The inside-out technique for tunneled dialysis catheter placement with central venous occlusion

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ABSTRACT

The "inside-out" technique eliminates the need for subclavian or femoral catheter placement by placing a supraclavicular catheter via a percutaneous femoral vein access. Few reports of its use in vascular surgery exist. The purpose of this article is to describe our version of the technique and report results. Between 2016 and 2017, the inside-out technique was performed on eight patients. All patients had more than four prior access sites and bilateral internal jugular vein occlusion. The technical success rates were 100% with no periprocedural complications and success in achieving dialysis access. One patient required catheter replacement within 48 hours, one catheter was used as a bridge to Hemodialysis Reliable Outflow (Hemosphere, a Cryolife Inc Company, Eden Prairie, Minn) graft placement, and one patient died of sepsis unrelated to their catheter. Our data show the inside-out technique to be safe and effective, removes the need for subclavian or femoral catheter placement, and should be a component of treatment algorithms for complex dialysis patients, which is consistent with National Kidney Foundation's Kidney Disease Outcomes Quality Initiative recommendations. (J Vasc Surg Cases and Innovative Techniques 2019;5:350-5.)

Keywords: Inside-out; Vascular catheterization; Dialysis access; Subclavian catheter; Femoral catheter

Patients with multiple, failed dialysis accesses and limited access sites can present as a significant challenge to vascular surgeons. It is known that the Fistula First initiative has caused the increased use of tunneled dialysis catheters. It also seems that the increased use of tunneled dialysis catheters has potentially led to an increased incidence of central venous occlusion.[1,2] The presence of central venous occlusion and the need for temporary or permanent dialysis catheter placement is especially problematic. Frequently, patients are left with femoral access as their only option, if subclavian access is to be avoided. Previous reports have described an "inside-out" technique for achieving central venous access that avoids the need for subclavian or femoral catheter placement by placing a supraclavicular catheter via a percutaneous femoral vein.[2-6] Although there are reports of pacemaker lead placement with this technique, as well as Hemodialysis Reliable Outflow (HeRO; Hemosphere, a Cryolife Inc Company, Eden Prairie, Minn) graft placement, there are very few reports in the vascular literature of its use to assist in catheter placement. The purpose of this article is to describe our version of the technique and report the results.

METHODS

We performed a retrospective review of our hemodialysis access database and identified all patients who underwent the inside-out technique of tunneled dialysis catheter placement from August 2016 to July 2017. All procedures were performed by a single surgeon (C.C.), in a hybrid operating room. Patient demographics, contrast volume, fluoroscopy time, and catheter patency, as well as secondary procedures, were captured. The study was approved by our institutional review board.

Procedural details. All procedures were performed using either general anesthesia or conscious sedation supplemented with local anesthesia. Ultrasound guidance was used for common femoral venous access, and a superior venacavogram with anteroposterior and oblique views was obtained to document the level of caval occlusion (Fig 1). An 8F, 81-cm long, braided transseptal sheath (Swartz Braided SL1, St. Jude Medical, St. Paul, Minn) was advanced until the tip of the dilator was at the level of the caval occlusion. The tip was then oriented anterolaterally toward the clavicular head (Fig 2). The back end of a 0.014 Confianza wire (Asahi Intecc, Aichi, Japan) was passed through the dilator and forced through the vein wall, achieving a subcutaneous location, and advanced until it tented the skin at the base of the neck posterior to the clavicle (Supplementary Figs 1 and 2). Next, a small incision was made over the wire where the skin was tented. The wire was grasped with a hemostat and retrieved from the subcutaneous tissue. The tissue tract was then dilated with a hemostat

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Fig 1. Superior venacavogram before intervention.

Fig 2. Contrast injection via SL1 catheter.

and a micropuncture sheath was then placed over the back end of the Confianza wire and advanced into the SL1 catheter. A contrast injection was used to confirm placement in the superior vena cava (SVC). Next, a 0.035 Amplatz Super Stiff guidewire (Boston Scientific, Marlborough, Mass) was advanced through the microsheath into the SL1 catheter. The guidewire was then advanced into an inferior vena cava while the SL1 catheter was withdrawn. The tunneled catheter was placed in standard fashion (Fig 3).

Patient population. A total of nine patients underwent inside-out technique catheter placement. One patient was excluded because it was a port placed for chronic dehydration caused by short gut syndrome. The characteristics of the eight patients who underwent the inside out technique are listed in Table I. They were on dialysis for an average of 116 months with a range of 60 to 231 months. They had an average of 11.5 previous dialysis access routes (tunneled catheters, grafts, or fistula) with a range of 6 to 36 previous dialysis accesses. All patients had an internal jugular (IJ) vein occlusion. Seven had subclavian vein occlusion and four had right brachiocephalic vein occlusion as well. Four patients had previously undergone subclavian vein stenting. No stents remained patent and no stent was recanalized.

