CLINICAL STUDY

Translumbar Infusion of *N*-Butyl Cyanoacrylate for the Treatment of Type II Endoleaks

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ABSTRACT

Purpose: To evaluate long-term efficacy of translumbar embolization of type II endoleaks exclusively supplied by the lumbar arteries in patients with growing abdominal aortic aneurysm sacs using *N*-butyl cyanoacrylate (NBCA) instilled via percutaneous needle access.

Materials and Methods: The study included 25 patients who developed type II endoleak after endovascular aneurysm repair. Inclusion criteria for intervention were defined as sac expansion > 5 mm detected with CT angiography at 6-month follow-up or later. Translumbar infusion of NBCA directly into the patent portion of the aneurysm sac was performed in all cases. Duplex US was performed the day after the intervention, and CT angiography was performed within the first month. Subsequently, duplex US was performed at 3, 6, and 9 months, and CT angiography or CT was performed at 12 months and annually thereafter.

Results: Translumbar embolization was achieved in all 25 patients. The endoleak resolved in 22 patients (88%) on duplex US performed 1 day after the embolization procedure. Three patients with persistent endoleak (12%) required repeat embolization. Two complications were detected and were managed conservatively.

Conclusions: This study demonstrates safety and efficacy of NBCA injection for treatment of type II endoleaks. This technique provides another option for the management of type II endoleaks.

ABBREVIATIONS

EVAR = endovascular aneurysm repair, NBCA = *N*-butyl cyanoacrylate

Although endovascular aneurysm repair (EVAR) has emerged as a less invasive alternative to open repair surgery, complications, such as endoleaks, graft migration, and continued aneurysm growth and rupture, have been described (1–3). Endoleak, defined as persistent flow outside the endograft but within the aneurysm sac after EVAR, is the most common complication (10%–20%) and remains a significant issue in a subset of patients (4). Various techniques, methods, and agents have been developed either in isolation or in combination for the treatment of types I and II endoleaks (5–8). This study reports a single-center experience using liquid embolic agent *N*-butyl cyanoacrylate (NBCA) directly infused into the patent portion of the aneurysm sac of the endoleak under biplane fluoroscopy guidance, assisted by cone-beam computed tomography (CT).

MATERIALS AND METHODS

The analysis included 25 patients (23 men; median age, 75.5 y; range, 64–87 y) who developed type II endoleak after EVAR of abdominal aortic aneurysms (average time 42 months), with sac expansion > 5 mm detected with CT angiography at 6-month follow-up or later between 2009 and 2012. Patients with type I and III endoleaks and type II endoleaks with inferior mesenteric artery involvement were excluded from the study. Patients with compromised renal function (estimated glomerular filtration rate < 30 mL/min) were also excluded. Nineteen patients were referred to this hospital from other institutions, and 6 were previously treated at this hospital.

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None of the authors have identified a conflict of interest.

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J Vasc Interv Radiol 2018; ■:1–7

https://doi.org/10.1016/j.jvir.2018.01.788

Bifurcated devices that were previously deployed included Endurant (Medtronic, Santa Rosa, California; n = 6) GORE EXCLUDER (W.L. Gore & Associates, Flagstaff, Arizona; n = 5), Zenith (Cook Medical, LLC, Bloomington, Indiana; n = 7), Ovation (Trivascular, INC, Santa Rosa, California; n = 1), Treovance (Bolton Medical, Barcelona, Spain; n = 2), E-tegra (JOTEC GmbH, Hechingen, Germany; n = 1), Anaconda (Vascutec Ltd, Renfrewshire, Scotland; n = 1), and Aptus (Aptus Endosystems, Inc, Sunnyvale, California; n = 2). The cases of patients who received an Aptus endograft have been evaluated in a multicenter trial.

A thorough medical history and baseline vascular assessment were obtained from all patients. Written informed consent was obtained from all patients according to the regulation of the hospital's ethical committee. Institutional review board approval for translumbar embolization of type II endoleaks with the use of NBCA was obtained before the intervention. Institutional review board approval for this single-institution retrospective study was also obtained.

