ELSEVIER

Case Report

Endovascular Aortoiliac Aneurysm Repair with Fenestrated Stent Graft and Iliac Side Branch Using Image Fusion without Iodinated Contrast Medium

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Background: The endovascular aneurysm repair (EVAR) is becoming the preferred method to treat an aortic aneurysm with its better short-term postoperative mortality and morbidity rates in comparison with the open repair. A main drawback of this method is the need to use a nephrotoxic iodinated contrast medium to visualize the aorta and its side branches.
Case Report: An 83-year-old man with an asymptomatic infrarenal aortic aneurysm of a 51-mm diameter accompanied by a 42-mm aneurysm of the left common iliac artery was treated with combined fenestrated EVAR (FEVAR) and iliac side branch stent graft (ISBG) under guidance of image fusion (IF) without the intraoperative use of iodinated contrast agent.
Conclusions: Complex EVAR (FEVAR and ISBG) using computed tomography angiography IF is feasible and together with the use of CO_2 angiography may help to abstain from need to nephrotoxic contrast medium.

The endovascular aneurysm repair (EVAR) is becoming more and more the preferred method to treat the aortic aneurysm replacing the traditional open repair and is performed, as reported, in more than the half of cases with aortic aneurysm in the well-developed countries.[1,2]

To facilitate the operative implementation of the endovascular aortic aneurysmal repair, especially in patients who need more complex endovascular procedures like fenestrated EVAR (FEVAR) or branched EVAR for various aortic aneurysms, the image fusion (IF) overlay technology could be used.[3]

The principle of this method is to register and fuse preacquired image data sets (e.g., computed tomography angiography [CTA] in this case) with another dynamic imaging modality, commonly intraoperative fluoroscopy, and to overlay real-time endovascular maneuvers to the preacquired background data set. Patient's informed consent has been acquired.

CASE REPORT

An 83-year-old man was admitted to the hospital with an asymptomatic infrarenal aortic aneurysm of 51-mm diameter accompanied by a 42-mm aneurysm of the left common iliac artery (Fig. 1).

The preoperative creatinine value was 1.12 mg/dL with a glomerular filtration rate of 60 mL/min.

The CTA (performed using the second generation of dual-source CT scanner; Somatom Definition, Siemens

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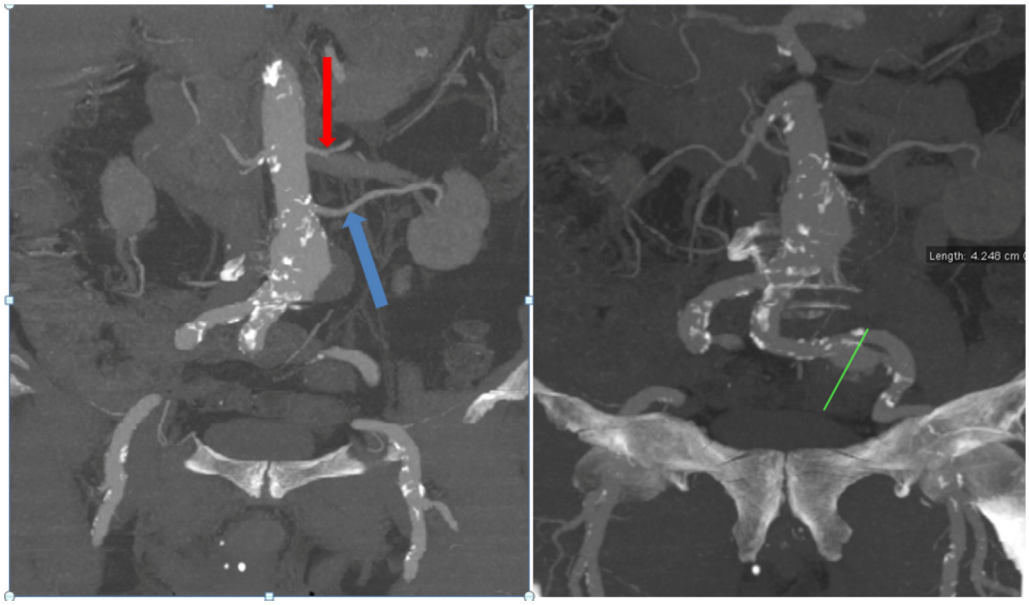

Fig. 1. Preoperative CT-angiography demonstrates an infrarenal aortic aneurysm of a 51-mm diameter accompanied by a 42-mm aneurysm of the left common iliac artery. The *upper red arrow* on the left image marks the left renal artery and the *lower blue arrow* marks the additional left renal artery.

