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Original Article

Non-imaging assisted insertion of un-cuffed, non-tunneled internal jugular venous catheters for hemodialysis: Safety and utility in modern day world



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ABSTRACT

Background: Absolute necessity in acute kidney injury (AKI) and ignorance in chronic kidney disease (CKD) make the use of un-cuffed, non-tunneled catheters an indispensable vascular access for hemodialysis. Although these catheters should be inserted under radiological guidance, it may not be feasible in certain circumstances. The aim of the present study was to evaluate safety and outcome of non-imaging assisted insertion of these catheters in internal jugular vein (IJV) for hemodialysis.

Methods: We analyzed 233 attempts of non-imaging assisted un-cuffed, non-tunneled IJV catheterization at our center. The immediate insertion complications, duration of use, rate and type of infection and other complications were assessed.

Results: Out of the 233 attempts, 223 (213-right, 10-left) were successful. The most common indication was AKI (n = 127, 54.5%), followed by CKD (n = 99, 42.5%). Successful catheterization at first attempt was achieved in 78.9%. Insertion complications were noted in 12.8% and included arterial puncture (5.2%), hematoma (3.0%) and malposition (2.1%). Amongst 219 catheters followed for 4825 days, the mean duration of use was 22 days. Catheter related infections occurred in 42 patients with an incidence of 8.7 per 1000 catheter days. Bacteraemia was present in 10/36 cases (27.7%), positive catheter tip cultures in 71.4% cases and staphylococcal species were the most common organism. Cumulative hazard analysis by Cox regression revealed a linear increase in the risk for infection with each week.

Conclusion: Non-imaging assisted insertion of uncuffed, non-tunneled catheters is associated with slightly higher rate of insertion complication but comparable outcome in terms of infection rate or days of use.

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At a glance commentary

Scientific background on the subject

Absolute necessity in acute kidney injury (AKI) and ignorance in chronic kidney disease (CKD) make the use of un-cuffed, non-tunneled catheters an indispensable vascular access for hemodialysis. Although these catheters should be inserted under radiological guidance, it may not be feasible in certain circumstances.

What this study adds to the field

The present study documented that over 200 insertion attempts the rate of insertion complications is slightly higher and infection rates and days of use were comparable when done without imaging assistance by residents in nephrology training; thus making it an acceptable alternative method of Internal Jugular Vein catheter insertion in circumstances where imaging is not available.

Vascular access forms the life line for patients on hemodialysis. While central venous catheters (CVCs) offer a readily available access for short-term hemodialysis, it is not ideal for long term use [1]. Non-tunneled CVCs are used in acute renal injury (AKI), where the need for hemodialysis is for few days, while tunneled cuffed catheters are preferred if the dialysis requirement is predicted to be longer. The Internal Jugular Vein (IJV) is the preferred site of insertion due to its lowest risk of infection, high likelihood of adequate flow and less risk of central vein stenosis. The ease of insertion, less amount of training needed and the fact that they can be put by the bedside make them a commonly used vascular access [2]. However, it is recommended that the use of CVC should be minimized due to their greater risk of complications, both mechanical and infectious along with associated morbidity and mortality in long term [3] and that the insertion should be performed under the real-time ultrasound guidance to reduce the risk of complications [3,4]. Although the use of imaging guidance reduces the rate of insertion complications, these modalities may not be available at the point of care in the economically weaker countries, and the only option in these would be to insert the catheters with the help of anatomical landmarks. This study was conducted to determine the incidence of complications during the blind insertion of un-cuffed, non-tunneled catheters and utility of these catheters in the face of such operational difficulties.

Materials and methods

The study was a prospective, observational, single centre study. A total of 233 non-imaging assisted attempts of IJV catheterization were documented between June 2009 and December 2010. The site, indication and past history of catheterization were noted. Right IJV was attempted first and if it failed, the insertion was attempted on the left side. Catheters inserted under ultrasound or fluoroscopy guidance and those

exchanged over guide wire were excluded. An informed consent was taken and the study was approved by the Institute Ethics Committee.

