CASE REPORT

Exploring inside a shaggy aorta using non-obstructive angioscopy

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SUMMARY

A shaggy aorta is reportedly related to atheromatous embolisation, which causes serious ischaemic damage to various organs. However, its characteristics are poorly understood. Non-obstructive angioscopy (NOA) has been developed to safely detect aortic plaques and injuries. A 70-year-old woman who was found to have a shaggy aorta on CT angiography underwent NOA for precise evaluation of vulnerable aortic plaques and injuries inside the aorta. Vulnerable aortic plaques included puff-like ruptures, chandelier-like ruptures and erosions seen throughout the aorta. Aortic injuries included flaps, slits, subintimal bleeding, dissection and multilayered partitions. The patient had no embolic symptoms or an elevated eosinophil count, estimated glomerular filtration rate or C reactive protein level, compared with the baseline. Various changes in spontaneous vulnerable plaques and injuries inside the aorta that were not apparent on CT were safely revealed on NOA. Thus, NOA may reveal findings indicative of spontaneous and postoperative atheromatous embolisation.

BACKGROUND

An atheroma with an irregular and spiculated appearance is commonly called a 'shaggy aorta'; however, this term has not been clearly defined.¹ A shaggy aorta may cause atheromatous embolisation² (cholesterol embolisation syndrome³), which causes ischaemic damage to the involved organs.⁴ It is also reportedly associated with stroke after thoracic and abdominal endovascular aneurysm repair.^{5 6} The characteristics of a shaggy aorta are poorly understood because direct visualisation was earlier believed to be too dangerous. A 6-Fr percutaneous non-obstructive angioscopy (NOA) system has been developed to safely detect aortic plaques and injuries using rotational pull back.⁷ We present a case wherein the inside of a shaggy aorta was clearly visualised.

CASE PRESENTATION

A 70-year-old woman was referred to our hospital for atypical chest discomfort. She had a history of hypertension, lacunar infarction, chronic obstructive pulmonary disease, percutaneous coronary intervention of the proximal portion of the right coronary artery and percutaneous transcatheter angioplasty of the right common iliac artery 2 years previously. Her current daily medications included 81 mg of aspirin. CT angiography demonstrated a 'shaggy aorta' in both the thoracic and abdominal

segments (figure 1). Coronary angiography was performed using the left brachial approach, but showed no significant stenosis.

INVESTIGATIONS

NOA of the aorta was carefully performed to evaluate the coronary and aortic stents and screen for aortic atherosclerosis.⁷ A protruding, thick and hazy atheroma (figure 1B) with a flap was detected at the aortic arch (figure 2A; video 1). An eccentric plaque (figure 1C) and vulnerable plaques were seen throughout the descending aorta (figure 2B). Debris spontaneously erupted from a puff-like rupture. At the site of erosion, adhered white and red thrombi were detected. A reddish and salmon-pink intima⁷ was observed where the blood pooled adjacent to an erosion, regardless of coronary blood flow; therefore, we thought that the bleeding originated beneath the intima.⁸ Moderate stenosis was observed at the thoracoabdominal aorta (figure 1D), with a chandelier-like rupture reflecting the light of the NOA, containing cholesterol crystals following the puff-like rupture and slit (figure 2C). Erosion and dissection were also demonstrated. Mural thrombi and a small dissection (figure 1E) were observed at the infrarenal abdominal aorta, and NOA showed a multilayered partition (figure 3A) and flap (figure 3B) (video 2).

OUTCOME AND FOLLOW-UP

The day after catheterisation, the eosinophil count (8100/ μ L at baseline, 6000/ μ L after catheterisation), estimated glomerular filtration rate (34.2 mL/min/1.73 m² at baseline, 35.2 mL/min/1.73 m² after catheterisation) and C reactive protein level (0.48 mg/dL at baseline, 0.37 mg/dL after catheterisation) were not significantly altered from the baseline values. The patient had no embolic symptoms at 30 days after the procedure.

DISCUSSION

A shaggy aorta is associated with a high risk of shower embolism after catheterisation or aortic surgery. Therefore, even investigating the inside of such an aorta is considered risky. Advances in transcatheter aortic valve implantation (TAVI) and endovascular aneurysm repair (EVAR) have enabled less-invasive treatment of aortic valve and aortic disease. However, patients with shaggy aortas may be at a high risk of developing thromboembolism even after TAVI and EVAR. TAVI using an embolic protection device can reportedly cause the

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Figure 1 Images of the shaggy aorta obtained using CT angiography. (A) Curved multiplanar reformatted image of the aorta. Protruding plaques and calcification were detected simultaneously. A flap was detected at the level of the diaphragm (area ③). Figures (B)–(E) are axial images of the parts in (A) indicated by the yellow arrows labelled ①–④. (B) Axial image at the level of the aortic arch. Protruding plaque or thrombi as low-density areas can be seen. (C) Axial image at the level of the descending aorta. Eccentric plaque or thrombi with mild stenosis can be seen. (D) Axial image at the level of the thoracoabdominal aorta. Eccentric plaque or thrombi with moderate stenosis can be seen. (E) Axial image at the level of the infrarenal aorta. A double lumen can be seen in a normal-sized aorta, suggesting a small dissection or penetrating atherosclerotic ulcer.

dislodgement of atheromas and carries a risk of cerebral lesions or stroke.^{9 10} Previously, intra-aortic atheromas were considered to be responsible for spontaneous embolism,¹¹ but the origin of atheromas is difficult to ascertain. Mobile aortic atheromas are a cause of atheromatous embolism, but they can only be diagnosed by transesophageal echocardiography.^{12 13} Thus, introduction of the novel NOA technique has helped overcome the problems associated with shaggy aorta examination.

