Endovascular Surgery for Inflammatory Abdominal Aortic Aneurysm with Contrast Allergy—Usefulness of Carbon Dioxide Angiography and Intravascular Ultrasound: A Case Report

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We report a patient with inflammatory abdominal aortic aneurysm who underwent endovascular aneurysm repair, despite his having an allergy to iodinated contrast medium and anatomy unsuitable for the procedure. Intravascular ultrasound-guided and CO₂-assisted aortic stent graft placement was performed, and the procedures resulted in the successful exclusion of the aneurysm with regression of the mantle sign and resolution of hydronephrosis.

Keywords: EVAR (endovascular aneurysm repair), inflammatory abdominal aortic aneurysms, contrast allergy

INTRODUCTION

Inflammatory abdominal aortic aneurysms (IAAAs), which account for 3%–10% of all abdominal aortic aneurysms (AAAs), are characterized by a thick aneurysmal wall with fibrosis and adjacent structure involvement.¹–³ Open surgical treatment of IAAA is inherently accompanied by higher complication and mortality rates because of technical problems related to inflammation and fibrosis.³ The difficulty of open surgical repair has led to consideration of endovascular aneurysm repair (EVAR) as the first preferred treatment.⁶ Recent studies have demonstrated that EVAR resulted in less frequent and less severe intra-operative complications.⁵,⁶ Therefore, the indication for EVAR has been extended to aneurysms unsuitable for open surgery, including IAAAs.

However, EVAR also has some limitations. Anatomical suitability for performing this technique must be carefully examined preoperatively. Intraoperatively, iodinated contrast medium (ICM) is routinely used for evaluating the initial success of the stent graft replacement in spite of its nephrotoxicity. Intravascular ultrasound (IVUS) and CO₂ angiography are powerful auxiliary techniques and may be an alternative to ICM for patients who have progressive renal dysfunction or allergies to ICM.

We present a patient with an IAAA who underwent EVAR, despite his having an ICM allergy and anatomy unsuitable for the procedure, and demonstrated the usefulness of IVUS and CO₂ angiography.

CASE REPORT

A 59-year-old male with an infrarenal AAA was admitted to our hospital. Four years previously, he was diagnosed with a small AAA, which enlarged 10 mm in size during these 4 years. The patient complained of slight abdominal pain. Vital signs including blood pressure, pulse rate, and respiratory rate were stable. Laboratory data revealed a C-reactive protein elevation of 2.7 mg/dL. His past history included a severe allergic reaction to ICM, long-term treatment of valvular disease,
cerebrovascular infarction, and complex regional pain syndrome after being struck by electric shock. His cardiac function was poor with a left ventricular ejection fraction of 35%, indicating that the patient was unlikely to be a candidate for open aneurysm repair. Plain computed tomography disclosed a thick aortic wall and right hydronephrosis demonstrating a severe inflammatory change in the retroperitoneum (Fig. 1A and 1B). The aneurysm maximal diameters, including thick surrounding tissues, were 64 mm in vertical diameter; and 86 mm, in horizontal diameter. These findings supported the diagnosis of IAAA. We selected endovascular repair, considering the patient’s risks and his ardent desire to undergo EVAR after he provided informed consent.

The anatomical suitability of the aneurysm for EVAR was examined. The aneurysm had a conical neck, and the actual landing area was short, approximately 10 mm in length (Fig. 1C). We chose the Zenith Flex® endovascular graft (COOK Medical, IN, USA) with a main body diameter of 36 mm. We preferred its suprarenal stent hook for securing the stable fixation in the short proximal neck. In addition, right common iliac artery showed aneurismal change and coil embolization on the hypogastric artery was necessary for preventing type 2 endoleak.

With the patient under general anesthesia, we performed coil embolization on the right hypogastric artery with CO2 angiography (30 cc infusion of CO2) (Fig. 2A). Location of the right renal artery, size of devices, and optimal fixation sites were confirmed by high-quality IVUS images (Volcano Visions, PV 8.2F: Volcano Japan Inc., Tokyo, Japan). For the precise placement, we used a sizing-catheter for the measurement and IVUS for the detection of the aortic branch orifices by marking on the monitor with water paint. We could confirm that the stent grafts were accurately placed and deployed just below the renal arteries. Additional bilateral leg deployment was performed under IVUS guidance and CO2 angiography (total CO2, 90 cc).
The flow within the grafts was good without stenosis (Fig. 2C) or delay. No primary endoleak could be visualized by means of the CO₂ completion angiography (Fig. 2C).

The postoperative course was uneventful. Eighteen months after the procedure, the size of the aneurysm had decreased from 86 mm to 60 mm (Fig. 3A and 3B). In addition, preoperative hydronephrosis resolved with stable renal function (Fig. 3B).