Procedure of catheter insertion

The patient was made to lie in trendelenburg position with head rotated to opposite side. The triangle made by two heads of sternomastoid muscle and clavicle was noted and carotid pulsation was felt at its apex. After cleaning and draping, 5 ml of 2% lignocaine was injected to achieve local anesthesia. A narrow bore guide needle was used to identify the location of IJV. Subsequently an introducer needle was inserted lateral to the carotid pulsation at the apex of the triangle at an angle of 30–45° to the horizontal planes, directed towards ipsilateral nipple. The needle was progressed slowly till a jet of blood was observed. The color of blood and non-pulsatile nature of flow with respiratory variation helped in identification of the venous puncture. After this, the J tipped guide wire was passed through the needle and the needle was removed. Subsequently a dilator was passed over the guide wire, followed by threading of the catheter over the guide-wire into the vein. After assuring free flow through both the ports, the catheter was sutured in place. Both the lumina were locked with heparin (5000 U/ml). Povidone iodine ointment was applied to the exit site and dry gauze dressing was done. Post procedure, the chest radiographs were done to confirm the catheter tip position. The catheters were inserted by residents-in-training. Each resident was made to observe 2–3 procedures, followed by 1–2 assisted insertion before they were allowed to do the procedure independently.

Outcome measurement

Various insertion complications like arterial puncture, hematoma, hemorrhage requiring transfusion, multiple attempts and failed cannulation were noted. The patients were followed-up at regular intervals to assess the functioning of catheter or any complication and the reasons for catheter removal were noted.

Definitions

All the cases of fever were investigated for the focus and in cases of suspected catheter related blood-stream infections (CRBI), the catheters were removed after drawing blood for culture through the catheter and after removal, catheter tip was sent for cultures. CRBI was defined as “Definite” if both the blood and the catheter tip cultures grew the same organism; “Probable” if only one of them was positive but defervescence occurred after antibiotic use with or without removal of the catheter or “Possible” CRBI if no other obvious source of fever was identified and both the cultures were negative [3,5,6]. In all the cases of CRBI, chest x-ray and echocardiography were done to exclude any other complications.

Statistical analysis

The data was maintained in excel sheet and was analyzed by SPSS version 17.0. Descriptive analysis was used to calculate

various figures; chi-square test was used to compare groups and Cox regression analysis was performed following variants: age, sex, diabetes, serum albumin, history of previous catheterization and indications of catheter insertion to identify factors associated with CRBI. The level of significance was kept at 5%.

Results

A total of 233 catheterization attempts were documented. While there were ten failed attempts, 223 catheterizations (213-right, 10-left) were successful. The mean age was 42.2 ± 16.3 years and 62.7% were males. The most common indication was AKI (n = 127, 54.5%), while 99 patients (42.5%) had chronic kidney disease, CKD. One hundred and seventy seven insertions (76%) were for newly detected renal dysfunction; 35 (15%) as a bridge to ambulatory peritoneal dialysis, and 7 (3%) were awaiting AV fistula maturation. Other indications were graft dysfunction (n = 7), replacement for catheter malfunction (n = 5) or infection (n = 9) (Table 1).

Successful catheterization and the number of attempts are shown in Table 2. About 79% subjects underwent successful catheterization in first attempt. The failure rate was more in those with previous catheterization as compared to the new cases (8.3% vs 3.2%, p = ns). All patients with failure on right side had successful catheterization on left sided. However, successful left sided catheterization required significantly more attempts as compared to that for right side (mean 1.7 vs 1.2, p < 0.01).

Insertion complications were noted in 12.8% including traumatic complications in 10.7%. These were arterial

Table 3 – Outcomes of successful cannulation.

Outcomes	Frequency (%)
Catheter removal	219 (98.2)
Elective removal	145 (65)
Malfunction	16 (7.2)
Accidental removal	9 (4.1)
Exit site infection	1 (0.5)
IJV thrombosis	1 (0.5)
CRBI	42 (18.8)
Uninvestigated fever	5 (2.2)
Lost to follow up	4 (1.8)
Total	223 (100)

puncture (5.2%), hematoma (3.0%), tip malposition (2.1%), hemothorax (1.3%), pneumothorax (0.8%) and hemorrhage (0.4%). One catheter had to be removed for uncontrolled bleeding from exit site, while one subject died due to hemothorax.

