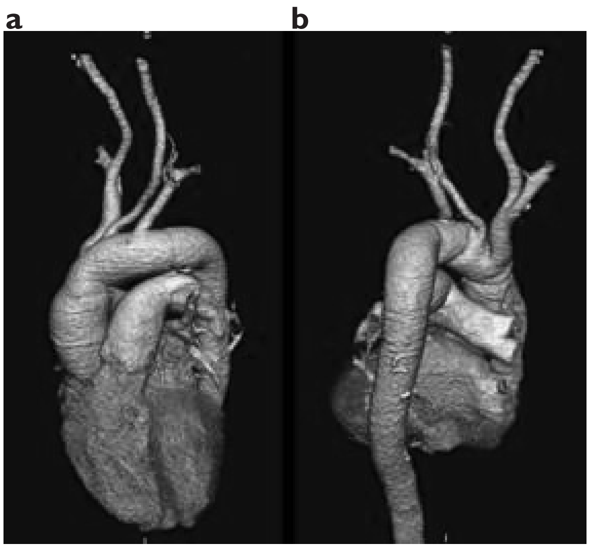

Figure 5 a-b Volume Rendering (3D VR): CT-Angio after sovraortic vessels debrunching.

artifacts, the best results have been reported from studies in which prospective gating with nonhelical scanning was used (Schoepf et al 1999; Boehm et al 2003; Marten et al 2003). Even in those studies, however, the clinical usefulness of the improved resolution was questionable.

Conclusion

In our experience MDCT ECG-gated could be useful to differentiate a "true" thrombosis of the sovraortic vessels from a thrombosis of the false lume dissection. Therefore it has contributed to not only characterize the cause of the thoracic pain but it has allowed correct preoperative assessment. In conclusion from the data found in the literature, the case matched our observation that the ECG-gated examination is mandatory every time a difference is present between CT imaging and clinical symptom in thoracic aorta disease.

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