**DISCUSSION**

IAAA is characterized by inflammatory changes in the periaortic retroperitoneum, featuring a triad of a thickened aneurysm wall, extensive peri-aneurysmal and retroperitoneal fibrosis, and dense adhesions of adjacent
abdominal organs.\textsuperscript{1–3} Surgical open repair for IAAA occasionally requires skilled procedures and results in worse perioperative mortality than typical AAA surgery. Recently, EVAR has been preferred for IAAA treatment over open surgery because of its excellent initial outcome.\textsuperscript{4,7} However, controversial problems have remained such as the lower regression rate of hydronephrosis in Paravastu's review.\textsuperscript{8}

Although EVAR has great benefit for high-risk AAA patients, the operative selection requires anatomical suitability. The presented case had 2 disadvantages for EVAR. (1) The aneurysm was anatomically unfit for the use of commercially available stent grafts because it had a short neck (hostile neck) of only 10 mm in length. Aneurysms with a short neck are usually subject to type 1 endoleaks. (2) The patient was allergic to ICM, which meant that ICM could not be used for the intra- and post-EVAR evaluation.

As the proximal type 1 endoleak is associated with a higher risk of late conversion and rupture, it should be treated intraoperatively. We have performed intraoperative management for the proximal site to treat the proximal type 1 endoleak, by applying a noncompliant balloon, an aortic cuff, or a Palmaz\textsuperscript{TM} (Cordis, Miami Lakes, FL, USA) stent, and achieved good results.\textsuperscript{9} In this case, the evaluation of the proximal type 1 endoleak might not be sufficient without ICM; thus, we decided to substitute IVUS and CO\textsubscript{2} angiography for ICM.

CO\textsubscript{2} is reportedly safe and useful, especially for patients with preexisting renal dysfunction, ICM allergy, or hyperthyroidism.\textsuperscript{9} Chao et al. revealed that creatinine values remained unchanged in patients who underwent CO\textsubscript{2}-directed EVAR. Furthermore, the short-term outcomes of patients who underwent CO\textsubscript{2}-directed EVAR with regard to the incidence of late endoleaks, endograft revision rate, accompanying complications, and the length of hospital stay were equivalent to those of ICM with CO\textsubscript{2}.\textsuperscript{10} From these findings, CO\textsubscript{2} as an angiographic contrast agent may be recommended to prevent dialysis and reduce the risk of contrast nephrotoxicity or allergic reactions. However, the chemical features of CO\textsubscript{2}, namely buoyancy and affinity for water, result in reduced anatomical definition and increased radiation exposure, which account for the disadvantages of the EVAR procedure. The flow of CO\textsubscript{2} is slower than that of ICM, which increased the radiation exposure time. In addition, CO\textsubscript{2} is absorbed in water too rapidly to evaluate the delayed backflow toward the aneurysmal sac that is typical of type 2 endoleaks.

IVUS has been reportedly adopted as an alternative method to ICM that allows for high-quality imaging for the identification of aortic aneurysm morphology and arterial anatomy, which is helpful in determining graft size and measuring the distance between aortic branches. IVUS can also be used to assess the adequacy of graft apposition after deployment.\textsuperscript{11} In our previous study, IVUS successfully reduced the required volume of contrast agents used for angiography during EVAR procedures.\textsuperscript{12} Therefore, IVUS helps in reducing the duration and necessity of contrast imaging during endovascular reconstruction and facilitates the precise placement of stent grafts. In our case, the operative time and radiation exposure, both of which are considered disadvantages of CO\textsubscript{2} angiography, could be reduced using accurate, immediate, and dynamic images obtained by IVUS. IVUS and CO\textsubscript{2} enabled us to visualize the anatomy of the patient adequately. Our experience indicates that the combined use of IVUS and CO\textsubscript{2} angiography can provide precise endovascular imaging and reduce the risk of ICM related complications.

Tracking postoperative changes of EVAR with plain CT and transabdominal ultrasound may not be sufficient,\textsuperscript{13} especially for evaluating endoleaks. Fortunately, our case demonstrated a drastic regression in aneurysmal diameter, regression of the surrounding tissue of the aorta, and resolution of hydronephrosis, which indicated successful exclusion of the aneurysm.

In conclusion, the combination of CO\textsubscript{2} angiography and IVUS for EVAR is a good alternative for patients who are allergic to ICM or those with progressive renal dysfunctions. However, simple CO\textsubscript{2} injection is not sufficient to evaluate the delayed flow of type 2 endoleaks. We were fortunately able to demonstrate the successful exclusion of IAAA, which was proven by the improvement of inflammation and regression of the characteristic thick aortic tissue and hydronephrosis.

\textbf{References}

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