Catheter failure and mortality in hemodialysis patients with the tunneled-cuffed catheter tip positioned in the inferior vena cava

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To the Editor: Permanent vascular access is a life-sustaining measure for hemodialysis-dependent patients. Generally, tunnelled cuffed catheters (TCCs) are regarded as a bridge access to arteriovenous fistula (AVF) or arteriovenous graft (AVG), and the guidelines discourage TCCs from being the first choice of permanent vascular access because of the higher risk of complications and shorter expected service life. However, notably, a subset (< 10%) of hemodialysis patients require permanent access through a TCC because they have exhausted other arteriovenous access options.

It is generally considered that the right internal jugular vein (IJV) is the preferred insertion site and that the catheter tip should be adjusted to the level of the caval atrial junction or into the right atrium to ensure optimal blood flow. However, the formerly standard operations might be unsuitable for re-establishing vascular access in the case of long-term hemodialysis patients with frequent catheter dysfunction and central vein obstruction (CVO). We previously reported that a patient with superior vena cava (SVC) occlusion successfully received a new TCC inserted with its tip in the inferior vena cava (IVC) and resumed regular dialysis, which indicated that positioning the tip of the TCC in the IVC might be another effective approach for patients with exhausted conventional access routes. Until now, however, placing a TCC tip in the IVCs has not been a widely accepted interventional approach. Therefore, this retrospective study aimed to investigate the efficacy and safety of placing the TCC tip in the IVC in a cohort of patients with exhausted vascular access.

From March 2013 to December 2016, a total of 33 maintenance hemodialysis patients underwent TCC exchange with the tips of the catheters positioned in the IVC. All the patients were aged > 18 years, had been on maintenance hemodialysis for at least 3 months with more than one hemodialysis access dysfunction (including AVF, AVG, and TCC), and met the following vascular conditions: (1) had anatomical positions of the SVC, right atrium, and IVC that were almost in a straight line, as shown in Figure 1A; (2) had a vascular condition that was not suitable for AVF/AVG or a new AVF/AVG; and (3) had a right IJV occlusion, and severe stenosis or occlusion of the right brachiocephalic vein and SVC. The TCC exchange procedures were performed under the guidance of digital subtraction angiography.

Each patient was placed in the supine position and received local anesthesia in the access center. The dysfunctional TCC was removed and then a new TCC was inserted. The puncture point was in the right side of the neck, and depending on the patient vascular condition, the insertion site was at the right brachiocephalic vein, SVC, or the original insertion site of the vein. If the patient brachiocephalic vein was not completely occluded, we punctured the proximal end of the right brachiocephalic vein to insert a TCC; if the patient brachiocephalic vein was completely blocked, we directly punctured the SVC; if the SVC was also blocked, we directly punctured and tunneled through the SVC, and then inserted the TCC. In some patients, we also inserted a catheter long enough to reach the IVC by using the previous tunnel and placement path, which was in-situ catheter replacement. A new catheter was placed in the IVC along the SVC and was passed through the right atrium (Figure 1A and 1B). The catheter length ranged from 23 to 27 cm. The arterial end of the TCC was placed at least 2 cm below the hepatic vein.

The primary outcomes recorded were death and catheter failure. The conditions of all the patients and TCC put in below the hepatic vein.

Lu Cheng and Qian Ren contributed equally to this paper.

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was defined as the requirement for a catheter exchange due to catheter-related bloodstream infections, CVO, or catheter dysfunction.

Continuous variables are presented as the mean ± standard deviation, and categorical data are presented as the frequency (%). All analyses were performed with SPSS version 22.0 (SPSS Inc., Chicago, IL, USA).

Among the 33 patients [Supplementary Table 1, http://links.lww.com/CM9/B29], 9 were male and 24 were female. The mean age was 63.3 ± 13.1 years, and the mean duration of hemodialysis was 46.7 ± 23.9 months. The primary diseases were glomerular diseases in 20 (60.6%) patients, diabetic kidney disease in 6 (18.2%) patients, polycystic kidney disease in 4 (12.1%) patients, bilateral renal artery stenosis in 2 (6.1%) patients, and obstructive nephropathy in 1 (3%) patient. The main reasons for the replacement of the TCC were catheter dysfunction in 19 (57.6%) patients, CVO in 27 (81.8%) patients, and catheter-related bloodstream infections in 1 (3.0%) patient. Ten (30.3%) patients had two failures to establish vascular access, and 13 (39.4%) patients had more than three failures, which included failed AVFs, AVGs, non-tunneled catheters, and/or TCCs. The causes of the last catheter failure included a variety of central venous abnormalities [Supplementary Table 2, http://links.lww.com/CM9/B29], the most common of which were SVC occlusion (30.3%) and SVC stenosis (27.3%).