RESULTS

Our results (Table II) were 100% technically successful. To date, there have been no complications related to the procedure. The average patency of the catheter has been 137 days with a range of 8 to 467 days. The average contrast volume is 40.9 mL with a range of 20 to 100 mL. The average fluoroscopy time was 15.1 minutes with a range of 5.8 to 56.1 minutes. Patients receiving catheters were ultimately bridged to either HeRO graft placement, hybrid graft placement, thigh graft placement, or chest wall graft placement. Three patients expired from

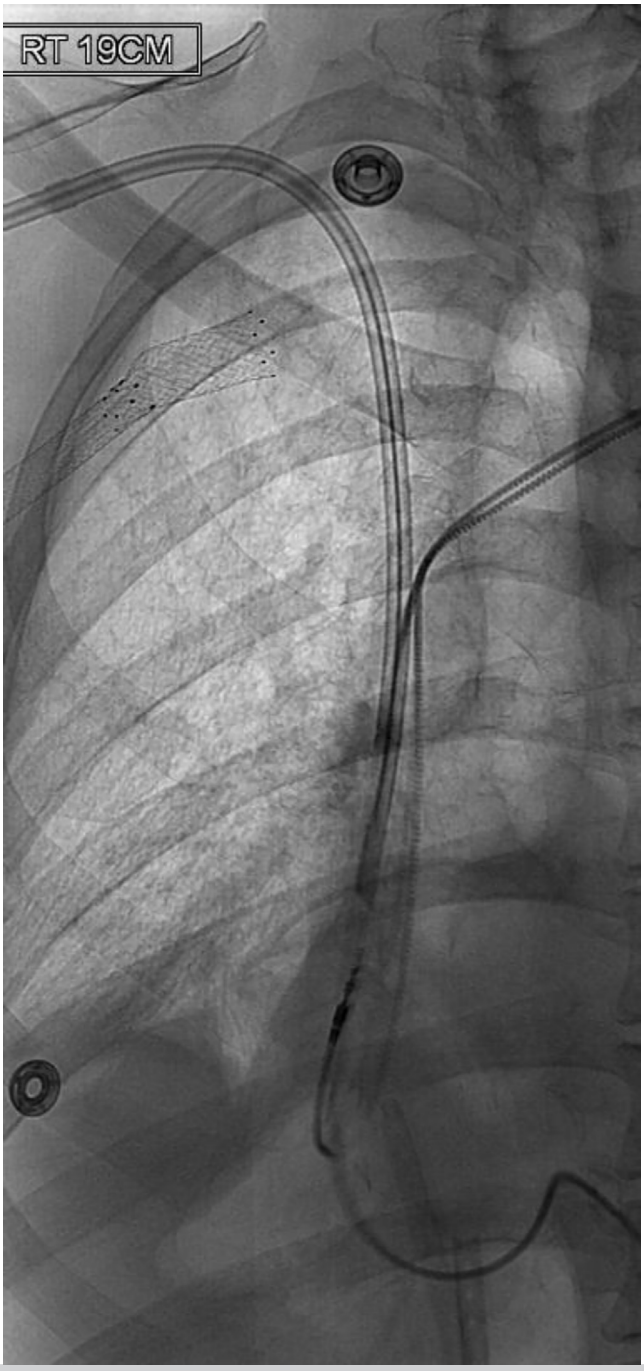

Fig 3. Tunneled catheter in place.

Table I. Patient characteristics (N = 8)

Characteristic	
Age, years, mean ± SD	59.8 ± 14.8
Male sex, No. (%)	3 (37.5)
No. of previous access	11.5 (6-36)
Time on dialysis, months	116 (60-231)

SD, Standard deviation.

Table II. Results

Results	
Technical success, No. (%)	8 (100.0)
Mean patency, days (range)	137 (8-467)
Procedural complications, No. (%)	0 (0.0)
Mean contrast volume, mL	40.9 (20-100)
Mean fluoroscopy time, minutes	15.1 (5.8-56.1)

noncatheter-related complications and one patient remains catheter dependent.

