Original Article

Outcomes of Tunnelled venous catheters for maintenance hemodialysis : an experience from Eastern India

Sanjay Dasgupta[1], Prasun Roy[2], Avinandan Banerjee[3], Smita Subhas Divyaveer[4], Rajendra Pandey[5]

Hemodialysis (HD) is most common form of renal replacement therapy (RRT) available to end stage renal disease (ESRD) in India. Vascular access (VA) is an essential component of HD. We planned this study to analyse incidence and risk factors of tunnelled venous dialysis catheter (TVC) related infectious and non-infectious complications. A prospective observational study conducted in a tertiary care hospital in Eastern India from May 2014 to May 2017. Consecutive ESRD patients of any etiology on maintenance HD via TVC were included. Data regarding etiology of ESRD, demographic profile, investigations, complications related to TVC insertion and those during follow up were noted and analysed. 120 patients were screened. 107 participants satisfied eligibility criteria and were included. Average follow up was 146.87±55.19 days. Cumulative incidences of infective and non-infective complications at the end of study period were 2.7 and 3.5 events per 1000 patient-days. 43(40.18%) patients developed catheter related infection, 42(39.25%) had catheter dysfunction and 13(12.15%) features of central venous stenosis (CVS). 29(27.10%), 14(13.18%) and 8(7.47%) patients needed catheter removal due to infection, catheter dysfunction and stenosis respectively. 21 (19.62%) and 2(1.86%) patients underwent TVC removal after arteriovenous fistula (AVF) maturation and renal transplantation respectively. 6(5.61%) patients died with a functioning TVC due to causes unrelated to TVC and 1(0.93%) died due to infection despite removal of TVC. We found a significant association of catheter related infection with economic class, place of living, previous internal jugular vein non tunnelled venous catheter (IJV NTVC) insertion, diabetes, prophylactic antibiotic catheter lock, haemoglobin and serum albumin levels.

Despite catheter related infection and catheter dysfunction, TVCs are an efficient form of VA in patients requiring unplanned dialysis initiation or for those without functioning AVF and complications are significantly lower than with non-tunneled venous catheters.

[*J Indian Med Assoc* 2019; **117(12):** 13-7]

Key words **: ESRD, Tunneled Venous Catheter, AV fistula.**

Hemodialysis (HD) is the commonest form of renal replacement therapy (RRT) in India[1] and therefore vascular access (VA) for HD and access related complications are immensely important issues. Arterio-venous fistula (AVF) is associated with least incidence of complications and is recommended as VA of choice for ESRD patients[2].

However, most chronic kidney disease (CKD) patients in India are referred late to nephrologists which precludes systematic planning for AVF prior to initiation of HD[3]. Therefore majority of patients started dialysis with uncuffed non-tunneled venous catheter (NTVC) followed by AVF and very few used grafts or tunneled catheters[4]. As compared to AV grafts, tunneled venous catheters (TVCs) are more readily available, relatively more economical and can be inserted by trained nephrologists. TVCs are preferable over NTVC owing to lesser risk of infectious complications[5].

Despite the risk of infection in some patients, potential advantages of TVC include no need of any maturation time ie, they can be used immediately, repeated skin puncture not required for HD, no short-term hemodynamic consequences, eg, changes in cardiac output or myocardial load which may occur after creation of AVF, they can provide access for a period of months to years unlike NTVC, permitting fistula maturation in patients who require immediate HD[6].

TVCs are therefore an under-utilised form of VA.

Department of Nephrology, NRS Medical College & Hospital, Kolkata 700014

[1]MD (Medicine), DM (Nephrology), Associate Professor

[2]MD (Medicine), Post Doctoral Trainee, Department of Nephrology, IPGME&R and SSKM Hospital, Kolkata 700020 and Corresponding Author

[3]MD (Medicine), DM (Nephrology), Consultant, Department of Nephrology, Calcutta Medical Research Institute, Kolkata 700027

[4]MD (Medicine), DM (Nephrology), Assistant Professor, Department of Nephrology, Postgraduate Institute of Medical Education and Research, Chandigarh 160012

[5]MD (Medicine), DM (Nephrology), Professor & Head, Department of Nephrology, IPGME&R and SSKM Hospital, Kolkata 700020

The data regarding the use of TVCs and TVC related complications from eastern part of India are scarce. Hence we planned this observational study with the aim of observing the complications of TVCs including the current sensitivity patterns for the catheter related blood stream infections (CRBSI) and to analyse the factors associated with these complications.

