Outcomes of transcaval endoleak embolization via laser fenestration of the inferior vena cava following endovascular abdominal aortic aneurysm repair

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ABSTRACT

This report describes a single center experience with laser fenestration of the inferior vena cava for the treatment of type 2 endoleak after endovascular abdominal aortic aneurysm repair. Our technique is reviewed, and clinical data after treatment are reported. Twelve patients underwent transcaval embolization via laser fenestration. Technical success was achieved in all cases (100%) with no postoperative complications. At a median follow-up of 12.9 months, no patient demonstrated a persistent endoleak and there were no cases of aortocaval fistula. Transcaval embolization, via laser fenestration, provides an additional strategy for the management of type 2 endoleak after endovascular abdominal aortic aneurysm repair. (J Vasc Surg Cases Innov Tech 2021;7:636-40.)

Keywords: Embolization; Endovascular repair; Abdominal aortic aneurysm; Endovascular treatment; Laser

Endoleak is a common complication after endovascular repair of abdominal aortic aneurysm (EVAR) and is the leading cause for reintervention.[1] Type 2 endoleak (T2EL) is the most common type of endoleak and occurs when there is backflow into the aneurysm sac from collaterals.[2] There are currently many proposed techniques for the management of T2EL; however, a gold standard has not been determined. As a direct approach, transcaval embolization, using a transjugular liver access needle for aneurysm sac access, has been reported.[3-5] The purpose of our study is to analyze our experience with an alternative treatment technique, laser fenestration of the inferior vena cava (IVC) into the aneurysm sac with transcaval embolization, for the treatment of T2EL after EVAR.

METHODS

Clinical database and patient cohort. Twelve patients who underwent treatment for T2EL with transcaval embolization after laser fenestration were identified in the years 2019-2021 and constitute the study cohort. This retrospective study was approved by our health care system's institutional review board. Data were obtained from the review of the electronic medical record and computed tomography angiography (CTA) studies. Technical success was defined as the ability to gain access to the aneurysm sac with no evidence of T2EL at case completion. Clinical success was defined as cessation of sac growth and no evidence of persistent endoleak on post-procedure imaging.

TECHNICAL DESCRIPTION

All patients underwent preoperative planning with standard post-EVAR CTA to exclude a type 1 or 3 endoleak. Furthermore, all patients underwent repeat CTA after endoleak treatment. Based on the pre-procedure CTA, the proposed sac entry site was identified, and important landmarks were noted. Gantry angles were calculated for the optimal view. If any uncertainty existed regarding sheath direction, intraprocedural cone-beam CT was used before laser fenestration. When we are planning for transcaval embolization via laser fenestration, we consider the optimal site for transcaval access to be a location where there is close apposition of the IVC and the abdominal aortic aneurysm (AAA) sac wall, absence of significant calcium near the desired fenestration site, and adequate distance between the stent graft fabric and the desired area of fenestration. Using standard techniques, the femoral vein was accessed, and a 16 French Aptus Tour Guide steerable sheath (Medtronic, Minneapolis, Minn) was passed into the IVC. The steerable sheath was directed against the IVC toward the aortic wall. A 2.3-mm Turbo Elite laser catheter (Phillips, San Diego, Calif) was then used to create a fenestration between the IVC and the AAA sac (Fig 1, *A*). The actual fenestration process took place in 1 second, and a standard laser setting of 60 fluence and 40 Hz frequency was used. Over a 0.035-inch guidewire, a long 5-French sheath was then passed through the indwelling venous sheath and into the aneurysm sac. An aortic aneurysm