DISCUSSION

Providing adequate dialysis access continues to challenge surgeons as dialysis patients live longer and exhaust their access options. Although it is well-known that catheter access is the least preferred method of long-term dialysis access, patients who have been on dialysis for extended periods of time frequently experience episodes during which they need catheter access either as a bridge to new access or for permanent access after all other options have been exhausted.[7] It has been established that subclavian vein access results in subclavian vein stenosis or occlusion up to 40% of the time. For this reason, IJ catheters are the preferred catheter access site.[8,9] Although catheters placed via the jugular cause stenosis and occlusion at a lower rate of 10%, they still cause occult lesions and repeated access often leads to subsequent occlusion.[10-12] When the IJ is exhausted, the next site is often femoral access. However, femoral access shows iliac stenosis around 20% and prohibitive infection rates that may be as high as 55%.[13,14] They are also uncomfortable and more challenging to expose easily for connection to the dialysis machine when located in the groin. Given a choice, most patients and practitioners would prefer to have catheter access located on the chest, but when the jugular or central venous system is occluded, this placement is typically not believed to be an option. Using the inside-out technique for catheter placement allows for avoidance of femoral catheter placement. The inside-out technique was developed to address central venous occlusion. It was first described in 1999 but has not been routinely implemented by vascular surgeons for access placement. The technique was initially developed by Farrell et al,[3] and these investigators described it to treat central venous occlusion in two patients who received radiation therapy for lung cancer and four patients from indwelling venous catheters. There have been other similar techniques to describe gaining access with central venous occlusion. Wellons et al[15] described accessing the patent SVC through a percutaneous needle, which compared with this technique, would be described as more of an outside-in technique. The initial description of the inside-out technique as we perform it

was used to place pacemaker leads in patients with central venous occlusion and was described by Elayi et al in 201.[4]

All eight of our patients presented with limited options for dialysis access after having been on dialysis for many years. Some investigators have recommended using this technique to establish a HeRO graft for long-term access. Murga et al[8] published their technique for HeRO graft placement in three patients. They showed this was a feasible technique.[5] Davis et al[2] published and expanded the literature on the inside-out HeRO. These devices had a 12-month patency of 30%. They suggested the inside-out HeRO graft should only be used as a final, potential alternative to catheter dependence.[2] One of our patient's inside-out catheter was transitioned to a HeRO graft, and three others were successfully transitioned to arteriovenous (AV) graft access: an upper arm hybrid graft, a thigh graft, and a chest wall graft. Three patients died owing to causes unrelated to their catheter, which were still working at time of death. Only one patient is currently catheter dependent.

There are other devices and catheters to perform the inside-out technique. Hadziomerovic et al[6] used a modified technique where an 80-cm metal stiffening cannula from a Percutaneous Gastrojejunostomy Catheter Kit-WH (Cook, Inc, Bloomington, Ind) was used to exit the vein. It was then snared in the subcutaneous tissue to gain access to the nonoccluded SVC.[6] Some physicians are working on other ways to facilitate the development of the inside-out technique. Dr John Gurley is one of the leaders of the inside-out technique and has developed the Surfacer inside-out access catheter system (Bluegrass Vascular Technologies, Inc, Lexington, Ky) that is fit to handle this problem. It is currently in clinical trials.[16] We have found that our technique uses commercially available products that are stocked and readily available at our facility to perform the procedure.

Although none of our patients had complications related to the procedure, this does not imply that this is a risk-free procedure. As with any procedure, there are potential complications. We did not have a patient develop an infectious complication after this technique, despite the increased complexity and operative time, compared with standard tunneled catheter placement; however, our series is small with limited follow-up. There is also a concern for arterial or venous injury when blindly passing a wire. Although the space behind the clavicle anterior to the subclavian vein should theoretically be clear of any major vessels, Hadziomerovic et al[6] recommend using ultrasound examination of the neck to examine the proposed tract when the sheath/cannula combination is positioned behind the clavicle. We suggest, if there is concern for potential injury, a preoperative computed tomography scan could help with planning or an intraoperative ultrasound examination should be performed. Wellons et al[15] saw some of these complications when they performed their outside-in technique on 22 patients. In the Wellons et al series, there were a total of three complications. These consisted of pneumothorax recognized immediately with fluoroscopy that was treated with chest tube at the time of the procedure, hemothorax that was found the evening after placement and treated with a chest tube, and unilateral arm and face swelling with no known cause that resolved in 1 week with conservative treatment.[13] Although, theoretically, any of these complications could also occur using the inside-out technique, we have not seen any of them in our series. Anatomically, the venous structures lie anteriorly in the thoracic outlet, so ensuring the wire/catheter orientation is anterior/lateral should help to limit the possibility of collateral injury.

Vascular surgeons will continue to see the more complex dialysis patients, as care for these patients improve and survival increases. Vascular surgeons need to continue to broaden their skills in all dialysis access options so that we can continue to expand options in complex dialysis access.

CONCLUSIONS

The inside-out catheter placement technique is a viable alternative for catheter placement in patients with central venous occlusion. This procedure allows avoidance of femoral catheter placement, and should be a component of every vascular surgeon's treatment algorithm for complex dialysis patients.