Preoperative planning included study and analysis of recent CT angiography. CT angiography was used to correlate the site of the patent portion of the aneurysm sac and the orifices of the contributing lumbar arteries to the anatomic landmarks and the landmarks of the stent graft. Landmarks used for access route planning were the bony structure, the atherosclerotic plaque, the metallic struts, the radiopaque markers of the endograft, and the strut free zones. These details facilitate the selection of the puncture site as well as the demarcation of the metallic struts and radiopaque markers of the endograft. The patient was subsequently placed in a prone position. Cone-beam CT was the first imaging modality used to identify all the above-mentioned landmarks. Accordingly, cone-beam CT was used to localize the site of the patent portion of the aneurysm sac and the orifices of the contributing arteries at the acquired axial images. Typically, access was obtained from a left paraspinal approach. In 2 cases, owing to the underlying anatomy, a right paraspinal-transcaval approach was performed without any complication. Any correction of angle was made before puncture of the aortic sac. A 22-gauge, 20-cm length Chiba biopsy needle (Cook, Inc) was used after infiltration with local anesthetic. One or 2 punctures were performed depending on the segments of the contributing lumbar arteries. After selection of the site and the angle of the puncture, the angiography unit (Axiom Artis dBA; Siemens Healthcare, Erlangen, Germany) was used in a biplane fluoroscopy mode to facilitate the guidance of the needle close to the sac of the aneurysm along the preselected pathway. In most of the cases (21 of 25; 84%) a new cone-beam CT scan was performed to confirm the needle trajectory toward the patent portion of the aneurysm sac close to the orifices of the vessels supplying the aneurysm sac. The needle was then advanced into position, and the stylet was removed. Through the wall of the aneurysm, the tip of the needle at the preselected position led into the patent portion of the aneurysm sac. Check for back flow was the next step. If back flow was not present, the needle was left in position, and a second needle was used to reach the target. In 3 cases, a new intravenous contrast-enhanced cone-beam CT scan was required to localize the patent portion of the aneurysm sac. When back flow was present, an extension tube was used to connect the hub of the needle to a Luer-Lok syringe (Germanos Medicals, Athens, Greece), and biplane digital subtraction angiography was performed. In a case in which the tip of the needle is close to the orifice of the afferent lumbar artery, retrograde flow can be instantaneously detected in the vessel's orifice, followed by washout and appearance of the efferent vessel. In contrast, when the tip of the needle is away from the afferent vessel's orifice, it is difficult to depict the latter afferent vessel because the contrast is primary directed by the flow into the efferent vessel. In such circumstances, the orifice of the afferent vessel was evaluated according to preoperative CT angiography. Angiography included aneurysmatography of the patent portion of the aneurysm sac and arteriography of the efferent and afferent lumbar arteries. The pattern of the flow was also studied. Biplane images were correlated to the coronal and sagittal images of preoperative multiplanar reconstruction CT.

The main goal of this procedure is embolization of the contributing vessels, and a secondary goal is embolization of the patent portion of the aneurysm sac of the endoleak. In 1 injection, > 2 vessels could be occluded. NBCA is diluted with ethiodized oil (Lipiodol; Guerbert S.A., Villepinte, France). In high-flow conditions or when the orifices of the lumbar arteries are quite close to the tip of the needle, a mixture of more concentrated NBCA is used (up to 50%). In slow-flow conditions or when the orifices of the lumbar arteries are distant from the tip of the needle, a less concentrated NBCA mixture is needed (23%–33%). The amount of glue prepared was larger than the volume of the patent portion of the aneurysm sac and the proximal part of the contributing lumbar arteries. For the glue injection, 10-mL, 5-mL, and 3-mL syringes were used. Before the NBCA injection, a thorough flush of the needle-extension tube system (Fig 1) with dextrose 5% solution is needed. NBCA injection was performed immediately after under biplane fluoroscopy or biplane acquisition. If the tip of the needle was sited at the proximity of the orifices of the lumbar arteries, the bloodstream led the NBCA into the efferent arteries, and a direct flow into them could be depicted. In such a case, NBCA injection was paused for a few seconds to let it solidify in the artery. Injection was resumed immediately after to let the NBCA penetrate the rest of the involved arteries in a retrograde manner through the patent portion of the aneurysm sac. When the NBCA failed to penetrate the arteries directly, additional NBCA was injected to achieve penetration or at least to occlude the orifices of the lumbar arteries filling as well as the patent portion of the aneurysm sac. In cases where $\geq$ 2 pairs of lumbar arteries were involved and were approached by double puncture, a second NBCA injection