European Journal of Radiology 74 (2010) 24–39

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Acute Aortic Syndrome and Blunt Traumatic Aortic Injury: Pictorial review of MDCT imaging

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ARTICLE INFO

Article history:
Received 23 June 2009
Accepted 23 June 2009

Keywords:
Aorta
Dissection
Trauma
CT
Emergency

ABSTRACT

Thoracic aortic emergencies have high mortality and morbidity and should be diagnosed accurately and treated promptly. Advances in treatment options have increased survival and management choices heavily depend on imaging findings. Speed, accuracy and availability have made Multi Detector Computer Tomography (MDCT) the first line modality in evaluating thoracic aortic emergencies and radiologists should be familiar with findings in these conditions. In this paper a pictorial review of the Acute Aortic Syndrome and Blunt Traumatic Aortic Injury will be given.

1. Introduction

Thoracic aortic emergencies, both non-traumatic and traumatic, are life-threatening conditions that need to be diagnosed accurately and treated promptly. Clinical as well as radiological presentation may vary, challenging the treating physicians and radiologists in emergency settings. Speed, sensitivity and availability have made Multi Detector Computer Tomography (MDCT) the modality of choice to evaluate patients suspected of suffering from acute thoracic aortic injuries.

The purpose of this paper is to illustrate MDCT findings of the most frequently encountered non-traumatic and traumatic thoracic aortic emergencies. Imaging technique, typical imaging findings, pitfalls and rarities will be discussed of the Acute Aortic Syndrome (AAS: aortic dissection, intramural hematoma and penetrating atherosclerotic ulcer) and Blunt Thoracic Aortic Injury (BTAI).

1.1. Imaging technique

Imaging protocols for MDCT evaluation of the thoracic aorta vary considerably, depending on the technical specifications of the CT-scanner (e.g. number of detector rows, the availability of electrocardiographic (ECG)-gating, etc.). Opinions on the use of multiple phases differ per institution and a variety of imaging protocols is recommended in the literature.

In general, axial reconstruction thickness should be between 1 and 3 mm, using 4×2.5 mm collimation, on four-row scanners, 16×1.25 mm (or 1.5 mm) on 16-row scanners, 64×0.5 mm on 64-row scanners and 128×0.6 mm on the new 128-row scanners. Oblique reconstructions, resembling the images obtained in conventional angiography, as well as sagittal, coronal and multiplanar reconstructions (MPRs) should be generated on a 3D workstation whenever findings are equivocal on axial data sets, necessitating axial reconstructions with one-third (3×2) to one-half (2×1) overlap in scanners up to 16 detector rows. Due to isotropic voxel datasets in scanners with 64 detector rows or more, overlap in axial reconstructions is not an issue.

Because displacement of intimal calcifications or a high-attenuating crescent in intramural hematomas (IMH) may be overlooked on contrast-enhanced images, a standard scanning protocol in non-traumatic aortic emergencies should include a non-enhanced phase of the thoracic aorta. In addition, arterial phase scans of the complete aorto-iliac trajectory should be acquired following intravenous contrast administration with a flow of 4–6 ml/s.

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0720-048X/$ – see front matter © 2009 Published by Elsevier Ireland Ltd.
doi:10.1016/j.ejrad.2009.06.023

To account for individual cardiac output, bolus triggering software should be used if possible, with the Region of Interest (ROI) placed over the proximal descending thoracic aorta and trigger set at 120 HU. A saline chaser should be utilized to tighten the bolus and eliminate streak artifacts from pooling of contrast material. A third phase scan (venous phase, 60 s after start of contrast administration) is not mandatory in all situations, but may be useful to evaluate late enhancement of false lumina and minor extravasations, as well as enhancement of the abdominal organs that may be compromised in aortic emergencies.

In case of traumatic aortic injuries, the trajectory imaged may be restricted to the thoracic aorta and scanning in a single contrast-enhanced phase may suffice. In trauma patients, who are often young, the radiation dose employed should be kept as low as possible.

