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Case Report

Utility of four-dimensional computed tomography angiography for evaluating the mobility of a thrombus in the ascending aorta

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ABSTRACT

Four-dimensional computed tomography has been used to evaluate moving structures and is a useful method to diagnose cardiovascular diseases. We report a case of cerebral infarction due to the thrombus in the ascending aorta, and utilized 4-dimensional computed tomography angiography for visualizing the movement of the thrombus, which prompted early surgical intervention to prevent further thromboembolism. Although transesophageal echocardiography is an established method to evaluate the ascending aorta, it has some contraindications and complications. Four-dimensional computed tomography angiography is an excellent alternative without blind spots to evaluate the ascending aorta more quickly than transesophageal echocardiography.

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Introduction

A thrombus in the ascending aorta is a potential cause of systemic embolism, and the majority is related to the established atherosclerotic lesions or aneurysm of thoracic aorta. Atherosclerotic disease of the aortic arch is associated with

the risk of ischemic stroke [1]. Established methods to evaluate the ascending aorta are contrast-enhanced computed tomography (CECT), transesophageal echocardiography (TEE), and magnetic resonance imaging (MRI). Recently we can make clear animation images with 4-dimensional computed tomography angiography (4DCTA). In this case, our 4DCTA could evaluate the mobility of a thrombus in the ascending aorta

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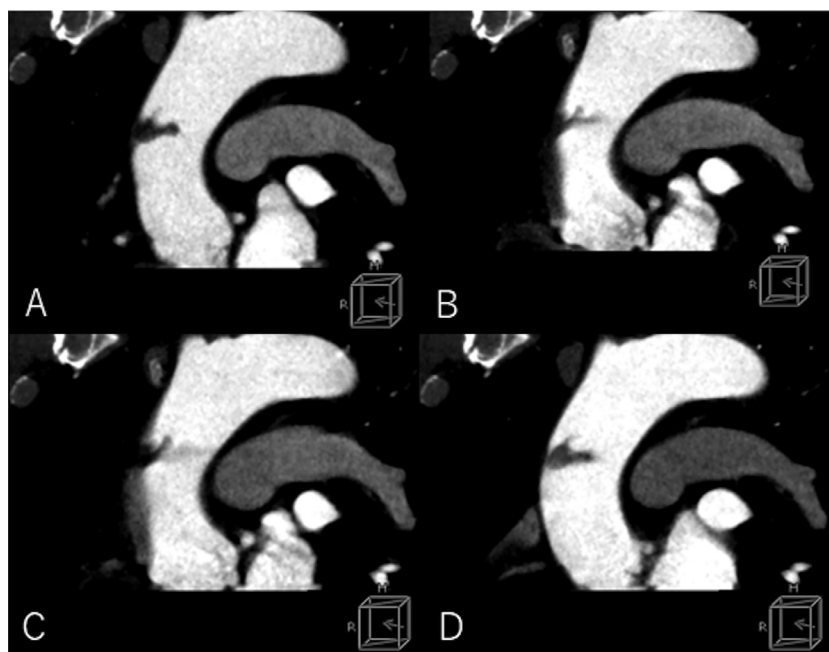


Fig. 1 – Selected frames from a dynamic study demonstrating the motion of the thrombus in the ascending aorta. (A) The first image. (B, C, D) 1, 2, and 3 seconds after the first image show the motion of the mobile thrombus.

and indicated the need for early surgical intervention. In some situations, CECT is more reasonable than TEE and MRI because CECT is faster, non-invasive, less complications, and less contraindications. If TEE or MRI is not available or is contraindicated, 4DCTA is an excellent alternative to detect and evaluate mobile thrombus in the aorta.

Case presentation

A 63-year-old man presented with a transient left hemiplegia and disturbance of consciousness. He did not have a medical history, and had been smoking a pack of cigarettes a day. Arriving at hospital, he did not complain left hemiplegia. However, during evaluations, he was found to have left hemiplegia and disturbance of consciousness, but improved thereafter. His symptoms fluctuated during initial presentations. Findings on brain computed tomography was unremarkable but MRI of diffusion weighted image revealed high-intensity signals in the right cortex of parietal lobe. We diagnosed him with acute ischemic stroke, and suspected ascending aortic dissection because his symptoms fluctuated, which was sometimes caused by ascending aortic dissection impairing blood flow of the right carotid artery. CECT revealed a thrombus which was protruding in the ascending aorta, and right renal infarction were also detected. Aortic aneurysm and/or multiple, ulcerated atherosclerotic plaques with an irregularly spiculated shape of the aortic wall were not detected. In addition, atrial fibrillation had not been documented. We treated him with unfractionated heparin to prevent further embolization. Transthoracic echocardiography could not detect the thrombus, but 4-dimension computed tomography angiography

revealed its shape and mobility (Fig. 1, Video supplement 1 and 2).

Therefore, we strongly considered it to be a mobile thrombus that could be a cause of ischemic stroke and a risk for further systemic embolization. In that condition, we hesitated to do TEE preoperatively. In the operating room, TEE was performed during the operation after the induction of the general anesthesia and it did not detect a patent foramen ovale, an atrial septal defect, and a thrombus in the left atrial appendage. In addition, TEE showed mobility of the thrombus in the ascending aorta as well as 4DCTA images, and no remarkable arteriosclerotic change (Video supplement 3). The patient underwent an operation with median sternotomy to remove a segment of the ascending aorta and to replace it with a short segment of prosthetic graft material (Fig. 2). The pathology of the removed aorta showed that the aortic intima was tore up and clots (white thrombus) were attached at the site of it. Together with the result of TEE, we diagnosed the thrombus in the ascending aorta as the cause of ischemic stroke according to the 4DCTA findings. After the surgery, he did not have any surgical complications and was discharged without the sequelae of the stroke.