Healthcare, Forchheim, Germany) showed a large additional left renal artery about 26 mm below the lower border of the left renal artery. Given the age of the patient, he was scheduled for endovascular treatment with a fenestrated stent graft using a custom-made repositionable fenestrated Anaconda stent graft (Vascutek, Inchinnan, United Kingdom) with one fenestration for the left additional renal artery and an iliac side branched stent graft (JOTEC E-iliac; JOTEC GmbH, Hechingen, Germany) for the left-sided common iliac artery aneurysm.

The preoperative CTA scans were loaded into the Allura system and processed, using special software (Vessel Navigator®, Philips, Best, Netherlands). The next stage of processing, also called ''segmentation of aorta and its side branches'' was performed automatically with manual correction and took about 3–5 min before the beginning of the surgery. In this step, the aorta and the procedure relevant side branches (and if necessary the exact position, size, and best angels to demonstrate the ostia) are marked.

The third step is the registration of IF overlay: the preoperative CT data set with marked (segmented) vessels of interest (aorta, visceral and internal iliac arteries) was aligned with the images derived, whereas the patient was on the operating table. Two single-shot exposures were performed with a minimum angular difference of $\geq 45°$.

These exposures where performed without any contrast having orientated the major bony structures of the CT that lie close to the area of interest (columnar spine, pelvic ring, and ribs) with the 2 exposure images using a 3-dimensional (3D) workstation (Philips VN on Xtra-Vision 8.8.1). After alignment, the vessels of interest (as selected from the CTA; e.g., aorta, renal arteries, iliac arteries, and so forth) were overlaid on the fluoroscopic image as a 3D-reconstructed image. This image stream was then routed to a separate dedicated color screen with higher magnification adjacent to the normal fluoroscopy screen in the hybrid operating theater.

The procedure was performed under general anesthesia in the hybrid operating room, which was equipped with a ceiling-mounted angiographic C-arm system (Allura, Philips). After intravenous application of 5,000 U of heparin, the common femoral arteries were punctured through femoral cutdown and were then cannulated. The main body of the fenestrated Anaconda stent graft was then deployed through the use of the radiopaque markers. The fenestration was cannulated, followed by placement and deployment of covered Atrium Advanta V12 (Atrium, Hudson, NH, USA) stent with flaring of the aortic third. Then, the crossover stabilizing wire for was placed followed by the body of the iliac side branch stent graft (ISBG; JOTEC E-iliac; JOTEC GmbH, Hechingen, Germany) being placed in the common and external iliac arteries. The left internal iliac artery was cannulated through the contralateral side allowing the insertion of the covered stent graft (Advanta® V12) to be placed inside the internal iliac artery via contralateral 12F sheath. After the final deployment of the ISBG, bridging and contralateral iliac flared legs from the Vascutek were deployed in the common iliac arteries, respectively (Fig. 2).

A completion angiogram using 40 mL of CO_2 was then performed (Fig. 3), followed by standard closure.

The total used amount of CO_2 was 100 mL with procedural time of 172 min, radiation dose (presented as dose area product) of 53,099.7 cGy $\times$ cm^2 and a radiation time of 28 min.