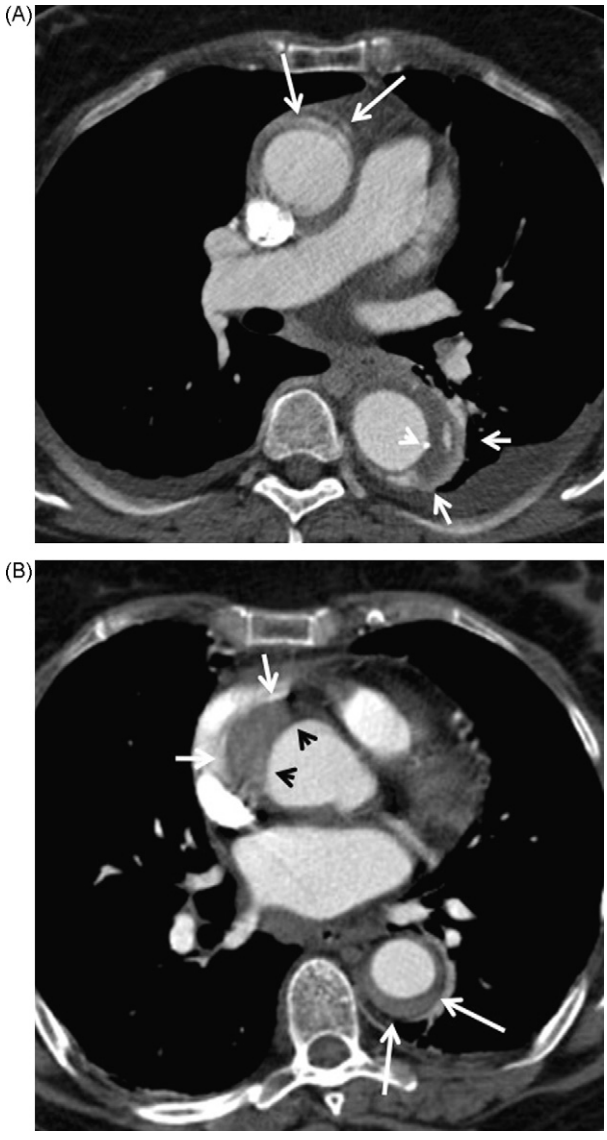

Fig. 1. Use of ECG-gating to reduce pulsation artifacts. (A) Due to pulsation artifacts (long arrows), involvement of the aortic root cannot be reliably excluded in a patient with an intramural hematoma of the descending aorta, as seen by displaced intimal calcification (arrowhead) and hematoma in the descending aortic wall (short arrows). Regions of contrast in the hematoma indicate the intima has been disrupted due to pressure by the intramural hematoma. (B) In another patient, scanned with prospective ECG-gating, clear intramural hematoma around the aortic root can be visualized (white arrows) with sharp delineation of the aortic wall (black arrowheads).

Pulsation, breathing and streaking artifacts may be troublesome even for the experienced radiologist, so these should be diminished if possible. ECG-gating may reduce pulsation artifacts, but comes at a cost of extra radiation exposure, and is therefore used only in equivocal cases in our institution (Fig. 1). A breath-hold technique should be used to minimize breathing artifacts, if possible by command in conscious patients or mechanically induced in ventilated patients. To minimize streak artifacts over the region of the branches of the aortic arch, contrast administration is preferably by injection in the right arm and a saline chaser should be utilized.

New scanner designs might offer some solutions to the above-mentioned problems. The need for breath hold and gating may be eliminated by use of a high pitch and a temporal resolution of 75 ms. Moreover, even in gated scans extremely low radiation doses may be obtained using a kV of 100.

Arms should preferably be raised above the head, not only to reduce noise and artifacts, but also to decrease radiation dose [1]. In some trauma situations, this may however not be possible.

Ideally, the CT and reading rooms should be in the emergency department or in close range, to reduce transportation times and facilitate communication of treating physicians and radiologists.

1.2. Acute Aortic Syndrome

In 2001 Vilacosta and San Román introduced the Acute Aortic Syndrome as an entity grouping clinically indistinguishable acute aortic diseases in patients presenting with aortic pain and a coexisting history of hypertension [2]. AAS may be caused by classical aortic dissection (AD), intramural hematoma (IMH) or penetrating atherosclerotic ulcer (PAU). Pain in patients with AAS is typically characterized as intense, acute, searing or tearing, throbbing and migratory. The part of the thoracic aorta affected will define the location of the pain, involving the anterior chest, neck, throat and even jaw in ascending aortic pathology and involving back and abdomen in descending aortic pathology. The different entities of AAS are interrelated, both IMH and PAU being able to progress to classic AD [2].

Although unstable thoracic aneurysms and pseudoaneurysms may present with similar pain, these usually do not present with hypertension and are therefore not included in AAS. These entities may be encountered on scans preformed to rule out dissection, but will not be further discussed in this paper.

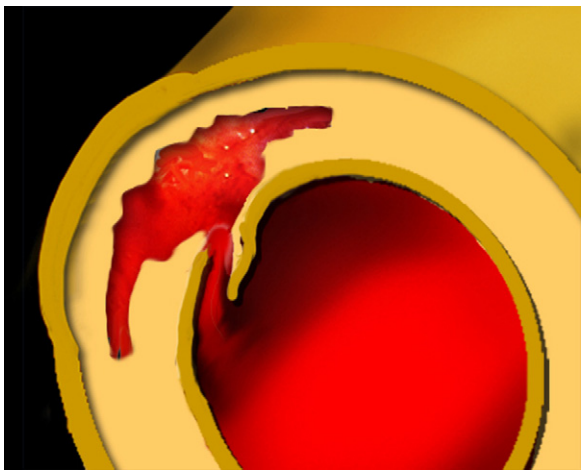

Fig. 2. Schematic drawing of classic aortic dissection. A clear breach of the innermost layer of the aortic wall can be seen with direct communication of true and false lumina and an intimomedial flap at the entry point to the false lumen in the media.