CLINICAL STUDY

Evaluation of Delayed Endoleak Compared with Early Endoleak after Endovascular Aneurysm Repair

Trong Binh Le, MD, Keun-Myoung Park, MD, Yong Sun Jeon, MD, PhD, Kee Chun Hong, MD, PhD, and Soon Gu Cho, MD, PhD

ABSTRACT

Purpose: To identify prevalence and evaluate outcomes of delayed endoleak (DEL) compared with early endoleak (EEL) after endovascular aortic aneurysm repair (EVAR).

Materials and Methods: Data of 164 patients who underwent elective EVAR at a single center were retrospectively analyzed. DEL was defined as any type of endoleak that was first detected ≥ 12 months after EVAR. Patients who had < 1 year of follow-up were excluded. Endoleak was classified into a more aggressive category if a patient had > 1 type of endoleak. Analysis included 81 patients (82.7% male). Mean age was 73.1 years ± 9.3. Median follow-up duration was 43 months (range, 12–135 months).

Results: Endoleak was present in 32 patients (39.5%), including 21 EEL (25.9%) and 11 DEL (13.6%). DEL consisted of 2 type I, 5 type II, 1 type III, and 3 type V (endotension). Median time to detection was 45 months (range, 15–60 months), and median follow-up duration was 62 months (range, 37–104 months). Compared with EEL, DEL had larger aneurysm diameters and higher rates of non–type II endoleak and reintervention. Type II DEL also required more reintervention procedures than type II EEL.

Conclusions: DEL had a noteworthy incidence and occurred late after EVAR. It predominantly consisted of non–type II endoleak and appeared to have more reinterventions than EEL. Meticulous long-term imaging surveillance to identify and manage DEL is critical.

ABBREVIATIONS

DEL = delayed endoleak, EEL = early endoleak, EVAR = endovascular abdominal aortic aneurysm repair

Short-term survival benefits of endovascular abdominal aortic aneurysm repair (EVAR) versus open repair in the treatment of abdominal aortic aneurysm have been widely accepted (1–4). However, these early advantages usually erode over time (2,4–7). A long-term study found that aneurysm-related deaths increased from 6 months after EVAR (4). The cause of death was prominently aneurysm rupture, which was partly due to sac expansion resulting from uncorrected endoleak (1,3–5). Endoleak is a major concern after EVAR with a reported incidence of 20%–50% of patients (1,8–10); approximately half of these endoleaks are type II (6,7). The natural history of type II endoleaks is poorly understood, and thus management of this type remains controversial, whereas type I and III endoleaks usually require early intervention (1,6,7,9). Spontaneous resolution of type II endoleak was reported in 35.4% of patients over a range of 3 months to 4 years (7,11). However, up to 20% of type II endoleaks persist over time and increase the risk of reintervention and aneurysm rupture (9,11). Although late endoleaks have been recognized in published reports, the frequency and clinical significance of endoleak detected ≥ 12 months after EVAR remains poorly defined (9). In 1 report, the incidence of delayed endoleak (DEL) was 13.1%, and type II DEL was significantly associated with sac enlargement compared with type II early endoleak (EEL) (9). This study aimed to identify the prevalence and evaluate outcomes of DEL compared with EEL.

From the Endovascular Training Center (T.B.L.) and Departments of Vascular Surgery (K.-M.P., K.C.H.) and Radiology (Y.S.J., S.G.C.), Inha University Hospital, Inha University School of Medicine, 7-206 Sinheung-dong 3-ga, Jung-gu, Incheon, Republic of Korea. Received May 13, 2017; final revision received September 22, 2017; accepted September 24, 2017. **Address correspondence to** Y.S.J.; E-mail: radjeon@inha.ac.kr

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MATERIALS AND METHODS

Definitions

DEL was defined as any type of endoleak that was first detected ≥ 12 months after EVAR with all follow-up

computed tomography (CT) angiograms within the first year being negative for endoleak (9,10). EEL was defined as endoleak detected within 12 months. Endoleaks are stratified into 5 types based on the source of communication between the systemic circulation and aneurysm sac (3). Type V endoleak has also been termed an endotension, which indicates aneurysm enlargement after EVAR without a detectable endoleak (8,12,13). Endoleaks were classified into a more aggressive category if a patient had multiple endoleaks. In particular, type I and III endoleaks are considered more aggressive than type II, IV, or V endoleaks. For example, a patient with both type I and II endoleaks was classified in the type I endoleak category. When endoleak was detected on the completion angiogram after EVAR, the management strategy was (*i*) conservative if the endoleak was considered benign (type II or IV) or (*ii*) aggressive with intraoperative adjunctive procedures, including balloon molding, aortic cuff, limb extension, or additional graft if the endoleak was considered malignant (type I III). If endoleak still existed on 30-day follow-up CT angiography, it categorized as EEL.

