CLINICAL STUDY

# Transabdominal Direct Sac Puncture Embolization of Type II Endoleaks after Endovascular Abdominal Aortic Aneurysm Repair

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## ABSTRACT

**Purpose:** To determine the efficacy and safety of transabdominal direct sac puncture embolization of type II endoleaks after endovascular abdominal aortic aneurysm repair (EVAR).

**Materials and Methods:** This retrospective review included 30 patients (4 women, 26 men; mean age = 79.1 years) who underwent 33 transabdominal direct sac puncture embolization procedures for type II endoleaks after EVAR. Embolization agents included cyanoacrylate glue only (45.5%), glue/coils (36.4%), and Onyx with or without glue/coils (18.1%). Technical success was defined as complete endoleak embolization on intraprocedural fluoroscopy. The primary outcome was freedom of aneurysm growth, which was defined as $\leq$ 5% aneurysm sac volume change on follow-up computed tomography (CT) imaging or $\leq$ 5 mm aneurysm sac diameter change on ultrasound without definite endoflow. Aneurysm sac volumes before and after embolization were manually segmented from CT images. The procedural complication rate was calculated.

**Results:** Technical success was achieved in 97% of patients (29/30). Follow-up imaging was available in 27 patients (25 CT; 2 ultrasound), and mean imaging follow-up duration was 15.5 months. Freedom of aneurysm growth was achieved in 85.2% of patients (23/27) after 1 or more embolization procedures. Median fluoroscopic and procedure times were 11.3 minutes and 90 minutes, respectively. The complication rate was 9.1% (3/33) and included 1 case of nontarget embolization with transient neuropraxia and 2 self-limiting rectus sheath hematomas relating to the percutaneous puncture site. No aneurysm-related mortality occurred during the follow-up period.

**Conclusions:** Percutaneous transabdominal embolization is a safe and efficacious treatment for type II endoleak, with a short procedure time.

## ABBREVIATIONS

EVAR = endovascular abdominal aortic aneurysm repair, IMA = inferior mesenteric artery, NBCA = N-butyl cyanoacrylate, T2E = type II endoleak

Type II endoleaks (T2Es) are the most common endoleak, occurring in 9%–30% of patients after endovascular abdominal aortic aneurysm repair (EVAR) (1–6). Inferior mesenteric artery (IMA) and lumbar artery patency have been associated with T2E development (6–8). T2E can be associated with adverse outcomes, including conversion to open repair, aneurysm sac growth (1,9–11), and reintervention for persistent T2E (10). Intervening for persistent T2E with aneurysm sac expansion of 5 mm (3,9,12,13), at least 8 mm (14), or 15 mm (1) has been suggested. The most common embolization techniques involve occluding the feeding artery and/or endoleak nidus within the aneurysm sac transarterially or via direct translumbar puncture of the aneurysm sac under computed tomography (CT) guidance with the patient prone.

Although the translumbar approach may be useful for accessing posterolateral endoleaks, it can be difficult to access endoleaks anterior to the stent graft and to cannulate lumbar artery origins, which face away from the catheter. Furthermore, prone positioning is often poorly tolerated in

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elderly patients. Percutaneous transabdominal direct sac puncture, which was first described by Boks et al for treating a T2E using thrombin and Histoacryl under ultrasound guidance, provides an alternative route for accessing T2E (15). The purpose of this study was to assess the technical feasibility, safety, and mid-term clinical efficacy of percutaneous transabdominal T2E embolization.

## MATERIALS AND METHODS

Institutional review board approval was obtained for this single-center retrospective study.

