Transgraft embolization by using long needle for the treatment of type II endoleaks after endovascular abdominal aortic repair

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ABSTRACT

We used a long custom needle (LCN) to improve transgraft embolization (TGE) in 10 reported cases that underwent TGE with LCN for type II endoleak (T2E) treatment after endovascular abdominal aortic aneurysm repair. TGE was performed with a LCN enabling the usage of microcatheter and embolization coils in 10 cases with T2E after endovascular abdominal aortic aneurysm repair. Embolization was successfully achieved in the nidus in all 10 cases. The aneurysmal sac diameter significantly decreased by TGE, and none of the 7 of 10 cases exhibited recurrence of sac expansion or T2E throughout the 2-year follow-up period. (J Vasc Surg Cases and Innovative Techniques 2020;6:590-4.)

Keywords: Transgraft embolization (TGE); Long custom needle; Type II endoleak; Endovascular abdominal aortic repair (EVAR)

The most common indication for reintervention after endovascular abdominal aortic aneurysm repair (EVAR) is the treatment of endoleak.[1,2] Although there is no consensus for optimal treatment strategy, transarterial, translumbar, transcaval, and perigraft approaches as well as open surgery are primarily considered as a management of problematic type II endoleak (T2E).[1-4]

The transarterial embolization (TAE) and translumbar embolization (TLE) are the most common approaches. There are only limited number of case reports regarding transgraft embolization (TGE).[5-8] In those cases, TGEs were performed with a coronary laser catheter,[6,7] Brockenbrough needle (BRK),[8] or transjugular liver access set[6]; therefore, procedures were not consistent. Since 2013, we applied TGE to evaluate the efficacy of TGE for treatment of T2E when TAE was in technical difficulties (there are no vessels that can be evaluated by computed tomography [CT] images and TAE was unsuccessful). Originally, we had used a BRK for TGE. BRK needs to puncture the nidus accurately with the needle. However, puncturing the nidus with the needle precisely are difficult because of coexisting thrombus and the graft flexion. In 2 cases, puncturing the nidus by BRK was unsuccessful. To improve our TGE operation, we used a long custom needle (LCN) with larger inner diameter to enable the usage of microcatheter. The aim of this study was to evaluate the feasibility and efficacy of TGE with LCN. A retrospective analysis was performed.

METHODS

Study participants were 10 cases who underwent TGE with a LCN at our hospital from June 2015 to November 2017. The study protocol was approved by Ethics committee of Fukuoka University (2016M079), and the patients were given informed written consent before the study. Informed consent was obtained from all participants.

LCN. Needle manufacturers produced the LCN (Fig 1) (Kaneko MediX Inc, Nasushiobara, Japan) Length is 1000 mm, with an 0.48 mm outside diameter and an 0.36 mm inside diameter. This LCN enabled us to use a microcatheter.

TGE. We performed TGE under general anesthesia, allowing us to handle any possible extra procedures. A 6F sheath with a 5F guide catheter (Mach 1, Boston Scientific, Inc, Marlborough, Mass) was inserted via the femoral artery percutaneously. The LCN was inserted through the catheter under the support of 0.035-inch guidewire (Radifocus 0.035-inch, Terumo Corp, Tokyo, Japan) to minimize the risk of perforation of a blood vessel or the sheath. When vessel torsion and flexure are strong, we have a limit for the insertion of LCN. When the needles adequately reached the nidus, blood flowback to the needle can be confirmed. In contrast, no blood flowback is confirmed when the needles are located within the thrombus. Therefore, when no blood flowback was confirmed when the needle was located within the thrombus, a 0.018- or 0.014-inch guidewire (SUCCEDO, Boston Scientific Inc or Cruise, Asahi Intec Co, Ltd, Seto,