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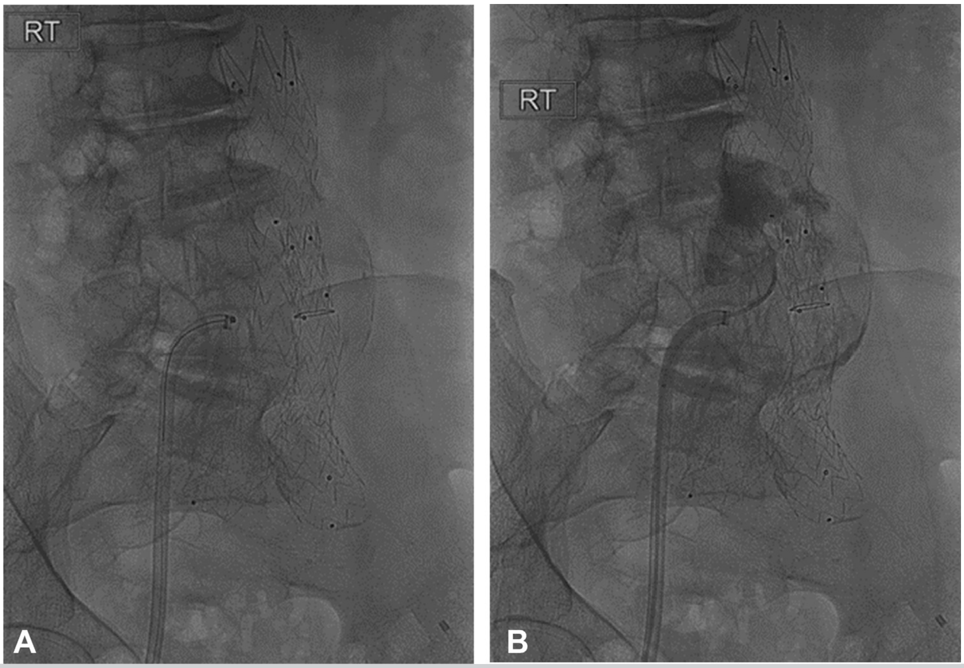

Fig 1. From the right femoral vein, a steerable 16 French sheath was passed into the inferior vena cava (IVC) and was directed against the vena cava and aortic walls. A 2.3-mm laser atherectomy catheter was then used to create a fenestration between the IVC and the aortic aneurysm sac **(A)**. An aortic aneurysm "sacogram" was performed identifying the endoleak as well as the aneurysm endoleak cavity **(B)**.

"sacogram" was performed identifying the endoleak as well as the aneurysm endoleak cavity (Fig 1, *B*). At the discretion of the operating surgeon, cone beam computed tomography was used selectively to confirm sac access (Fig 2). After successful access, the aneurysm sac is probed to look for areas of active flow. Based on our experience thus far, it is unclear if selecting the inflow and outflow vessels is necessary to successfully treat the endoleak. Selection of these vessels is technically feasible, but given the favorable results without this approach, selective vessel subselection is felt to be unnecessary. Multiple embolization coils ± fibrin sealant (Tisseel; Baxter Healthcare, Deerfield, Ill) were placed in the aneurysm sac (Fig 3, *A*). At the completion of the procedure, the sheath was pulled back into the IVC and a final cavogram was performed to confirm that there was no evidence of an aortocaval fistula (Fig 3, *B*). The femoral vein sheath was then removed, and manual pressure held for hemostasis.

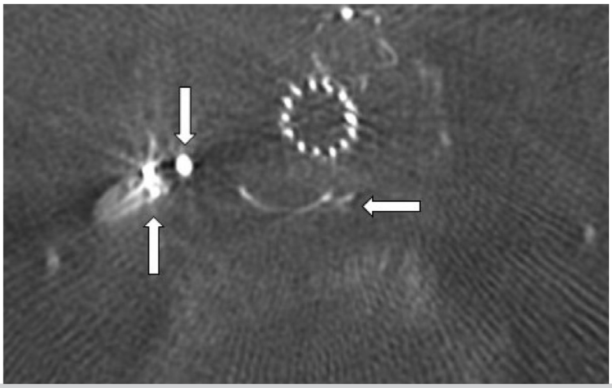

Fig 2. Cone beam computed tomography (CT) was used selectively to confirm successful aneurysm sac access. The *upward arrow* points to the tip of the steerable 16 French sheath. The *downward arrow* identifies the tip of the laser catheter, and the *horizontal arrow* indicates a guidewire within the aneurysm sac.

RESULTS

Twelve patients with persistent T2EL and AAA sac growth underwent transcaval embolization via laser fenestration of the IVC. A variety of stent graft types were used at the initial AAA repair, and specifics regarding aortic implants, along with patient demographics, are provided in Table I.

Mean time from initial EVAR to endoleak treatment was 82.6 ± 56.1 months. In 8 patients (67%), transcaval embolization via laser fenestration was the initial procedure for the T2EL. No patients in this series underwent previous transcaval embolization procedures. In the remaining four patients (33%), two patients were treated with a previous translumbar approach and two other patients were treated via a transarterial route. Early in our experience, six transcaval embolization procedures were performed under general anesthesia. As our comfort level grew with this technique, the remaining 50%