All patients achieved adequate blood flows (>250 mL/min) to complete the first session of hemodialysis after the catheterization procedure. Only one patient experienced pain in the right shoulder and neck after the procedure, but it was relieved after a single intramuscular injection of 50 mg of tramadol. The remaining 32 patients did not suffer from hemorrhage, arrhythmia, pulmonary embolism, or other complications.

The mean survival time of TCCs with the catheter tip in the IVC was reckoned at 58.5 (95% CI 48.8–63.4) months by Kaplan–Meier analysis [Figure 1C]. The survival rates of TCCs with the catheter tip in the IVC were 87%, 83%, 75%, and 71% at 1, 2, 3, and 4 years, respectively. The service life expectancy of TCC at 75 months was reckoned at 0.71 using the life table method. The highest incidence of catheter dysfunction occurred 12 months after catheterization.

Eleven patients died during the follow-up period. The mean survival time of the patients was reckoned at 56.2 (95% CI 46.9–65.4) months by Kaplan–Meier analysis [Figure 1D]. The patient survival rates were 88%, 82%, 70%, and 67% at 1, 2, 3, and 4 years, respectively. The patient life expectancy at 75 months was reckoned at 0.67 using the life table method. The highest mortality rate occurred at 12 months after catheterization.

This present retrospective observational study focused on patients who had multiple CVOs and were unable to have a new AVF or AVG established, and this study indicated that the position of a new TCC with the tip placed in the IVC, as a long-term vascular access, might be safe and efficient.

In fact, it is anatomically feasible to place the tip of the catheter in the IVC in cases of multiple obstructions in the SVC and the right atrium. Ideal vascular access should not only provide adequate blood flow for dialysis but also have sufficiently long use-life and a low rate of complications. However, at present, there is little research about placing the catheter tip in the IVC. In addition to the case reported previously,[3] only one study by Mayer et al[4] showed that placing a catheter tip in the IVC achieved the flux demand of dialysis and showed no severe side effects caused by TCCs in a group of 13 patients. The present study yielded consistent results. From the extant studies and the present study, placing the catheter tip in the IVC was an effective approach to establish vascular access for dialysis and was also a safe procedure without additional complications. In the study conducted by Mayer et al[4], eight of the 13 patients used TCC as a transitional procedure for future AVFs or AVGs. Conversely, most of the patients in the present study used TCC as the only long-term vascular access route for dialysis. Thus, the goal of the present research was to solve...
the problem of exhausted vascular resources for end-stage hemodialysis patients. TCC with the tip inserted in the IVC might, for these patients, be their last and only opportunity to survive.

The survival rate of TCCs determines the number of vascular access re-establishments and patient survival. When TCCs were first used and the tip of the TCC was placed in the right atrium or SVC-atrial junction, Shingarev et al[5] reported that the survival rate of the first TCCs was 34% during the first 12 months; another study showed that the survival rates of the first TCCs were 82%, 71%, 56%, and 42% at 1, 2, 3, and 4 years, respectively.[6] In the present study, the survival rates of TCCs with tips in the IVC were 87%, 83%, 75%, and 71% at 1, 2, 3, and 4 years, respectively. These data suggested that TCC with the catheter tip in the IVC is feasible for long-term vascular access for hemodialysis. However, previous studies indicated that patients with TCC as long-term vascular access route had a higher patient mortality rate than patients with AVF or AVG.[7,8] A previous study reported by Shi et al[6] showed that the median survival time of patients who first used TCC was 56.3 months, which was similar to that of the patients in the present study. Therefore, placing the tip of the catheter in the IVC might not increase the incidence of death.

In conclusion, placing the tunneled-cuffed catheter tip in the IVC was safe and efficacious for end-stage hemodialysis patients with CVO who had exhausted vascular resources, and was feasible for long-term vascular access.

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Conflicts of interest
None.

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