Some modalities do enable aortic atherosclerosis evaluation, such as transesophageal echocardiography, aortography,

Figure 2 Angioscopic images for each of the areas indicated in figure 1B–D. Continuous images were connected to each other (B and C). The series of images resembled a caterpillar because the catheter was rotated in a cylinder-shaped aorta. (A) A flap was detected on a yellow plaque at the aortic arch (arrows). (B) Puff-like ruptures, erosions, reddish subintimal bleeding and salmon-pink subintimal bleeding were detected throughout the descending aorta. Debris scattered from the puff-like ruptures and erosions. (C) Puff-like ruptures, slits, chandelier-like ruptures, erosions and dissections were detected throughout the thoracoabdominal aorta.

Video 1 Video of flap indicated in figure 2A.

CT angiography and intravascular ultrasound. NOA has been applied to aortas and has detected aortic plaques on autopsy examination. The preliminary data regarding the region from the ascending aorta to the iliac artery in 75 consecutive patients who had or were suspected to have coronary artery disease and no previous detection of aortic aneurysm indicated plaque rupture or erosion could be detected in 86.7% of the patients by NOA, and the number of plaque ruptures and erosions averaged 5.3 ± 5.0 per patient as determined using NOA, without any complications.⁷ Additionally, many types of advanced atherosclerotic plaques were clearly demonstrated using NOA although they were missed in traditional imaging modalities. Transesophageal echocardiography is a non-invasive method to demonstrate aortic plaques, but it may provide the limited information only in aortic arch and descending aorta. Aortography is a traditional method to evaluate the blood flow and the size of aorta invasively. It may miss the information of aortic plaque. CT angiography may non-invasively provide the three-dimensional information including plaques and thrombi. However, its images are static unless performed with ECG gating. The spatial resolution of NOA and CT are 0.15 mm and 0.5 mm, respectively. As shown some examples in reference 7, information of aortic plaques obtained by CT angiography was found to be rough compared with those by NOA because of the limited spatial resolution of CT. Also, 10 MHz intravascular ultrasound for aorta may catch up with images of CT at best. Aortic fluorine 19 (¹⁹F) MRI and 18F-fluoromisonidazole positron emission tomography have

Figure 3 Angioscopic images for the area indicated in figure 1E. (A) Multilayered partition (B) Flap. left: angioscopic images, right: illustrated as dotted lines.

Video 2 Video of multilayered partition indicated in figure 3.

been used in attempts to detect vulnerable plaque, although this use remains experimental. These modalities have the essential limitation of poor spatial resolution.⁷

The only disadvantage of NOA is an invasiveness but it can be performed safely if trained. In the technique we used, a 6-Fr guiding catheter (Ikari 3.5; Terumo, Tokyo, Japan) inserted into a 4.2-Fr probing catheter and a fibre catheter (diameter 0.75 mm) is slowly and carefully pulled back and rotated to enable vessel-wide screening inside the aorta.⁷ In our experience, approximately 500 patients including our patient did not have any complication for 30 days after NOA despite having extensive atheromas. Another advantage of NOA is that it can be conducted in live patients, unlike autopsies. In our patient, we found spontaneous vulnerable plaques and injuries inside a shaggy aorta by using NOA. The puff-like ruptures, chandelier-like ruptures and erosions seen are characteristic of vulnerable aortic plaques on NOA.⁷ Puff-like ruptures and flaps may be responsible for atheromatous embolisation because debris scatters from these plaques. The chandelier-like rupture in the present patient had a yellow surface and reflected the light of NOA, suggesting the presence of cholesterol crystals. As shown previously, asymptomatic scattering of debris from vulnerable plaques inside the aorta occurs commonly in approximately 80% of patients with coronary artery disease.⁷ The type and size of emboli that cause symptomatic atheromatous embolisation should be examined further. Salmon-pink and reddish subintimal bleeding was observed in the present case, suggestive of an active intima-medial or medial injury. Subintimal bleeding has been seen at the edge of coronary stent sites⁸ and inside aortic aneurysms.⁷ Thus, some injuries beneath the intima might cause intimal bleeding in a shaggy aorta. CT angiography could not demonstrate multilayered partitions and flaps because of limitations in spatial resolution. Now NOA can be performed for qualitative or semiquantitative analysis of aortic plaque. Development of NOA is in progress for quantitative analysis to overcome the disadvantage.

In the present case, a shaggy aorta evaluated using NOA showed combinations of vulnerable plaques and intimal/subintimal injuries. Detection of these features using NOA may help decrease the risk of spontaneous or postoperative atheromatous embolisation.

Learning points

- ▶ A shaggy aorta that has a protruding, thick and hazy vessel wall may cause atheromatous embolisation.
- ▶ A 6-Fr percutaneous non-obstructive angioscopic system has been developed to safely detect aortic plaques and injuries.
- ▶ A shaggy aorta evaluated using non-obstructive angioscopy (NOA) showed combinations of vulnerable plaques and intimal/subintimal injuries.
- ▶ Detection of vulnerable plaques and intimal/subintimal injuries using NOA may help decrease the risk of spontaneous or postoperative atheromatous embolisation.

Contributors SK, ST, YT and KK contributed to the conception and planning of the work. ST and YT participated in the conduct and SK wrote the manuscript. SK, ST, YT and KK gave final approval of the version published. SK was responsible for the overall content as guarantor.

Competing interests None declared.

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