### Patient Population/Selection

Thirty patients with isolated T2E referred for endoleak management underwent 33 transabdominal direct sac puncture embolization procedures from December 2011 to September 2016 at a quaternary care, large vascular referral center. Many patients in this study were referred after EVAR from outside centers, because of T2E complexity, lack of expertise, and/or failed previous management. Six of 30 patients had previously undergone unsuccessful transarterial T2E embolizations. For post-EVAR patients at our institution, imaging follow-up consisted of computed tomography angiogram (CTA) usually within 6 weeks, CTA and/or ultrasound with Doppler at 6 months, and yearly CTA. Selection criteria for transabdominal embolization included internally or externally referred patients with (*i*) type II lumbar endoleaks with or without IMA contribution (ie, endoleak/contrast seen mostly in the posterior inferior aspect of the sac) diagnosed on CTA; (*ii*) a safe, unobstructed path from the anterior abdominal wall to the perfused portion of the sac; and (*iii*) an indication for treatment. Indications for treatment included $>$ 5 mm increase in sac diameter enlargement and/or a $>$ 5% increase in aneurysm sac volume on the most recent CTA compared to their last CTA after EVAR or after previous transarterial embolization. The presence of safe, unobstructed access from the anterior abdominal wall to the perfused part of the sac, without needing to traverse organs or major intervening arterial structures, was determined based preprocedure imaging. Patients without unobstructed access, and patients with isolated IMA endoleak without lumbar artery contribution, were excluded from the study (n = 13). They were treated with translumbar (n = 4) and transarterial (n = 9) embolization, respectively. Demographics are listed in **Table 1**. The median interval between EVAR and the primary transabdominal T2E embolization was 2.1 years (mean: 2.8 years; range: 40 days–8.9 years). Twenty-five patients with both pre- and post-embolization CTA were included in evaluating freedom of aneurysm growth based on CT. Two patients with clinical follow-up with ultrasound with Doppler, without CTA follow-up, were included in assessing treatment efficacy and clinical success. Imaging follow-up was not available for 3 patients.

**Table 1.** Patient and Aneurysm Demographics

| Characteristic | Number or Mean ± SD |
|---|---|
| Age, mean ± SD (range) (years) | 79.1 ± 7.1 (range: 62–90) |
| Men | 26 (86.7%) |
| Women | 4 (13.3%) |
| Mean aneurysm diameter at index endoleak treatment | 65.6 ± 5.4 mm |
| Mean increase in sac diameter from index EVAR | 12.1 ± 7.4 mm |
| Bifurcated stent-grafts | 29/30 (96.6%) |
| Type of Endograft | |
| Cook Zenith* | 21/30 (70%) |
| Medtronic Endurant† | 6/30 (20%) |
| Gore Excluder‡ | 3/30 (10%) |
| Pre-embolization Type II endoleak CTA findings | |
| Lumbar endoleak only | 23/30 (76.7%) |
| IMA and lumbar endoleak | 7/30 (23.3%) |
| IMA endoleak only | 0 (0%) |
| Comorbidities | |
| Diabetes | 5 (16.7%) |
| Smoking history | 7 (23.3%) |
| Hyperlipidemia | 14 (46.7%) |
| Hypertension | 20 (66.7%) |
| Coronary artery disease | 9 (30.0%) |
| Prior myocardial infarction | 5 (16.7%) |
| Prior peripheral artery disease intervention | 1 (3.3%) |
| Prior transient ischemic attack or stroke | 1 (3.3%) |
| Chronic obstructive pulmonary disease | 2 (6.7%) |
| Renal failure | 2 (6.7%) |
| On dialysis | 1 (3.3%) |

CTA = computed tomography angiogram; EVAR = endovascular abdominal aortic aneurysm repair; IMA = inferior mesenteric artery; SD = standard deviation.
*Bloomington, Indiana.
†Minneapolis, Minnesota.
‡Newark, Delaware.

### Outcomes

Safety and procedural parameters were assessed in all 30 patients who underwent 33 transabdominal embolizations. Procedure-related complications were classified as major or minor based on the Society of Interventional Radiology Clinical Practice Guidelines (16). Technical success was defined as complete endoleak embolization on intraprocedural fluoroscopy. Treatment efficacy (ie, clinical success) was evaluated in 27 patients with follow-up imaging, defined as freedom of aneurysm growth based on CT or aneurysm stability without definite endoflow on ultrasound. The primary outcome was freedom of aneurysm growth, defined as $\leq$ 5% aneurysm sac volume growth on follow-up CT imaging or $<$ 5 mm growth in aneurysm sac diameter on ultrasound without definite endoflow. All CTs were reviewed by a board-certified diagnostic radiologist