Discussion

4DCT is a 3-dimensional computed tomography with temporal resolution [2]. 4DCT has been used to evaluate the movement of the acromioclavicular joint, cerebral aneurysm, arteriovenous malformations, a tethered aortic mechanical valve leaflet, sizing for transcatheter aortic valve implantation, in radiation oncology for planning purpose of lung cancer

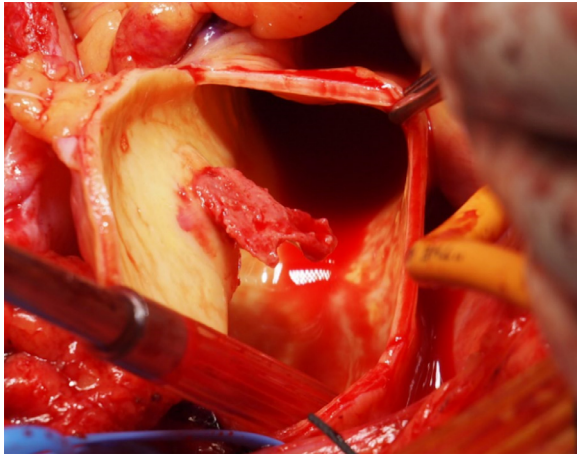


Fig. 2. – Aortotomy showing the thrombus in the ascending aorta. Pathological examination revealed that there was a red thrombus with ruptured fibrous capsule below which was a cholesterol-rich atherosclerotic plaque. (Color version of figure is available online).

and breast cancer, and localizing parathyroid gland of hyperparathyroidism [2].

Previous reports demonstrated that a mobile thrombus in the ascending aorta is a risk for cerebral, visceral, and peripheral embolization which can lead to a life-threatening state [3], and the majority is related to the established atherosclerotic lesions or aneurysm of thoracic aorta. The presence of atherosclerotic plaques in the aorta is a risk factor for initial and recurrent ischemic stroke [1,4]. But in younger patients, nonaneurysmal minimally atherosclerotic or normal aorta also has a mobile thrombus which could be a source of infrequent embolism [5]. Our patient was 63-year-old, and his pathological examination showed the red thrombus with slight atherosclerotic change. He smoked a pack of cigarettes a day but did not have any other risk factors of atherosclerosis. The pathophysiology of the embolism is different between younger patients and older patients. Younger patients aged <60 years have aortic atherosclerosis with pure clot formations without TEE evidence of profuse atherosclerosis, but older patients aged >70 years have pure atherosclerosis debris [5]. They represent a specific variant of aortic atherosclerosis with high embolic potential in younger patients. Older patients have many risk factors, on the other hand, younger patients have few risk factors except for smoking. Smoking is a single risk factor of atherosclerosis of the aorta [6] and can be a sole risk of the mobile thrombus in the aorta [5], as shown in this case.

Since our patient had the thrombus in the ascending aorta, he had a further risk of ischemic stroke due to the thrombus, however, that depended on the status of the thrombus. Anticoagulation therapy and surgical procedures play an important role in the management of the thrombus. Early aortic surgery should be considered in such a case with high risk of thromboembolism because anticoagulation alone is associated with a high risk of recurrence and complications [7]. We needed to evaluate the status of the thrombus promptly to indicate whether the early surgical intervention was required or

not. Although both 4DCTA and TEE were available in our hospital, 4DCTA was initially performed to evaluate the mobility of the thrombus in the ascending aorta because we could not perform TEE immediately at that time due to his unstable condition. We also could not perform 4-dimensional-flow cardiovascular magnetic resonance (4D-CMR) because MRI in our institution could not perform it. We checked the state of the thrombus just before and during surgery with TEE, which was consistent with the 4DCTA findings.

Although TEE is an effective method to evaluate the mobility of thrombus in the ascending aorta [5], recent upper gastrointestinal surgery, esophageal varices, bleeding, tumor, and scleroderma are contraindications for the procedure. In addition, gastrointestinal perforation, aspiration pneumonia, swallowing pain, and tooth damages are possible complications during and after TEE [8]. Furthermore, TEE sometimes cannot explore the upper part of the ascending aorta due to the interposition of the left bronchus [9]. In contrast, 4DCTA can provide more complete evaluations in the aorta without blind spot compared with TEE. 4D-CMR is 3-dimensional, time-resolved, 3-directional velocity-encoded magnetic resonance that provides flow velocity data within a volumetric region across the cardiac cycle, and is an excellent method for evaluating the aorta [10]. However, since it takes times, 4D-CMR is suitable for stable patients and 4D-CTA is better in the emergency situation than 4D-CMR.

Although 4DCTA has disadvantages such as radiation exposure, allergic reaction for contrast media, and renal failure due to contrast-induced nephropathy, 4DCTA is more comfortable for patients than TEE which is stressful for them and need shorter scanning time than 4D-CMR. If TEE and 4D-CMR is not available or contraindicated, 4DCTA is an excellent alternative to detect and evaluate mobile thrombus in the aorta.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.radcr.2019.12.005](https://doi.org/10.1016/j.radcr.2019.12.005).

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