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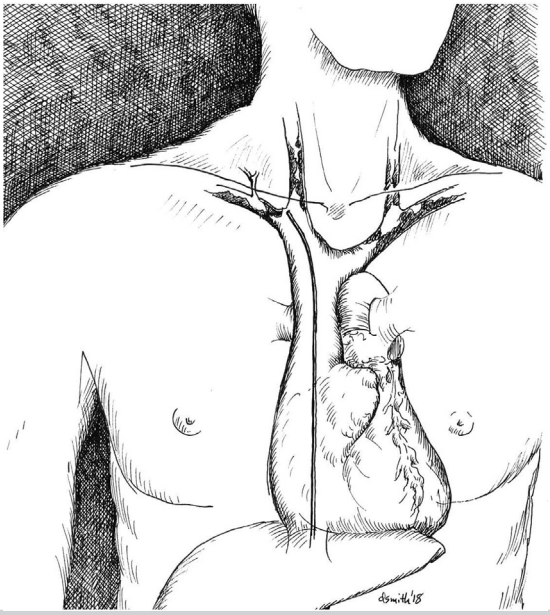
DISCUSSION

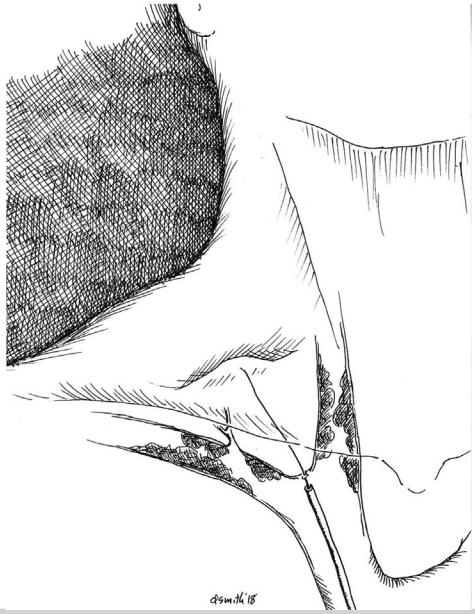
Dr Eleftherios S. Xenos (*Lexington, Ky*). I would like to thank the association for giving me the opportunity to discuss this manuscript. The authors describe the inside out technique to recanalize central venous occlusions. This technique was first described in 1999, but there seemed to be only few additional reports in the literature after the original description. It is based on the consistent anatomic relationships of the thoracic central veins. The central veins are bounded anteriorly by soft tissues the clavicle and skin. A needle directed anteriorly will not encounter arteries nerves or pleura, which lie posterior and lateral to the central veins. The technique has been used for placement of dialysis access as well as for pacemaker or defibrillator lead placement. It is important to note that the technique does not aim to restore venous patency, but simply to gain a sufficient track to permit passage of a hemodialysis catheter. The authors describe their experience with eight patients. They report 100% technical success without procedural complications. I have the following questions for the authors. (1) What was the length of the occlusion for these patients? In cases of occlusion of the entire SVC from the atrium to the innominate how do the authors verify that the needle is not directed toward the atrial appendage? (2) Is biplane fluoroscopy used? Does the preoperative planning include the possibility for need of a covered stent graft and (3) because this technique does not truly recanalize a vessel but creates a passage for the catheter, can the authors describe how the three patients were transitioned to AV graft access?

Thank you for the opportunity to review this interesting manuscript.

Dr Brian M. Freeman (*Greenville, SC*). Thank you for your insight and questions. To address the first question, we do not know the true length of the occlusions. Some patients had an occluded SVC and others had occluded IJ and or subclavian veins. For the second question, we do not use biplane, but will position in steep left anterior oblique projection to make sure the SL1 sheath is angled at the clavicle head. We do not plan ahead with a covered stent graft or computed tomography scan because we take advantage of the natural anatomy that you mentioned. A covered stent is, however, something that we have available in the room in case there is an injury owing to abnormal anatomy or technical error. In addition, owing to this concern is why we do the case with anesthesia. Your final question, we actually now have five patients who went on to be transitioned back to noncatheter AV access. One patient was transitioned to a HeRO graft. Two patients were transitioned back to their upper extremity grafts once the infected field had cleared. These two patients were able to have successful access through collateral flow even with central venous occlusions. One patient was transitioned back to his lower extremity AV graft once the infected field was cleared. One patient was had new lower extremity AV graft placed. Thank you for your questions.



Supplementary Fig 1. SL1 sheath in position before puncturing the vein with a 0.014 wire base.



Supplementary Fig 2. A 0.014 wire exiting the vein and tenting the skin before skin incision and wire retrieval.