Feasibility of applying computed tomography angiography in diagnosing and classifying aortic intramural hematoma

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Abstract. IMH is a common manifestation of aortic disease, which is also a common lesion in acute aortic syndromes. It is often considered as a precursor of AD. Paying close attention to the development of IMH is important for the prognosis of patients. CTA can effectively determine the location and range of IMH and whether it is associated with AD. At present, post-processing techniques of computed tomography angiography include MPR, CPR, VR. These methods are commonly used to evaluate IMH.

1. Introduction
Aortic intramural hematoma (IMH) is a progressive pathological process. Unlike aortic dissection (AD), it has no intimal tear and the blood is confined between intima and media to form hematoma[1-2]. But if the intima ruptures and the blood enters the false lumen, it will develop into an extremely dangerous AD, so IMH is the beginning of AD[3-4]. Clinically, the symptoms of IMH and AD are sometimes very similar, it is particularly significant to make rapid and accurate diagnosis and differential diagnosis[5]. In traditional examination methods, using electrocardiogram or myocardial enzyme screening to judge them is unsatisfactory. Studies have shown that MRI, transesophageal echocardiography (TEE) and computed tomography angiography (CTA) are often used in the diagnosis of IMH[6-7]. However, the MRI examination takes a long time, and patients with metal materials in their bodies are not intolerant. In TEE, when IMH presented a subtle echo appearance and the crescentic wall thickness was less 7-mm, there are errors in the identification of IMH and AD[8-9]. Therefore, CTA with the powerful post-processing functions is the gold standard, which can not only determine the location and extent of hematoma, but also determine the risk ratio of developing AD and whether it is accompanied by other aortic diseases[10-12]. This provides great help for the prognosis and clinical treatment of patients. With above information, post-processing techniques of CTA can make classification easily, which are divided into Stanford type A and Stanford type B [13-15].

The purpose of this research was to evaluate the feasibility of computed tomography angiography in IMH. We will use the multi-planar reconstruction (MPR), surface reconstruction (CPR), volume rendering (VR) and other post-processing techniques to diagnose and classify IMH.

2. Materials and methods

2.1. Patient characteristics
From Sep 2020 to Nov 2020, 168 patients with or without chest pain performed aortic CTA were selected into this research. They underwent examination of aortic CTA for diagnosing IMH, AD or other
aortic diseases. Patients with severe arrhythmia, liver and kidney dysfunction, iodine allergy and other related contraindications were excluded.

2.2. Computed tomography protocol
Aortic CTA were used on 256 slice CT (GE Spectrum CT) with low dose scanning, the scanning direction was from head to toes. The range was from the chest entrance to 1 cm below the greater trochanter of femur. And the concrete parameters included that slice thickness was 0.9 mm, tube voltage was 120 kVp, tube current was 800 mAs and frame rotation speed was 330ms/circle.

2.3. Post-processing technique
It is obvious that IMH could be assess according to the axial section images. Besides imaging doctors observing from work center, patients could get a film with 144 axial sections. It covered the whole aorta. Multi-planar reconstruction (MPR) was used to evaluate aorta. We usually print 16 MPR images as a film which showed the physiological structure of the aorta, including its branches, such as superior mesenteric artery, celiac trunk. As for surface reconstruction (CPR), it mainly showed the location and degree of IMH, as well as the involved vessels. Furthermore, volume rendering technique (VR) relied on the three dimensional reconstruction to show the aorta. In this background, aorta was more vividly than before.

3. Results and Discussions

3.1. Patient characteristics
In this group, 56 patients (33.3%) were diagnosed as aortic intramural hematoma, the ratio of male to female is about 3:1. The rest were diagnosed with other aortic diseases or normal cases.

3.2. Stanford type A
IMH of Stanford type A involves the ascending aorta (with or without involvement of the descending aorta). As shown in Fig.1.1, showed aortic intramural hematoma was observed in the ascending aorta (white arrow). Fig.1.2 showed the intramural hematoma in the CPR. In addition, we could clearly observe the brachiocephalic artery, left common carotid artery and left subclavian artery. Fig.1.3 showed the intramural hematoma in the descending aorta (white arrow). Fig.1.4 showed 3D reformatted image of intramural hematoma.