Data Collection

This study was approved by the institutional review board. Informed consent was obtained from all patients. Data of 164 patients who underwent elective EVAR using commercially available devices for infrarenal abdominal aortic aneurysms from December 2005 to March 2017 were retrospectively analyzed. The following patients were excluded: (*i*) patients with EVAR for isolated iliac artery aneurysms (n = 12), (*ii*) patients who had < 1 year or loss of follow-up (n = 54), and (*iii*) patients who recently received EVAR and did not have 1 year of follow-up (n = 17). There were 81 patients (82.7% male; mean age, 73.1 y ± 9.3) identified for analysis. The overall median follow-up duration was 43 months (range, 12–135 months). Follow-up CT angiograms were obtained at discharge or during the first 30 days and at 6 months and at 12 months in the first postoperative year. After 12 months, CT angiography was recommended annually with an alternative option for contrast-enhanced ultrasound. Medical records and CT scans of each patient were carefully reviewed. Patient demographics, clinical characteristics, and comorbidities were documented. Type of endoleak, date of detection, type of stent graft, follow-up duration, and reintervention and complications after the procedure were also recorded. Abdominal aortic aneurysm profiles were reviewed from preoperative CT angiography. Sac diameters were documented according to the maximum diameter comparison from axial, sagittal, and coronal images. Clinical data were retrieved from hospital electronic medical records.

The CT angiography protocol included a detector coverage of 40 mm, gantry rotation time of 0.6 seconds, scan thickness of 1.25 mm, and image reconstruction interval of 2.5 mm using a 64-slice multidetector CT. Helical scan images were acquired from the xyphoid process to the feet in the supine position. Three separate imaging examinations were performed: (*i*) scan before contrast enhancement to identify opacities, (*ii*) contrast scan after infusion of nonionic contrast medium (BONOREX IOHEXOL 300; Central Medical Services, Seoul, Korea) with average dose of 2 mL/kg of body weight at 5 mL/s, and (*iii*) delayed phase scanned at 180–210 seconds after injection with slice thickness of 5 mm. Computer-assisted bolus-tracking software was used to determine the optimal scan delay for the arterial phase in each patient. All contrast-enhanced ultrasound scans were performed by 1 interventional radiologist (Y.S.J.) using a convex array probe (Philips iU22; Philips Healthcare, Andover, Massachusetts). Position, shape, internal echo, and diameter of the aneurysm were recorded. Color Doppler scan was performed to examine the blood flow and its signal within and around the graft. To fully evaluate size, location, direction, and sources of flow and phases of a detected endoleak, 4.8 mL of contrast agent (SonoVue; Bracco Imaging, Milan, Italy) was given intravenously, divided into 2 sessions.

Four types of stent grafts were used in this study, including 35 Zenith (Cook, Inc., Bloomington, Indiana), 21 Endurant (Medtronic, Minneapolis, Minnesota), 13 GORE EXCLUDER (W.L. Gore and Associates, Inc, Flagstaff, Arizona), and 12 Seal (S&G Biotech Inc, Seongnam, Korea). EVAR was indicated after multidisciplinary discussions and consensus between vascular surgeons and the interventional radiologist, considering each patient's age, clinical condition, imaging findings, and instructions for use of specific stent grafts. All procedures were performed by 1 interventional radiologist (Y.S.J.) with 15 years of experience in EVAR.

Table 1. Baseline Demographics and Comorbidities of Patients

Variables	No-Endoleak Group (n = 49)	EEL Group (n = 21)	DEL Group (n = 11)	*P* Value
Demographics				
Age, y, mean ± SD	72.1 ± 8.9	74 ± 10.6	76.1 ± 8.5	.386
Sex, male, n (%)	42 (85.7)	16 (76.2)	9 (81.8)	.625
Hostile neck, n (%)	22 (44.9)	9 (42.8)	7 (63.6)	.483
Comorbidity (%)				> .05
Smoking	17 (34.7)	10 (47.6)	6 (54.5)	
Hypertension	35 (71.4)	16 (76.2)	6 (54.5)	
Coronary artery disease	6 (12.2)	3 (14.3)	1 (9.1)	
Diabetes mellitus	15 (30.1)	9 (42.3)	3 (27.3)	
Cerebrovascular disease	2 (6.1)	1 (4.8)	0 (0)	
Hyperlipidemia	11 (22.4)	7 (33.3)	2 (18.2)	
Device				
Zenith	17	10	8	.147
Endurant	17	2	2	< .01
Excluder	10	3	0	.052
Seal	5	6	1	.174

DEL = delayed endoleak; EEL = early endoleak.