Materials and methods

This is a prospective observational study conducted in a tertiary care hospital in Eastern India from May 2014 to May 2017. Consecutive ESRD patients of any etiology who presented to our institution requiring dialysis initiation and continuation of maintenance hemodialysis twice or thrice a week via TVC aged 12 years or more were included. Patients were followed up till end of study period or until removal of TVC whichever was earlier. Written informed consent was taken from all patients. As a protocol TVC is inserted electively in ESRD patients both indoor and as a day care procedure for outdoor ESRD patients, in those who did not have a mature AV fistula at the time of HD initiation or those awaiting renal transplant, after stabilisation and two or more heparin free dialysis sessions via a NTVC in femoral or left internal jugular vein (IJV) to minimise the risk of uremic bleeding and to prevent complications during TVC insertion. If patients were referred to our institute with non-tunnelled dialysis catheter inserted in right IJV, inserted within prior 2 weeks and had no evidence of active infection they are considered for right IJC TVC insertion over the guide wire if the site was optimal else a new site was used.

All patients undergo a screening ultrasonography (USG) with doppler imaging of right internal jugular vein to assess its patency and relation to internal carotid artery. The TVC used is Mahurkar Staggered tip catheter without sidehole, 14.5 Fr Insertion is done with all aseptic precautions with cardiac and vitals monitoring under local anaesthesia with USG guidance in an operative room. Skin is disinfected with 10% providone iodine solution and left for air drying before starting the procedure. After insertion povidone ointment 10% is applied to the exit site and dressing is done. Postprocedure the patency and flow in each of the catheter lumens is checked. Heparin lock is given in each of the lumen according to the volume indicated on the catheter. An X-ray PA view is obtained on the same day to confirm appropriate placement of catheter. Prophylactic systemic antibiotics at the time of catheter insertion and antibiotic locks are not routinely used and the decision regarding its use is left to the discretion of the treating nephrologist. Following successful placement of the catheter the temporary venous access is removed and dialysis is continued via TVC.

The data regarding the etiology of ESRD, demographic profile, complications related to TVC insertion and those during follow up were noted. In case of TVC removal, the reasons were noted. Blood investigations including hemoglobin and serum albumin were recorded. Blood cultures using samples from the catheter and from peripheral vein were done whenever the patient was febrile and did not have any other likely source of infection. Definitions of catheter related infections and catheter dysfunction used were as per KDOQI (Kidney Disease Outcomes Quality Initiative) guidelines[7].

Exit site infection, tunnel infection and definite, probable as well as possible catheter related bacteraemia were all considered together as infectious complications. All patients with catheter related bacteremia were treated with systemic antibiotics for at least 2 weeks if they clinically responded. If patients presented with severe sepsis and/or did not respond within 48 hours of initiation of empiric broad spectrum antibiotics, TVC was removed and further dialysis was continued via NTVC. For catheter dysfunction not due to catheter malposition conservative management with raw heparin lock, 2500U/ml of urokinase, 2ml in each limb of permcath was tried and repeated once. If it did not result in improvement of catheter dysfunction then TVC was removed. In all patients were counselled for AVF creation at the earliest. TVC was removed after fistula maturation or successful renal transplantation. Data was analysed using SPSS software version 21. Factors associated with various complications of TVC were studied.

Results

120 patients with ESRD without any ready VA requiring dialysis initiation were screened. Of these, only 41 patients (34.16%) had been counselled for AVF before referral to our institute and 8 (7.47%) of these patients had AVF failure. In 13 of 120 patients had evidence of clot or narrowing of right IJV lumen and were not considered for Rt. IJV TVC insertion. A total of 107 ESRD patients underwent Rt. IJV TVC insertion during the study period. In one patient TVC could not be inserted in Rt. IJV despite absence of occlusion on screening ultrasonography and doppler. TVC was inserted in femoral vein. This patient has been excluded from analysis. The demographic profile of these patients has been shown in Table 1. The range of age of patients was 12 to 70 years. Of these 36(33.6%) had diabetic kidney disease. The other etiologies of CKD were glomerulonephritis, urinary tract obstruction.

