Endovascular Abdominal Aortic Aneurysm Repair Using Transvenous Intravascular US Catheter Guidance in Patients with Chronic Renal Failure

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ABSTRACT

Purpose: To describe the transvenous application of intracardiac echocardiography (ICE) for guidance during endovascular aortic repair (EVAR).

Materials and Methods: Eight patients with an infrarenal abdominal aortic aneurysm (AAA) and chronic renal failure were determined suitable for EVAR. The procedure was performed by deploying the transcaval and transiliac vein guidance of an ICE catheter to reduce the dosage of iodinated contrast medium. Multiple guidance parameters were assessed. The present study describes the EVAR procedure and postprocedure transabdominal ultrasound (US) follow-up results at 3–4 months.

Results: The eight procedures were completed by using transvenous ICE guidance. No contrast medium was used in five patients, and 3–20 mL of isoosmolar contrast medium was administered in the other three. No endoleaks were detected by ICE immediately after stent deployment. One patient who had a single functioning kidney developed renal failure that was attributed to manipulation-related cholesterol embolization. That patient became dependent on dialysis and died 3.5 months after the procedure. No endoleaks were detected at 3–4-month US follow-up in the other seven patients.

Conclusions: Transvenous ICE guidance is a promising method to reduce the dosage of iodinated contrast medium in patients with renal dysfunction undergoing EVAR. A prospective trial comparing this modality versus digital subtraction angiography guidance with iodinated contrast medium in terms of safety, accuracy, and long-term efficacy is recommended.

ABBREVIATIONS

AAA = abdominal aortic aneurysm, DSA = digital subtraction angiography, EVAR = endovascular aortic aneurysm repair, ICE = intracardiac echocardiography

One limitation of endovascular aortic repair (EVAR) for abdominal aortic aneurysm (AAA) involves the cumulative risk of contrast agent–induced nephropathy associated with the multiple administrations of iodinated contrast medium for planning computed tomographic (CT) angiography, intraprocedural digital subtraction angiography (DSA) guidance, and postprocedure CT angiographic surveillance. Preexisting renal dysfunction is associated with increased procedural morbidity and mortality (1–7), and was the only comorbidity found in a recent study (8) to be an independent predictor of early mortality.

The present study assessed the feasibility of transcaval and transiliac vein intracardiac echocardiographic (ICE) monitoring for EVAR guidance using a catheter system originally designed to monitor noncoronary cardiac interventions (9).

MATERIALS AND METHODS

The present study was conducted at a major university-affiliated tertiary medical center and included eight patients who met the inclusion criteria for EVAR guided by transvenous (caval and iliac) ICE, specifically chronic renal failure (creatinine level > 1.8 mg/dL), infrarenal

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origin of the AAA with a diameter greater than 55 mm, suitable anatomy for conventional EVAR as determined by preliminary noncontrast CT or magnetic resonance (MR) angiography, and a patent venous access to the inferior vena cava and bilateral iliac veins. Suitable patients were informed of the risks and benefits of the procedure, and institutional review board approval was obtained for the conduct of this research, review of records, and preparation and submission of the manuscript.

We were prepared to use iodinated contrast medium in the event that the procedure was not progressing as expected or the duplex assessment did not appear to provide adequate information. Patient characteristics are listed in Table 1. All procedures were performed in the angiography suite (Innova; GE Healthcare, Milwaukee, Wisconsin) under general anesthesia. The ICE device (AcuNav; Biosense Webster, Diamond Bar, California) consists of an ultrasound (US) probe mounted on a steerable catheter. It provides duplex and color Doppler information via a phased-array system that operates over a wide frequency range, a large depth of field, and a 160°–360° circumferential image (Vivid I cardiovascular US system [GE Healthcare] with application software version 10.1.0 [build 68, build date August 4, 2009] and system software version 3.1.10 [build date October 12, 2008]).

EVAR Procedure

The procedural details are summarized in Table 2. The Endurant 2 stent-graft (Medtronic, Santa Rosa, California) was used in all cases. Bifurcated grafts were implanted in four patients. The other four patients received an aortouniiliac stent, and the contralateral common iliac artery origin was occluded with the Endurant Occluder (Medtronic) by the ipsilateral retrograde femoral approach. Occluder positioning was guided by fluoroscopic observation of the aortic bifurcation calcification and/or the location of the point at which the previously deployed main graft body crossed the contralateral aortoiliac junction. Success of this occlusion was then verified by duplex ICE via the common iliac vein on the side of occlusion. Femorofemoral bypass was performed before surgical closure of the arteriotomies. The average estimated fluoroscopy and procedure times were 30 minutes and 150 minutes, respectively.

Graft deployment was guided by fluoroscopy together with transvenous ICE monitoring (Figs 1–3). The ICE catheter, which was inserted via the femoral, internal jugular, or greater saphenous vein, was initially positioned in the inferior vena cava to localize the renal arteries and confirm their patency. Subsequently, the lower (ie, caudal) main renal artery was catheterized from the femoral approach, and a Bentson guide wire (Cook, Bloomington, Indiana) was positioned as a marker to facilitate precise graft positioning. Following proximal graft deployment, the ICE catheter was directed into the common iliac vein(s) to guide and confirm the distal landing of the graft in relation to the hypogastric artery. After balloon dilatation of the graft components, the ICE catheter was used to search for the presence of endoleak, which entailed duplex and color Doppler assessment of the graft lumen along its length, with particular attention paid to the landing zones and areas of stent overlap. Additional postdeployment features examined by transvenous ICE included patency of the renal and hypogastric arteries, adequacy of expansion of the stent components, and apposition of the graft to the vessel wall.

We injected a small amount (3–20 mL; average, 11 mL) of isoosmolar contrast medium (Visipaque; GE Healthcare) in three patients to verify the patency of the lowest or single renal artery before and after graft deployment. It was not possible to pass the main body of the graft through a heavily calcified segment of the common iliac artery in one patient, and this obstacle was overcome by the placement of a 10 × 38-mm balloon-expandable stainless-steel stent (Dynamic Stent;

Table 1. Patient Demographic Data

Pt. No.	Age (y)/Sex	Preoperative Creatinine (mg/dL)	Maximum AAA Diameter (cm)	Preinterventional Imaging
1	78/M	3*	7 (proximal to aortobifemoral graft)	Noncontrast CT
2	73/M	1.9	6.1	Noncontrast CT, noncontrast MR angiography
3	76/M	1.8	6	Noncontrast CT
4	81/M	2.0	5.7 (AAA); 4.5, 3.9 (bilateral common iliac)	Noncontrast CT
5	70/M	3.2	7 (AAA); 4 (right common iliac)	Noncontrast CT, noncontrast MR angiography
6	80/M	2.5	6.6	Noncontrast CT
7	66/M	3.3	5.5	Noncontrast MR angiography
8	76/F	1.8	5.7	Noncontrast CT

AAA = abdominal aortic aneurysm.
*Single functioning kidney.