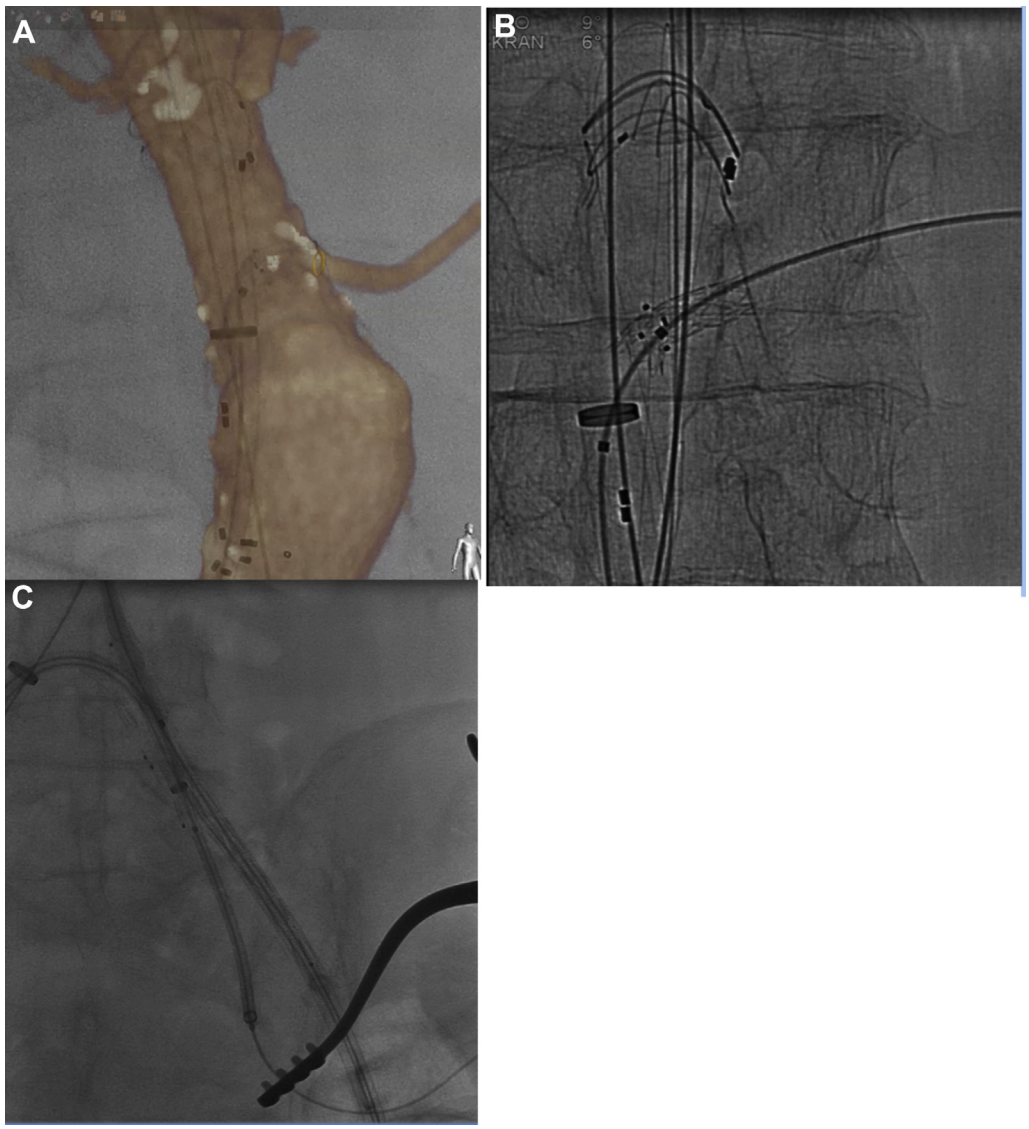

Fig. 2. **(A)** A digitally generated overlay IF shows a good position of the fenestrated stent graft in the infrarenal aorta with the stent in the left additional renal artery through the fenestration. **(B)** High resolution X-ray demonstrating the proximal part of the Anaconda stent. **(C)** Iliac side branch in the left common and external iliac artery, with the Advanta in the internal iliac artery.

The postoperative contrast-enhanced ultrasonography showed a minimal type II endoleak in the aneurysmal sac with no type I or III endoleak (Fig. 4). Figure 5 shows how the same ultrasound image would look like without endoleak (digitally edited).

There was no alteration in creatinine during hospital stay, and the patient was discharged with a creatinine clearance of 63 mL/min (with creatinine of 1.08 mg/dL).

DISCUSSION

To the best of our knowledge, this is the first case description of a combined FEVAR and ISBG deployment procedure under guidance of CTA superimposed on live fluoroscopy and CO_2 angiography without the intraoperative or postoperative use of iodinated contrast agent with an effective exclusion of both the aortic and left common iliac artery aneurysms.

The first case of an EVAR with no contrast medium was reported by Kobeiter et al.[4] who described a thoracic endovascular aortic repair (using a tube stent graft in the descending aorta) under guidance of CTA superimposed on live fluoroscopy without the use of iodinated contrast agent before, during, and after deployment.

Fig. 3. The completion angiography using the CO_2 shows perfused left sided additional renal artery and internal iliac artery (external iliac artery still occluded).