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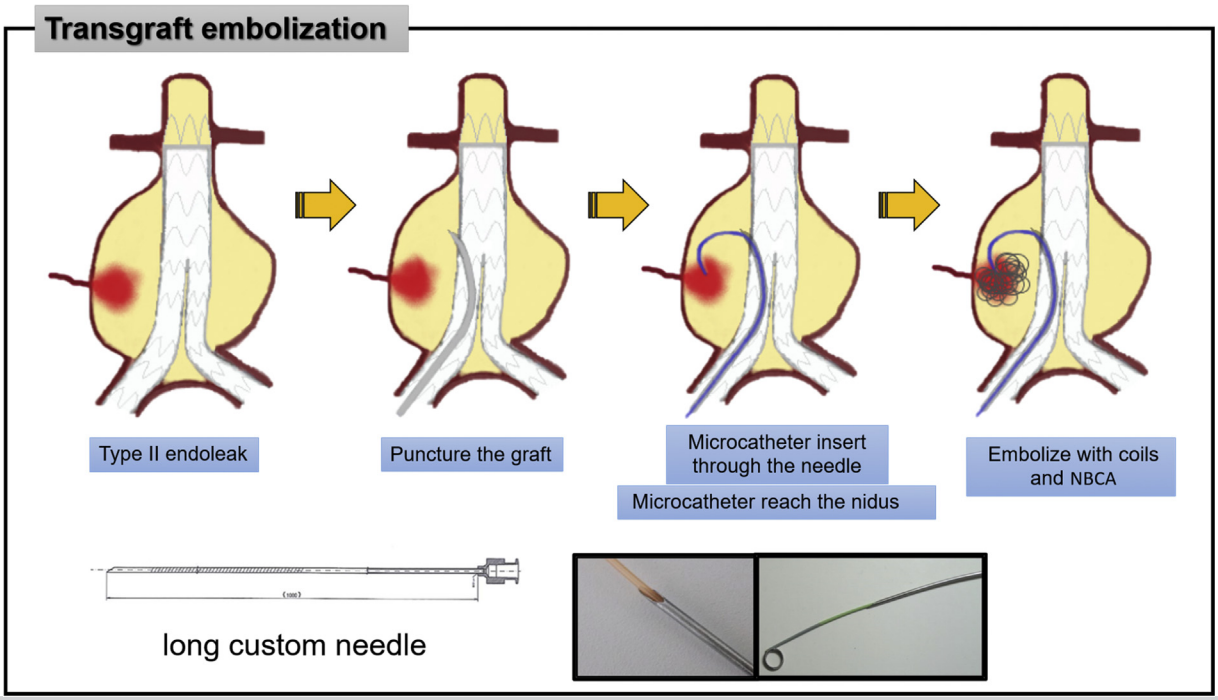

Fig 1. Transgraft embolization (TGE) by using a long custom needle (LCN). The LCN has a larger inner diameter (0.035-inch) compared with the Brockenbrough needle (BRK) (0.014-inch). Its length is 1000 mm (outer diameter, 0.48 mm; inner diameter, 0.36 mm). It is a flat bevel point needle. This LCN with lager diameter enabled us to use a microcatheter and 0.018- or 0.021-inch coil while BRK requires much smaller coil (0.010-inch), precluding the usage of microcatheter. *NBCA,* n-butyl-2-cyanoacrylate.

Table I. Demographics and characteristics in 10 patients

Variable	No. (%) or mean ± SD
Demographics	
Age	79.4 ± 8.87
Female	2 (20)
Characteristics	
Smoker	2 (20)
Hypertension	8 (80)
Diabetes	2 (20)
Hyperlipidemia	4 (40)
Coronary artery disease	2 (20)
Cerebrovascular vascular disease	0 (0)
Peripheral artery disease	2 (20)
COPD	2 (20)
Creatinine (mg/dL)	1.16 ± 0.32
eGFR	46.8 ± 18.7
Hemodialysis	0 (0)
Antiplatelet	2 (20)
Anticoagulant	2 (20)
ASA score	1.30 ± 0.46
Intervals between EVAR and TGE (years)	3.4 ± 1.1

ASA score, American Society of Anesthesiologists Score; *COPD,* chronic obstructive pulmonary disease; *eGFR,* estimated glomerular filtration rate; *EVAR,* endovascular abdominal aortic aneurysm repair; *SD,* standard deviation; *TGE,* transgraft embolization.

