Type I Endoleak Management After Endovascular Repair of Infrarenal Abdominal Aortic Aneurysm: Utilization of N-butyl Cyanoacrylate Embolization in a Case of Failed Secondary Intervention

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ABSTRACT: A 52-year-old male patient with an infrarenal abdominal aortic aneurysm underwent an endovascular aneurysm repair procedure. At the end of the procedure, a type 1A endoleak was detected. Because there was no margin for placement of an aortic extender cuff, balloon dilatation was performed with an expectation for total resolution. A control angiogram performed 2 days later showed that the endoleak persisted and balloon dilatation was performed at the attachment site one more time. A control CT scan performed 2 days after the secondary procedure revealed that the type IA endoleak persisted and had grown larger. Open surgical repair was rejected by the patient. The patient underwent a single session of N-butyl cyanoacrylate embolization of the type IA endoleak using a transarterial approach. Coil utilization was not required. Technical success was achieved in the patient with complete resolution of the endoleak confirmed by follow-up CT studies. There were no procedure-related complications.

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Endovascular stent grafting is a valid therapeutic option for conventional open surgical repair of infrarenal abdominal aortic aneurysms. Endovascular aneurysm repair (EVAR) is less invasive than open repair and has less associated periprocedural morbidity.1 Successful endovascular abdominal aneurysm repair is defined as complete exclusion of blood flow from the aneurysm sac. Complications of EVAR vary, including distal stent-graft migration, graft limb thrombosis, peripheral embolization, graft infection, and most commonly perigraft leak, also known as endoleak. Endoleak is defined as any blood flow outside the endovascular graft and within the intact aneurysm sac. Type IA endoleak is defined as a persistent perigraft channel of blood flow caused by a
failure of the graft to seal the proximal landing zone adequately. The risk of rupture is high, which necessitates a secondary intervention in the majority of cases.\textsuperscript{2,3}

**CASE REPORT**

A 52-year-old male patient was found to have an 80-mm asymptomatic infrarenal abdominal aortic aneurysm during renal artery Doppler study conducted for resistant hypertension. The patient had several comorbid conditions including coronary heart disease, inadequately managed hypertension, and diabetes mellitus. It was assumed that he had poor pulmonary reserves due to his history of chronic heavy smoking (2 packs per day for the last 30 years). The patient, being aware of his multiple comorbidities and the risks of general anesthesia, did not want to undergo open surgery for a condition that was asymptomatic at that moment. So, the decision was made to proceed with endovascular aortic aneurysm repair.

The patient underwent endovascular aneurysm repair. The patient had a proximal neck length of 8 mm with an infrarenal angulation of 70 degrees; aortic neck diameter was 32 mm. An Endurant abdominal aortic aneurysm stent graft system with total covered length of 170 mm was used (Medtronic); proximal and distal graft diameters were 36 mm and 20 mm respectively. At the end of the procedure, a small type IA endoleak was detected. There was no margin for placement of an aortic extender cuff, so balloon dilatation was performed with an expectation for total resolution. A control angiogram performed 2 days later showed that the endoleak persisted and balloon dilatation was performed at the attachment site one more time. A control CT scan performed 2 days after the secondary procedure revealed that the type IA endoleak persisted and had grown larger (Figure 1).
Open surgical repair was rejected by the patient. The patient underwent a single session of N-butyl cyanoacrylate (NBCA) embolization of the type IA endoleak using a transarterial approach.

Preprocedure angiography was performed, using the right common femoral artery for access, which delineated the anatomy of the endoleak. Because the leak was massive, bare stent placement was not feasible.

For selective catheterization of the aneurysm sac, over a 0.035” guidewire, a 5 Fr Simmons Imager II catheter (Boston Scientific) was introduced between the proximal stent-graft attachment site and the aortic wall. By using manual injection of contrast, the origin of the type IA endoleak was evaluated. A 2 Fr Excelsior 1018 microcatheter (Boston Scientific) was advanced coaxially through the 5 Fr catheter into the endoleak inflow and a selective angiogram of the aneurysm sac was performed (Figure 2). A mixture of 0.5 mL of Histoacryl NBCA resin (B. Braun) and 3.5 mL of Lipiodol oil-based iodine contrast (Guerbet) was prepared. The microcatheter was flushed with 5% dextrose solution to prevent premature precipitation of NBCA. Under

Figure 2. Angiogram of the aneurysm sac.
continuous fluoroscopic guidance, a total of 3 mL of 12.5% NBCA solution was injected slowly through the microcatheter for 25 seconds; meanwhile the catheter was gradually withdrawn toward the leading edge of the graft to form a cast within the endoleak inflow (Figure 3). Both catheters were withdrawn from the patient within seconds before complete polymerization could occur.