3.3. Stanford type B
IMH of Stanford type B only affects the descending aorta. As shown in Fig.2.1, showed aortic intramural hematoma was observed in the descending aorta (white arrow). ascending aorta is normal. Fig.2.2
showed ascending aorta without intramural hematoma. Fig.2.3 showed the intramural hematoma in the descending aorta (white arrow). Fig.2.4 showed 3D reformatted image of intramural hematoma.

![Fig.2 CTA features of Stanford type B. (2.1) Axial section images of the IMH (white arrow). (2.2) Ascending aorta in the CPR. (2.3) Sagittal images of the IMH (white arrow). (2.4) VR of aorta.](image)

4. Conclusion
Post-processing techniques of aortic CTA can evaluate and classify aortic intramural hematoma effectively. Close observation of the development of IMH has important clinical significance for the prognosis of patients. If it formed the severe conditions such as AD, pericardial effusion or pleural effusion, CTA will also be diagnosis timely.

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References
[1] Oderich GS, Kärkkäinen JM, Reed NR, et al. Penetrating Aortic Ulcer and Intramural Hematoma[J]. Cardiovasc Intervent Radiol. 2019 Mar;42(3):321-334.
[2] Kruse MJ, Johnson PT, et al. Aortic intramural hematoma: review of high-risk imaging features[J]. J Cardiovasc Comput Tomogr. 2013 Jul-Aug;7(4):267-72.
[3] Mussa FF, Horton JD, et al. Acute Aortic Dissection and Intramural Hematoma: A Systematic Review[J]. JAMA. 2016 Aug 16;316(7):754-63.
[4] Tanaka A, Leake S, Estrera AL. Management strategies in acute type B aortic intramural hematoma[J]. Curr Opin Cardiol. 2017 Nov;32(6):687-691.
[5] Ciccone MM, Dentamaro I, Masi F, et al. Advances in the diagnosis of acute aortic syndromes: Role of imaging techniques[J]. Vasc Med. 2016 Jun;21(3):239-50.
[6] Ferrera C, Vilacosta I, Cabeza B, et al. Diagnosing Aortic Intramural Hematoma: Current Perspectives[J]. Vasc Health Risk Manag. 2020 Jun 8; 16: 203-213.
[7] Li Z, Lu B, Chen Y, et al. Acute type B aortic intramural hematoma: the added prognostic value of a follow-up CT[J]. Eur Radiol. 2019 Dec;29(12):6571-6580.
[8] Mansour M, Berkery W, et al. Mild thickening of the aortic wall: subtle intramural hematoma? [J]. Echocardiography. 2001 Aug;18(6):519-22.
[9] Song JK. Aortic intramural hematoma: aspects of pathogenesis 2011[J]. Herz. 2011 Sep;36(6):488-97.
[10] Herrán FL, Bang TJ, Restauri N, et al. CT imaging of complications of aortic intramural hematoma: a pictorial essay[J]. Diagn Interv Radiol. 2018 Nov;24(6):342-347.
[11] Haring B, Kickuth R, et al. [Aortic Intramural Hematoma: a Challenging Diagnosis] [J]. Dtsch Med Wochenschr. 2019 Apr;144(7):484-488.
[12] Chao CP, Walker TG, Kalva SP. Natural history and CT appearances of aortic intramural hematoma[J]. Radiographics. 2009 May-Jun;29(3):791-804.
[13] Paolucci M, Van Damme H, et al. [Type A intramural hematoma of aorta: An undervalued clinical entity] [J]. J Med Vasc. 2018 May;43(3):206-212.
[14] Li L, Jiao Y, et al. Thoracic Endovascular Aortic Repair versus Best Medical Treatment for High-Risk Type B Intramural Hematoma: A Systematic Review of Clinical Studies[J]. Ann Vasc Surg. 2018 Oct; 52: 273-279.
[15] Gutschow SE, Walker CM, Martinez-Jiménez S, et al. Emerging Concepts in Intramural Hematoma Imaging[J]. Radiographics. 2016 May-Jun; 36(3): 660-74.