Aichi, Japan) and microcatheter (Renegade, Boston Scientific Inc) were inserted to the sac to seek the nidus. The first step of TGE was performed with coils (Interlock Fibered IDC Occlusion System, Boston Scientific, or Ruby Coil, Penumbra, Alameda, Calif). When the microcatheter was reached to the targeted vessel, TGE was performed in both the nidus and vessel. The second step of TGE was performed with cyanoacrylate. After flushing with 50% glucose solution (approximately 10 mL) through the catheter, a mixture of n-butyl-2-cyanoacrylate (NBCA, Histoacryl; B. Braun, AG, Melsungen, Germany) and iodized oil (Lipiodol 480 Injection 10 mL; Guerbet Japan, Tokyo, Japan) at a ratio of 1:2 or 1:3 was infused to the nidus (and the vessel) with the contrast aortography.[9]

RESULTS

Among 244 cases that underwent EVAR from April 2011 to April 2017, T2E was observed in 51 cases (21%). Treatment was considered if a sac enlargement of 5 mm between follow-up imaging. Twenty six cases followed up and 25 cases needed reintervention. In general, a transarterial approach (superior mesenteric artery, internal iliac, or other branch) was used for treatment of T2E. Eight cases were performed with TEA (16%) and two cases of the TEA were performed with TGE by BRK. TGEs were performed in 19 cases (LCN 10 cases, BRK 9 cases) with T2E (37%). In TGE by BRK, T2E recurrence was observed