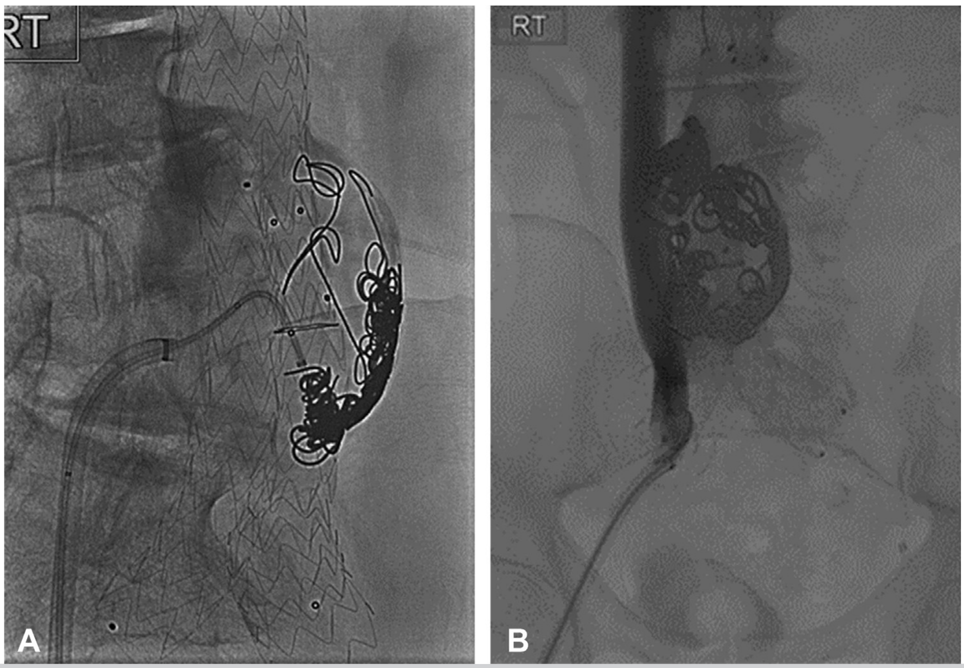

Fig 3. After confirming success aneurysm sac access, multiple embolization coils and fibrin sealant were placed in the aneurysm sac **(A)**. At the completion of the procedure, the sheath was pulled back into the inferior vena cava (IVC) and a final cavogram was performed to confirm that there was no evidence of an aortocaval fistula **(B)**.

of procedures were performed under conscious sedation. The right common femoral vein was the venous access site in all but one patient (92%). In the single case of left-sided access, ultrasound examination performed at the time of venous access demonstrated an atretic right femoral vein. The mean number of coils used per procedure was 36.7 ± 14.6. At the discretion of the operating surgeon, 10 patients (83%) were treated with fibrin sealant in addition to coils. Technical success was achieved in all cases (100%) with no postoperative complications. Furthermore, no patient demonstrated a persistent endoleak after treatment, and there were no cases of continued aneurysm sac growth or the presence of aortocaval fistula indicating 100% clinical success. The mean hospital stay after transcaval embolization was 1.1 days, and the 30-day survival rate was 100%. On follow-up, only one patient is deceased at 499 days after the procedure. This death has been attributed to squamous cell cancer of the lung. Further periprocedural details regarding the transcaval embolization procedures are provided in Table I.

The mean pre-EVAR AAA sac diameter was 58.1 ± 6.9 mm. After EVAR, most patients experienced favorable sac remodeling and our cohort demonstrated a mean post-EVAR sac diameter of 53.2 ± 8.0 mm. Despite initial favorable results after EVAR, persistent T2EL led to AAA sac growth and our population demonstrated a mean pre-transcaval embolization sac diameter of 68.6 ± 11.8 mm. The mean follow-up after laser fenestration of the IVC and transcaval embolization was 12.9 ± 6.7 months. The mean AAA size after laser fenestration of the IVC and transcaval embolization was 65.2 ± 11.9 cm. Clinical success, as defined as no evidence of persistent endoleak on surveillance imaging after transcaval embolization, was achieved in all 12 patients (100%). However, after transcaval embolization, AAA size did not differ statistically when compared with pre-transcaval embolization AAA sac diameter ($P = .59$).

