Feasibility of applying computed tomography imaging in acute aortic syndromes

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Abstract. Acute aortic syndromes (AAS) is one of the most frequently symptoms with acute chest pain. Aortic computed tomography angiography can assess aortic dissection, penetrating aortic ulcer, and intramural hematoma effectively. Imaging features include false and true lumen of aorta in aortic dissection. False lumen is usually larger than true lumen. Imaging features of intramural hematoma include thickened wall which is more than 5 mm, the thickened wall is not enhanced after injection of contrast agent. Imaging features of penetrating aortic ulcer include niche from the aortic wall. Post-processing methods include multi-planar reconstruction (MPR), curved-planar reconstruction (CPR) and volume rendering (VR). These methods are common techniques to assess acute aortic syndromes.

1. Introduction

Acute aortic syndromes (AAS) is one of the most frequently symptoms with acute chest pain (ACP) [1-3]. AAS is the common cause for life-threatening aortic disorders. These aortic disorders include classic aortic dissection (AD), penetrating aortic ulcer (PAU), and intramural hematoma (IMH) [4-7]. AAS is used for differential diagnosis from acute coronary artery disease (CAD) and pulmonary embolism (PE) in ACP. AD is the first common cause, followed by intramural hematoma and penetrating aortic ulcer. Computed tomography imaging, especially computed tomography angiography is still the first choice in timely diagnosis of acute aortic syndromes. Conventional aortic dissection can be diagnosed easily in computed tomography angiography, usually showing false lumen and true lumen. With help of ruptured location and involvement associated aorta, aortic dissection is classified to different systems, such as Stanford system, Stanford type A will involve the ascending aorta, and Stanford type B will involve the descending aorta [8-10]. However, as life-threatening disorders, intramural hematoma and penetrating aortic ulcer are usually misdiagnosed, because the imaging features of IMH and PAU are similar to the aortic atherosclerosis [11]. Regarding to different treatment, such as, endovascular treatment, open surgical management, or other medical therapy, accurate diagnosis of acute aortic syndromes with CTA is important.

The purpose of this research was to evaluate the feasibility of computed tomography angiography in differentiation diseases of aortic dissection, penetrating aortic ulcer, and intramural hematoma. Multi-planar reconstruction, Curved-planar reconstruction and other post-processing techniques are used in our study to evaluate aortic diseases.
2. Materials and methods

2.1 Patient characteristics
From Jul 2019 to Nov 2019, 146 patients performed aortic CTA were enrolled into this research. All patients were underwent examination of aortic CTA for accessing ACP, such as AD or PAU. Patients with the relevant contraindications were excluded, such as arrhythmia, iodic allergy, severe renal failure or organ failure.

2.2 Computed tomography protocol
Aortic CTA were used on Brilliance iCT, and the parameters included rotation time of 0.27 s, coverage with 80 mm. Tube voltage with 120 kVp, tube current with 800 mAs and slice thickness with 0.9 mm. Scanning range was from the level of subclavian artery to the proximal segment of femoral artery. The automated bolus tracking (ABT) technique was performed in aortic CTA, when CT value of region of interest (ROI) higher than 150 Hu, scanning was performed after delay of 4-7 s. Contrast agent (Omnipaque, 350 mg/ml) 80-100 ml at 5.0 ml/s.

2.3 Post-processing technique
Axial section images were used to assess AAS in all patients. Besides observing from workstation, a film with 192 axial sections was printed, and the range was from lung apices to the proximal segment of femoral artery. Multi-planar reconstruction (MPR) was used to evaluate aortic artery. A film with 16 MPR images was printed, the images showed main organ of the aorta, such as ascending thoracic aorta, aortic arch, descending thoracic aorta, renal artery, superior mesenteric artery, celiac trunk, bilateral common iliac arteries and the proximal segment of femoral artery. Furthermore, volume rendering technique (VR) was used to evaluate above arteries. Volume rendering (VR) technology can show the structure of each branches of the aorta. MPR technique was used to evaluate degree of stenosis.

3. Results and Discussions

3.1 Patient characteristics
Aortic dissection was found in 54 patients (36.9%). Aortic atherosclerosis was found in 51 patients (35.1%). IMH was diagnosed in 19 patients (13.0%). Penetrating atherosclerotic ulcer of aorta was diagnosed in 22 patients (15.0%).

3.2 Aortic dissection
Aortic dissection was divided into Stanford type A and B. Imaging features included double lumen, the true lumen was smaller than false lumen. As shown in Fig.1a, aortic dissection was observed in the aortic arch (white arrow). Fig.1b showed in the proximal segment of aortic arch (white arrow). Fig.1c showed involved SM artery. Fig.1d showed VR imaging of aorta.

Fig.1 CTA features of aortic dissection. (a) Dissection (white arrow). (b) Dissection (white arrow). (c) SM artery. (d) VR of aorta.
3.3 Intramural hematoma
Imaging features of intramural hematoma included thickened aortic wall, without enhancement. As shown in Fig.2a, intramural hematoma was observed in the aortic arch (white arrow). Fig.2b showed intramural hematoma in the ascending aorta. Fig.2c showed intramural hematoma in the ascending and descending aorta. Fig.2d showed VR imaging of aorta.

![Fig.2 CTA features of intramural hematoma.](image)

3.4 Penetrating atherosclerotic ulcer
CT imaging features of penetrating atherosclerotic ulcer would show niche outside the lumen, which could induce mild niche, moderate niche. As shown in Fig.3a, intramural hematoma was observed in the aortic arch (white arrow). Fig.3b showed penetrating atherosclerotic ulcer (white arrow). Fig.3c showed penetrating atherosclerotic ulcer. Fig.3d showed VR imaging of penetrating atherosclerotic ulcer.

![Fig.3 CTA features of penetrating atherosclerotic ulcer.](image)

4. Conclusion
Technique of aortic CTA can evaluate classic aortic dissection, penetrating aortic ulcer, and intramural hematoma. Multi-planar reconstruction, Curved-planar reconstruction and other post-processing techniques are effective methods to evaluate acute aortic syndromes.

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