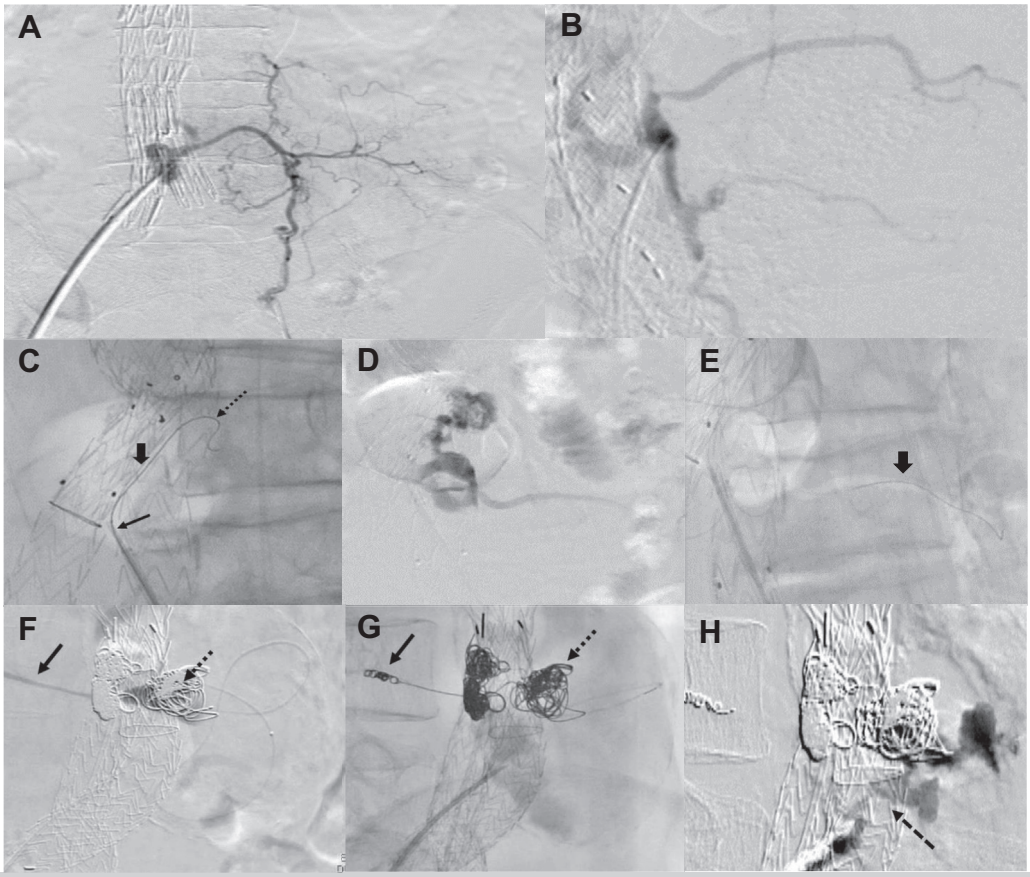

Fig 2. Fluoroscopic images of transgraft puncture and identification of the nidus and feeding vessels. **A,** A case with Zenith Flex (patient 6). The aneurysmal sac was directly punctured with a long custom needle (LCN) inside the graft. When the needle correctly placed in the nidus, the contrast agent was injected and identified the nidus and feeding blood vessels (lumber and iliolumbar arteries). **B,** A case with EXCLUDER (Patient 7). The nidus and feeding vessel (lumber artery) were identified. **C,** For patient 10, because the needle (*thin arrow*) was not able to reach the nidus, a guidewire (*dotted arrow*) and a microcatheter (*thick arrow*) were inserted through the needle. **D,** When the microcatheter adequately reached the nidus, the contrast agent was injected and identified the nidus and feeding blood vessels (lumber artery). **E,** A selective approach to the feeding vessel was achieved with microcatheter (*arrow*). **F,** For patients 3, the nidus was embolized with coils (*dotted arrow*) through the microcatheter followed by embolization in the feeding vessel (*arrow*). **G,** After the nidus embolization with coils (*dotted arrow*), the microcatheter was further inserted to the feeding vessel and coil embolization was performed in the vessel (*arrow*). **H,** An n-butyl-2-cyanoacrylate (NBCA) embolization (*dotted arrow*) was performed at the proximal part of the nidus from the site of puncture.

in one case after follow-up because there was no enlargement of sac. Patients background characteristics are shown in Table I. Approach to the nidus were successfully achieved in all 10 cases, and selective approach to the target vessel was also achieved in 2 cases (Fig 2). Embolization was successfully completed with both coil and NBCA from all cases. The TGE resulted significant decrease in diameter of the aneurysmal sac with only one exception (patient 5), and none exhibited recurrence of sac expansion or T2E throughout the follow-up period (Table II).

DISCUSSION

As far as we searched, this study is the first to summarize accumulated data from 10 cases who underwent TGEs with the consistent procedure and comprehensive follow-up observations for 2 years. The main advantage of TGE is that it can enter into the aneurysm sac without damaging the aneurysm wall. Our LCN cleared several technical difficulties associated with TGE. Embolization with liquid embolics alone may increase a risk of undesired distal embolization, which could lead to paralysis.[5-9] Ironically, embolization with both coils and NBCA may compromise the ability of a contrast-enhanced CT scan to detect potential endoleak owing to halation. Fluoroscopic angiography of the nidus during the TGE could identify type I endoleaks, as well as endoleaks from the vasa vasorum and arteriovenous fistula, which might not be detectable with contrast-enhanced CT scans.[10] A complete occlusion of the nidus is mandatory

Table II. Time course of changes in the aneurysmal sac diameters before and after transgraft embolization (*TGE*)

ID	Stent graft	Feeding vessel			Before EVAR	After EVAR	Before TGE	6 Months after TGE	1 Year after TGE	2 Years after TGE
		Name	No.	Diameter, mm						
1	EX	LA	1	2.65	47	41	49 (+8, +20%)	46 (−3, −6%)	44 (−5, −10%)	40 (−9, −18%)
2	EX	LA	1	2.7	54	53	61 (+8, 15%)	55 (−6, −10%)	52 (−9, −15%)	–[a]
3	EX	LA	2	2.8	62	45	55 (+10, 22%)	51 (−4, −7%)	51 (−4, −7%)	51 (−4, −7%)
4	EX	LA	1	2.65	49	45	56 (+11, 24%	54 (−2, −4%)	51 (−5, −9%)	46 (−10, −17%)
5	EX	LA/ IMA	1	3.82(LA)	70	64	70 (+6, 9%)	70 (0, 0%)	70 (0, 0%)	70 (0, 0%)
6	ZN	LA	2	2.64	42	43	56 (+12, 30%)	54 (−2, −4%)	–[b]	–
7	EX	LA	2	2.1	100	89	94 (+5, 6%)	90 (−4, −4%)	–[c]	–
8	ZN	LA	2	2.1	53	49	54 (+5, 10%)	50 (−4, −7%)	46 (−8, −15%)	43 (−9, −17%)
9	EX	LA	1	3.8	90	83	93 (+10, 12%)	92 (−1, −1%)	92 (−1, −1%)	88 (−5, −5%)
10	EN	LA/ Vas	1	3.2(LA)	72	68	77 (+9, 13%)	74 (−3, −4%)	69 (−8, −10%)	69 (−8, −10%)
Mean					64 ± 18	58 ± 160	67 ± 16 (8.4 ± 2.3)	63 ± 16 (−2.9 ± 1.6)	59 ± 15 (−5.0 ± 3.1)	58 ± 17 (−6.4 ± 3.5)