Details of previous VA and dialysis duration have been shown in Table 1.

The range of blood flows used immediately postprocedure was in 280-320 ml/min with an average flow of 288 ml/min. Complications associated with TVC insertion have been shown in Fig 1. Other complications include one episode each of seizures and flash pulmonary edema. Two patients had accelerated hypertension.

Table 1 — Patient Characteristics (n=107)

Age (average ± standard deviation)		40.7 ±21.42
	<18	18 (16.82%)
	18-44	44 (41.12%)
	45-59	16 (14.95%)
	≥60	29 (27.1%)
Sex	MALE	62 (57.9%)
	FEMALE	45 (42.1%)
Socio economic condition	LOWER MIDDLE (III)	40 (37.4%)
	UPPER LOWER (IV)	53 (49.5%)
	LOWER (V)	14 (13.1%)
Living place	RURAL	56 (52.3%)
	URBAN	51 (47.7%)
Number of previous venous access	0	19 (17.8%)
	1	28 (26.2%)
	2	38 (35.5%)
	3	20 (18.7%)
	4	2 (1.9%)
Previous right internal jugular NTVC*	YES	48 (44.9%)
	NO	59 (55.1%)
Diabetic kidney disease	YES	36 (33.6%)
	NO	71(66.4%)
Number of HD sessions per week**	2	54 (50.5%)
	3	53 (49.5%)
Hemodialysis duration (month)		12.1±5.55
Hemoglobin(gm/dl)		8.79±1.02
Albumin (gm/dl)		3.2±0.62
Prophylactic antibiotic catheter lock	YES	54 (50.5%)
	NO	53 (49.5%)

*NTVC: non tunnelled venous catheter
**HD: Hemodialysis

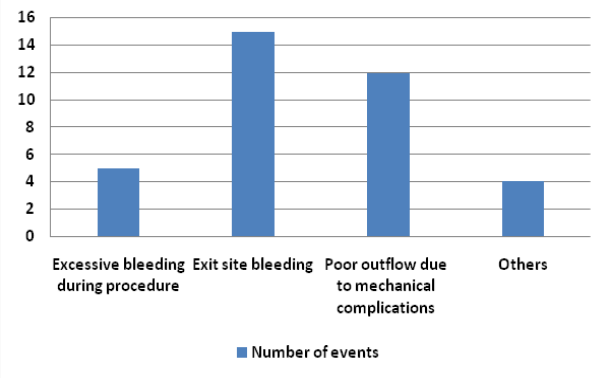

Fig 1 — Complications associated with TVC insertion

The average follow up was 146.87±55.19 days. The cumulative incidences of infective and non-infective complications at the end of the study period were 2.7 and 3.5 events per 1000 catheter-days. In 43 (40.18%) patients developed catheter related infection during the study. 42(39.25%) patients had catheter dysfunction and 13 (12.15%) patients had features of central venous stenosis (CVS). Total 81 (61.68%) required TVC removal during the study period. 13 (12.15%) patients at 3 months and 70 (65.42%) patients at 6 months underwent TVC removal. 29(27.10%); 14(13.18%) and 8 (7.47%) needed catheter removal due to infection, catheter dysfunction and stenosis respectively. 21 (19.62%) and 2(1.86%) patients underwent TVC removal after AVF maturation and renal transplantation respectively. 6 (5.61%) patients died with a functioning TVC due to causes unrelated to TVC and 1 (0.93%) died due to infection despite removal of TVC. Four patients had exit site infection, all were treated conservatively initially. Three of these responded to therapy while one patient developed tunnel infection and required removal of dialysis catheter. Two patients had tunnel infection as well as bacteraemia and the TVC was removed in both these cases. Thirty seven patients had catheter related bacteraemia and 26 of these required TVC removal. Positive blood cultures (sent prior to initiation of antibiotics) were available for 10 patients. 5 of these were positive for methicillin resistant staphylococcus aureus, two coagulase negative staphylococci, one each for drug resistant enterococcus, klebsiella pneumoniae and acinetobacter. The factors that were associated with catheter related infection, catheter dysfunction, central venous stenosis and the corresponding Odds ratios have been shown in Table 2. Rural living place, number of previous venous accesses, haemoglobin, serum albumin and use of catheter lock were significantly associated with catheter related infection. Number of previous venous accesses and duration of HD were significantly associated with central venous stenosis.