DISCUSSION

The most common approaches for an isolated T2EL are transarterial, translumbar, or transcaval embolization. Previous descriptions of a transcaval approach to a T2EL involve using a curved transjugular liver access (TIPS) needle system for sac access from the IVC.[6]

The largest series of transcaval embolizations using a TIPS needle for the treatment of endoleak after EVAR is from Giles et al.[7] In this series, 29 transcaval embolizations were performed with a technical success of 90% and reintervention rate of 17%.[7] In this series, the authors report two instances (7%) of graft puncture with the TIPS introducer needle. In both instances, the authors report that the puncture site sealed immediately without a need for intervention.[7] Similarly, a recent literature review of six studies using a TIPS needle, encompassing 90 patients, found a technical success rate of 94% with no reported case of 30-day mortality.[8] The most common periprocedural morbidity was thrombophlebitis within

Table I. Demographics, procedural, and follow-up information of 12 consecutive patients who underwent type II endoleak treatment via laser fenestration of the inferior vena cava (IVC) with transcaval embolization

Variable	n = 12	% or SD
Age at procedure, years	77.3	±8.3
Male	12	100%
Mean BMI, kg/m^2	27.8	±7.0
Hypertension	10	83%
Dyslipidemia	12	100%
Diabetes mellitus	2	17%
Tobacco history	8	67%
CAD	5	42%
Prior MI	4	33%
CHF	3	25%
Atrial fibrillation	5	42%
CKD (Cr > 1.5 mg/dL)	3	25%
COPD	3	25%
Endografts implanted		
Medtronic Endurant	4	33%
Gore Excluder	3	25%
Cook Zenith	2	17%
Medtronic Talent	2	17%
Medtronic AneuRx	1	8%
Time from EVAR to TCE, months	82.6	±56.1
Previous endoleak treatment attempt	4	33%
Conscious sedation	6	50%
General anesthesia	6	50%
Ultrasound-guided access	12	100%
Right-sided venous access	11	92%
Confirmation with cone beam CT	6	50%
Mean number of coils used	36.7	±14.6
Patients treated with fibrin sealant	10	83%
Mean amount fibrin sealant used, mL	5.5	±3.4
Mean procedure time, minutes	181.7	±58.4
Mean fluoroscopy time, minutes	50.3	±18.3
Fluoroscopy dosage, Gy cm^2	942	±557
Technical success	12	100%
Clinical success	12	100%
Postoperative complications	0	0
Mean hospital stay, days	1.1	±0.7
30-day survival rate	12	100%

BMI, Body mass index; *CAD,* coronary artery disease; *MI,* myocardial Infarction; *CHF,* congestive heart failure; *CKD,* chronic kidney disease; *Cr,* creatinine; *COPD,* chronic obstructive pulmonary disease; *EVAR,* endovascular abdominal aortic aneurysm repair; *TCE,* transcaval embolization; *CT,* computed tomography; *SD,* standard deviation.

30 days (3.3%). In this review article, the mean follow-up was 18.4 months and the need for reintervention rate was 13%.

After over a decade of experience with translumbar embolization of endoleaks,[9] our group began transcaval embolization using a TIPS needle approach. Unfortunately, we were not satisfied with the rigidity and lack of maneuverability that arose with the use of the TIPS needle. Because of these constraints, we transitioned to a transcaval approach with a steerable sheath and laser fenestration. We believe that this technique allows for access at different points along the aortocaval interface and may extend the number of patients suitable for a transcaval embolization procedure. Although transcaval laser fenestration is now our preferred method to address T2EL, we do acknowledge some potential disadvantages. The first issue is that our venous access requires a 16 French sheath. We did attempt this technique using smaller steerable sheaths but found that the most distal end of these sheaths did not retain the desired angulation during introduction of the laser catheter. We are still striving to find the perfect sheath for this procedure. Although we acknowledge a potential advantage of the smaller sheath size associated with the TIPS needle approach, we have not encountered any venous access complications with the use of a larger sheath. Another potential disadvantage of this technique is our mean fluoroscopy time of 50 minutes and mean patient radiation dose of 942 Gy cm^2. In previous reports of transcaval embolization of endoleaks,[5-8] patient radiation dose is inconsistently reported so it is currently difficult to define what is an acceptable level for this procedure. We also acknowledge the health care costs associated with this technique as a potential disadvantage. To lower equipment costs, we perform this procedure with pushable coils as they provide the greatest volume of embolization material with the lowest associated cost. Lastly, we acknowledge that the abundance of coils used in our case series make it difficult to detect a small aortocaval fistula or continued endoleak.

This report demonstrates excellent technical and early clinical success with no perioperative complications, including no instances of inadvertent graft fenestration. At a mean follow-up of 12.9 months, no patients were found to have recurrent T2EL. Although we acknowledge that that our series includes a small number of patients with only short-term follow-up, we believe that this novel technique presents advantages over the more traditional transcaval embolization techniques that may include a decreased risk of unintentional puncture of the existing endograft and greater applicability to patients with anatomic contraindications to the use of a TIPS needle.

CONCLUSIONS

Transcaval embolization, via laser fenestration, provides an additional strategy for management of type II endoleaks after EVAR.

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