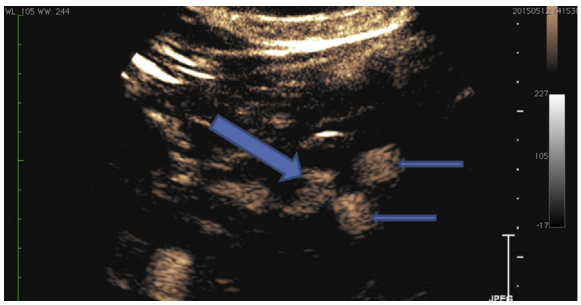

Fig. 4. The postoperative contrast-enhanced ultrasonography shows a minimal type II endoleak in the aneurysmal sac (*large arrow*) with perfused legs of stent graft (*small arrows*).

Kaladji et al.[5] have also reported a series of 6 patients, requiring EVAR and presenting with severe chronic renal impairment, who successfully underwent EVAR without the use of preoperative and intraoperative contrast agents.

Another case, in which a ruptured thoracoabdominal aortic aneurysm was treated using an off-the-shelf branched stent graft and carbon dioxide as the exclusive contrast agent, was reported by Constantinou et al.[6]

The use of carbon dioxide angiography during the endovascular procedures by Criado et al. have been shown to be safe and reliable in EVAR procedures in a series with 114 patients (CO_2 was used exclusively

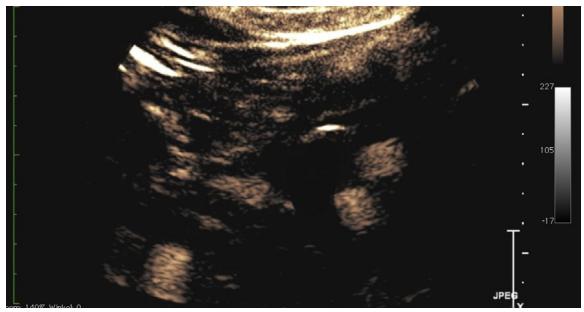

Fig. 5. Digital edit of Figure 4 showing how the same ultrasound image would look like without endoleak.

in 72 patients and in an additional 42 patients iodinated contrast was given with a mean amount of 389 ± 17 mL of CO_2 per case).[7]

We have also demonstrated in a previous article (Shahverdyan et al.[8]) the technical feasibility of total EVAR for juxtarenal and pararenal aortoiliac aneurysms by combining the Vascutek Anaconda custom-made repositionable fenestrated stent graft with the iliac side branched stent graft in patients with aortoiliac aneurysm.

In our practice, we intend to use additional iodinated contrast medium in the following situations: (1) if the bowel contains a large amount of air that can distort the CO_2-digital subtraction angiography; (2) in case of uncertainty of the presence of endoleak; (3) in case of suspicion of rupture (e.g., renal artery); and (4) if the Trendelenburg position is not possible, and the hypogastric arteries are not visualized.

In conclusion, complex EVAR (FEVAR and ISBG) using CTA-IF is feasible and together with the use of CO_2 angiography may help to abstain from need to nephrotoxic contrast medium and widen the spectrum of endovascular indication to include also patients with impaired renal function.

REFERENCES

1. Swedvasc's årsrapport 2014 för 2013 års verksamhet Nkfk, Sweden.
2. Dua A, Kuy S, Lee CJ, et al. Epidemiology of aortic aneurysm repair in the United States from 2000 to 2010. J Vasc Surg 2014;59:1512–7.
3. Fukuda T, Matsuda H, Doi S, et al. Evaluation of automated 2D-3D image overlay system utilizing subtraction of bone marrow image for EVAR: feasibility study. Eur J Vasc Endovasc Surg 2013;46:75–81.
4. Kobeiter H, Nahum J, Becquemin JP. Zero-contrast thoracic endovascular aortic repair using image fusion. Circulation 2011;124:e280–2.
5. Kaladji A, Dumenil A, Mahe G, et al. Safety and accuracy of endovascular aneurysm repair without pre-operative and intra-operative contrast agent. Eur J Vasc Endovasc Surg 2015;49:255–61.

6. Constantinou J, Giannopoulos A, Jayia P, et al. A new technique of branched stent graft treatment for ruptured thoracoabdominal aortic aneurysms. Vasc Endovascular Surg 2013;47:296–9.
7. Criado E, Upchurch GR Jr, Young K, et al. Endovascular aortic aneurysm repair with carbon dioxide-guided angiography in patients with renal insufficiency. J Vasc Surg 2012;55:1570–5.
8. Shahverdyan R, Gray D, Gawenda M, Brunkwall J. Technical feasibility of endovascular aortoiliac aneurysm repair combining Anaconda fenestrated and Zenith iliac side-branched stent grafts. J Vasc Surg 2015;61:1324–8.