Discussion

VA is the cornerstone of HD and the best form of VA is AVF. AVF should ideally be placed 6 months prior to anticipated dialysis initiation[6] to facilitate planned dialysis initiation when indicated. However, most CKD patients in our country are referred late to nephrologists which results in unplanned, often emergency dialysis initiation[4]. The delay in planning and creation of AVF was reflected in our study as well, as only about 30% patients of the screened patients had been counselled for AVF prior to anticipated dialysis initiation. However, of these only 23.52% patients actually had AVF done. This is in sharp contrast from developed countries where majority of patients had failed or immature AV access as the indication for TVC placement[8]. Almost 50% patients had >2 NTVC insertions prior to TVC insertion. Late referral, lack of motivation of patients and primary health care providers for timely VA creation, inadequate availability of technical expertise for TVC insertion at peripheral health care centers may have been

Table 2 — Factors associated with catheter related infection, catheter dysfunction and central venous stenosis

	Catheter related infection			Catheter dysfunction			Central vein stenosis		
Variable	OR	95% CI	p value	OR	95% CI	p value	OR	95% CI	p value
Age	1.016	0.997-1.035	.099	1.001	0.983-1.019	0.925	0.999	0.972-1.026	0.921
Sex (f)	1.867	0.851-4.100	0.119	2.041	0.930-4.481	0.075	2.465	0.749-8.114	0.132
Socio economic condition(upper lower)	0.244	0.061-0.974	0.046	0.455	0.138-1.502	0.455	1.067	0.2-5.696	0.94
Living place (rural)	2.839	1.265-6.369	0.002	0.534	0.245-1.164	0.115	0.754	0.236-2.414	0.635
No of previous venous access	2.970	1.804-4.888	<0.001	1.047	0.722-1.516	0.810	18.293	3.987-83.925	<0.001
Previous right internal jugular NTVC*	0.342	0.154-0.762	0.009	0.821	0.379-1.781	0.618	0.052	0.006-0.415	0.005
Diabetic kidney disease	3.1182	1.357-7.164	0.007	1.458	0.648-3.281	0.362	1.828	0.565-5.912	0.313
Number of HD** sessions per week	1.115	0.515-2.416	0.782	1.205	0.557-2.605	0.636	0.857	0.268-2.742	0.795
Hemodialysis duration (month)	1.017	0.949-1.091	0.628	0.953	0.888-1.023	0.184	1.142	1.014-1.288	0.029
Hemoglobin	0.609	0.406-0.914	0.017	0.886	0.606-1.294	0.530	0.668	0.374-1.195	0.174
Albumin	0.064	0.022-0.184	<0.001	0.626	0.329-1.190	0.153	0.515	0.190-1.393	0.191
Prophylactic antibiotic catheter lock	5.957	2.518-14.092	<0.001	1.926	0.882-4.206	0.1	2.557	0.736-8.884	0.14

the factors responsible for multiple previous NTVC insertions resulting in occlusion of Rt.IJV lumen. As early as 2 weeks of NTVC insertion was found to occlude Right IJV lumen.

Only about 1/3rd of the patients were diabetics. Though diabetes is the most common cause of ESRD in our country the representation of diabetic kidney disease was low. This is possibly due to relatively earlier detection of CKD in diabetic patients, better and continued follow up of diabetic CKD patients allowing timely VA creation and also probably due to proportionately higher referral of non-diabetic CKD than diabetic kidney disease to our institute.

As shown in Fig 1, the most common complication associated with TVC insertion was exit site bleeding. Catheter related infection and catheter dysfunction were both equally common complications of TVC insertion. However, catheter dysfunction more often resulted in TVC removal. 67.44% of patients with catheter related infection required catheter removal; in rest of the patients catheter could be salvaged with antibiotic therapy. Change of the TVC for catheter related infection over guide wire was not a part of the study protocol. Hence, we cannot estimate whether this manoeuvre would have resulted in higher catheter salvage. The incidence of infective complications reported in published studies has been variable and ranged between 2.5 and 5.5 cases/1000 catheter-days[9].