The patient did not require general anesthesia or conscious sedation during the procedure. Control CT angiography 48 hours after the procedure showed no residual endoleak. There were no procedure-related complications. The patient was safely discharged home. CT angiography as a part of our routine follow-up algorithm 6 months after the procedure showed no signs of an endoleak (Figure 4).

**DISCUSSION**

Type I endoleaks may resolve spontaneously during follow-up, however they generally require a secondary intervention because of a higher risk of rupture compared to more benign types of endoleaks. Type IA endoleaks are usually treated using a variety of secondary interventions including balloon expansion of the proximal sealing stent, proximal extension of the graft to lengthen the landing zone or using a bare stent at the attachment site. These methods have certain limitations: Balloon dilatation and stent placement are not always successful in sealing the endoleak, and stent-graft extension can only be performed if there is adequate additional anchoring zone.

If secondary interventions fail to seal type IA endoleaks, endovascular techniques such as transarterial embolization should be considered as an alternative to open
surgical conversion. Use of liquid embolic agents such as NBCA has been described as a possible treatment method for both type I and type II endoleaks.\(^5,6\)

Embolization can be achieved via a transarterial method. When selective catheterization of the endoleak is not successful due to anatomic limitations and equipment problems, several percutaneous routes including transabdominal, transcaval (right sided), and translumbar (left sided) approaches may be utilized.\(^4\)

Several embolic materials may be used for endoleak occlusion. Coil embolization of type I endoleaks has been reported as a successful alternative to open surgical repair. On the other hand, potential for recanalization and continued transmission of systemic pressure through the thrombus and surrounding coils, which is termed as coil compaction, may be problematic. NBCA can isolate the aneurysm sac from the systemic circulation and reduce the possibility of recanalization.\(^4,5\)

Widespread acceptance of EVAR as an alternative to open surgical repair has led to a changing refer-

Figure 4. Follow-up CT angiography 6 months after the procedure showing no signs of an endoleak.
eral pattern within the medical community; patients with unsuitable anatomy, defined in the instructions for use (IFU) of endografts, are now being referred more frequently. Patients such as the one presented in this case with high-risk anatomic aneurysm characteristics (non-IFU) have larger sac diameters ($\geq 60$ mm) with shorter ($\leq 10$ mm) and more angled (>60 degrees) necks. In recent published research, midterm outcomes of non-IFU patients were comparable to those achieved in IFU patients using a similar range of EVAR devices.7

Fenestrated EVAR was not an option in our case because at the time of this procedure the cost of fenestrated stents was not covered by the health care system and thus such stents were not available in the market.

In a review by Moulakakis et al, the authors report that although primary technical success was achieved in all patients with chimney graft technique, 14% of cases had type I endoleaks and 4% of patients required secondary intervention. This increase in endoleak rate is attributed to the patent blood flow in the gutter formed between the chimney grafts and the main body stent. It is also reported that long-term endograft durability and proximal fixation still remains a significant concern.8 In our patient, the distance between the renal arteries and superior mesenteric artery was short. So, we assumed, if chimney graft EVAR was to be performed, the patient would need subsequent chimney grafts for the superior mesenteric artery in addition to the renal arteries. This would mean additional procedure time, radiation dose, use of excessive contrast material, and increased risk of nephrotoxicity, as well as greatly increased cost.

The Palmaz XL stent (Cordis Corporation) is known for its strong radial force providing a stronger and more persistent seal and thus is a valid alternative for type I endoleak management if balloon angioplasty fails. Its use as a prophylactic measure in non-IFU cases is advocated in medical literature. However a recent analysis by Byrne et al reported that in 146 elective EVAR cases requiring Palmaz stents, 14% of the patients still had type I endoleaks at the end of the procedure. They were found to be associated with a greater number of postoperative leaks, especially type I endoleaks, and predict a greater need for secondary interventions.9 In our case, once the endoleak was noted at the end of the procedure, we felt that we would jeopardize our chance of NBCA embolization to occlude the endoleak if a Palmaz stent failed. A Palmaz stent also would increase cost. In case of failure of the NBCA embolization to occlude the endoleak, our next management option would be visceral debranching surgery and graft extension.

**CONCLUSION**

In case of an endoleak in such non-IFU patients, we believe that the use of NBCA as a single embolizing agent in endoleak repair, when compared to use of coils with or without NBCA, is technically simpler and more cost effective. It also requires a considerably shorter procedure time, which in turn means less radiation exposure per procedure.

A main argument against the use of NBCA is the risk of severe complications such as tissue necrosis and inadvertent embolization of normal vessels secondary to uncontrolled reflux. The administration of NBCA requires the operator to be experienced and well acquainted with the behavior of NBCA. The endovascular therapist should closely monitor the progress of NBCA cast during the entire injection and be ready to end the injection when risks arise.
In the failed secondary endovascular treatment of type IA endoleaks after EVAR of infrarenal abdominal aortic aneurysms, NBCA embolization using a transarterial approach appears to be technically feasible and quite effective in experienced hands.

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