After TGE, in parenthesis, difference (mm and %) from that before TGE; *Before TGE*, in parenthesis, difference (mm and %) from that after EVAR; *EN*, Endurant; *EVAR*, endovascular abdominal aortic repair; *ID*, patient identification number; *IMA*, inferior mesenteric artery; *Ex*, EXCLUDER; *LA*, lumbar artery; *Vas*, vasa vasorum; *ZN*, Zenith Flex.
[a]Patient 2 did not attend the 2-year follow-up.
[b]Patient 6 moved to the other hospital after the 6-month follow-up.
[c]Patient 7 deceased owing to pneumonia (not associated with the aneurysmal sac or TGE).

to achieve a favorable outcome. Because the TGE procedure requires direct puncture of the endograft, there is a concern for a potential type III endoleak (T3E) attributed to graft fabric tear or disruption owing to the needle puncture. In this procedure, the additional placement of the endograft can be optimized to prevent a T3E.

In our experiment, when NBCA contacted with the fabric (expanded polytetrafluoroethylene and Dacron) of the endograft, the puncture hole occluded instantly. In addition, the leak from a puncture hole was not observed even at a pressure of 200 mm Hg. Furthermore, a LCN can puncture the endograft with minimal damage to the fabric. Therefore, we did not need additional replacement of the endograft. A larger diameter sheath is necessary if adding an endograft. None of the patients who underwent TGE at our hospital had exhibited T3E on a contrast-enhanced CT scan throughout the follow-up period. Although we successfully accomplished 10 TGE operations with the LCN, the study size is not considered sufficiently large enough to enable us to conduct a robust assessment in clinical practice.

In conclusion, the aneurysmal sac diameter significantly decreased compared with that before TGE. None of the 10 cases who underwent TGE by LCN in this study exhibited recurrence of aneurysmal sac expansion or T2E throughout the 2 year follow-up period (n = 10 for 6 months, n = 8 for 1 year, and n = 7 for 2 years). If TAE or TLE are not feasible, TGE can be considered as a minimally invasive treatment for T2E. The success rate of TGE can be improved by using LCN if the microcatheter can be inserted to the nidus. However, the concern of T3E and serial observations are still necessary. TGE with LCN can be an effective option for the treatment of T2E after EVAR, especially when other procedures such as TAE and TLE are not feasible.

REFERENCES

1. Brown A, Saggu GK, Bown MJ, Sayers RD, Sidloff DA. Type II endoleaks: challenges and solutions. Vasc Health Risk Manag 2016;12:53-63.
2. Bryce Y, Lam CK, Ganguli S, Schiro BJ, Cooper K, Cline M, et al. Step-by-step approach to management of type II endoleaks. Tech Vasc Interv Radiol 2018;21:188-95.
3. Fabre D, Fadel E, Brenot P, Hamdi S, Gomez Caro A, Mussot S, et al. Type II endoleak prevention with coil embolization during endovascular aneurysm repair in high-risk patients. J Vasc Surg 2015;62:1-7.
4. Stavropoulos SW, Park J, Fairman R, Carpenter J. Type 2 endoleak embolization comparison: translumbar embolization versus modified transarterial embolization. J Vasc Interv Radiol 2009;20:1299-302.
5. Nakai M, Ikoma A, Loffroy R, Midulla M, Rao P, Kamisako A, et al. Transgraft sac embolization combined with graft reinforcement for refractory mixed-type endoleak. Cardiovasc Intervent Radiol 2019;42:620-4.
6. Mewissen MW, Jan MF, Kuten D, Krajcer Z. Laser-assisted transgraft embolization: a technique for the treatment of type II endoleaks. J Vasc Intervent Radiol 2017;28:1600-3.
7. Jan MF, Mewissen MW. Type II endoleak following endovascular repair of infrarenal abdominal aortic aneurysm: innovative transgraft approach to contemporary management. J Patient Cent Res Rev 2015;2:118-26.

8. Koike Y, Date K, Kiss BD, Obara AWD, Matsui S. Trans-stent graft embolization using a Brockenbrough needle for delayed rupture due to isolated type II endoleak after endovascular aortic aneurysm repair. Interv Radiol 2017;2:111-5.
9. Wilmot A, Stavropoulos SW. Embolization of a recurrent type 2 endoleak using the liquid embolic n-Butyl Cyanoacrylate. Semin Intervent Radiol 2007;24:38-42.
10. Hideyuki T, Masanori I, Seishi N, Masashi T, Hideki Y, Akihiro Y, et al. Imaging findings of atypical type II endoleak through vasa vasorum after abdominal endovascular aneurysm repair. Cardiovasc Intervent Radiol 2018;41:186-90.

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