A recent cohort study by Lisa M *et al* reported an overall incidence of confirmed or possible CRBSI as 0.19/ 1000 catheter days which was much lower than our study. Another study from United States reported 4.6 episodes / 1,000 catheter days. Multiple factors can be associated with catheter related bacteremia. Studies from other parts of the country reported 0.4 bacteremia episodes per 1000 catheter days[10]. A possible reason for low incidence could be routine use of prophylactic antibiotic lock solution in all participants in that study. However, such a strategy may be associated with increased risk of antibiotic resistance. The pattern of drug sensitivity and resistance was not specified in that study. We found infections due to resistant organisms more commonly in patients in whom prophylactic antibiotic locks were used but the statistical significance could not be evaluated because of small number of culture positive reports. The use of antibiotic locks however cannot replace the immensely important role of universal precautions and strict adherence to hand hygiene but is complementary to these measures.

We found a significant association of catheter related infection with economic class, place of living, previous Right IJV NTVC insertion, diabetes, prophylactic antibiotic catheter lock, haemoglobin and serum albumin levels. Early detection of CKD, prompt follow up and timely referral to nephrologists may prevent development of significant anemia and hypoalbuminemia due to malnutrition and this in turn may reduce the risk of catheter related infections. Additionally the presence of anemia and hypoalbuminemia may be related to economic status. It has been suggested that the target for catheter-related bloodstream infection (CRBSI) incidence must be less than 1 per 1000 catheter days[11].

TVC are more preferable to NTVC as these are associated with lower incidence of complications. The reported incidence of CRBSI with NTVC was as high as 8.70 per 1000 catheter days in a study from India[12]. These

are significantly higher than those reported with TVC. Hence, TVC must be given a consideration in patients requiring dialysis for prolonged duration especially in case of ESRD patients in clinical setting when mature AVF is not likely to be available for use within few weeks.

All cases of early catheter dysfunction were due to malposition or kink of catheter and all were corrected. In those with late catheter dysfunction TVC removal was done in 33.33% of cases. CVS required TVC removal in 7.47% of all cases. In other patients with CVS dialysis was continued via TVC as these patients had no other feasible VA options or other forms of RRT. Catheter dysfunction can be because of multiple causes like intraluminal, catheter tip or extrinsic thrombus, uncommonly intra-atrial thrombus, fibrin sheath and central venous stenosis. The reported incidence of these varies from 13 to 57%[13] and may be symptomatic or asymptomatic. Contrast venography with fluoroscopy is helpful in definitive diagnosis in most cases but is not accessible widely. As per protocol conservative treatment was tried in cases of catheter dysfunction not due to malposition and if it was unsuccessful TVC was removed. As venography was not used the relative incidence of each of the causes of TVC dysfunction could not be determined. More than 50% of patients with catheter dysfunction also had catheter related infection. Catheter dysfunction particularly due to fibrin sheath can cause both dysfunction and infection. No clinical variable was significantly associated with catheter dysfunction. Overall however number of previous NTVC particularly Right IJV TVC was associated with features of central venous stenosis. This is largely if not entirely preventable cause of CVS.

The causes of TVC drop out (TVC removal for any cause) in our study were quite different from that reported in other part of our country[14]. Disparate rates of TVC complications mentioned above are likely reasons for the different causes of TVC drop-out and drop-outs do not necessarily indicate technique failure. An important contributing factor may be counselling and continuous evaluation and planning for AVF in our study. AVF was considered at each follow up even when patients had a functioning TVC in situ. As a result AVF maturation was reason for TVC drop-out in significant number of cases.

Limitations of our study include relatively less number of patients, only Right IJV TVC was studied and incidences of exact causes of catheter dysfunction could not be estimated. The strengths of our study include prospective design and technique of TVC insertion with use of only ultrasonography guidance which is widely available. This study also demonstrates that Right IJV TVC insertion can be relatively safely done under ultrasonography guidance when fluoroscopy is not available.

Conclusion :

TVCs are an efficient form of VA in patients requiring dialysis initiation which was not pre-planned or for those in whom AVF creation is not feasible or has failed. It is associated with complications like catheter related infection and catheter dysfunction. Conservative treatment may salvage TVC despite these complications in some cases. Despite these complications TVC has superior outcomes as compared to NTVC. Early diagnosis and continued follow up of CKD with planning of vascular access well ahead of anticipated dialysis requirement may prevent the complications associated with vascular access.

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