Total duration of catheter usage was 4825 days with mean duration of 22.03 ± 11.75 days. Four patients were lost to follow up, while in majority, catheters were removed for elective reasons (n = 145, 66.2%). The reasons for catheter removal are summarized in Table 3.

CRBI was diagnosed in 42 cases with incidence of 8.70 per 1000 catheter days. Definitive CRBI was seen in 14.3%, probable CRBI in 54.8% and possible CRBI in 30.9% (Fig. 1), while clinical evidence of exit site infection was noted in 40.5% of CRBI. Bacteremia was observed in 10/36 cases (27.7%). Staphylococcal species were the most common cause of bacteremia (97%) including methicillin sensitive *Staphylococcus aureus* (MSSA, 60%), coagulase negative staphylococci (CONS, 20%) and methicillin resistant *S. aureus* (MRSA) in 1 case. Catheter tip cultures were positive in 71.4% of the cases (Table 4). Secondary infectious complications were noted in 2 subjects (1-infective endocarditis, 1- pancreatic pseudo cyst infection) and *S. aureus* was cultured from blood as well as catheter tip in both these cases.

Using Cox regression analysis, the occurrence of CRBI did not correlate with age, sex, diabetes, serum albumin, prior catheterization or number of attempts (Table 5). CRBI

Table 1 – Baseline demographic data.

Characteristic	n (%)
Age, years (mean ± SD)	42.2 ± 16.32
Sex	
Male	146 (62.7%)
Female	87 (37.3%)
Diabetes	31 (13.3%)
Previous history of catheterization	44 (20.1%)
Indication for insertion	
Acute renal failure	127 (54.5%)
Incident CKD	21 (9%)
Prevalent CKD	78 (33.5%)
Post transplant graft dysfunction	7 (3%)

Abbreviation: CKD: Chronic kidney disease.

Table 2 – Number of attempts.

	Number of attempts	Frequency (%)
Successful catheterizations	One	184 (78.96)
	Two	26 (11.16)
	Three	12 (5.15)
	Four	1 (0.43)
Failed catheterizations	One	1 (0.43)
	Three	5 (2.14)
	Four	4 (1.7)
Total		233 (100)

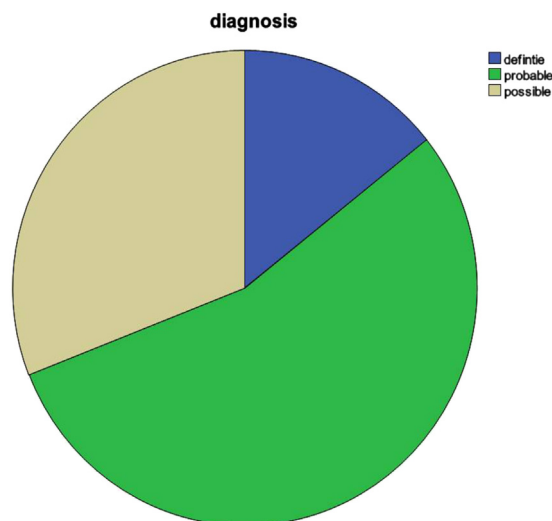


Fig. 1 – Diagnosis of CRBI (n = 42).

Table 4 – Culture results for CRBI (n = 42).

Culture result	Catheter tip n (%)	Blood cultures n (%)
Sterile	12 (28.6)	26 (61.9)
Mixed flora	3 (7.1)	0
MRSA	6 (14.3)	1 (2.4)
MSSA	7 (16.7)	6 (14.3)
CONS	7 (16.7)	2 (4.8)
Acinetobacter	3 (7.1)	1 (2.4)
E. coli	3 (7.1)	0
Pseudomonas	1 (2.4)	0
Not available	0	6 (14.3)

Abbreviations: MRSA: methicillin resistant *S. aureus*; MSSA: methicillin sensitive *S. aureus*; CONS: coagulase negative Staphylococci.

occurred more frequently in patients who underwent catheterization for CKD (27.7%) as compared to those with AKI (11.9%, $p = 0.03$). The cumulative hazard analysis revealed a linear increase in risk for infection with each week, however there was no threshold before which the CRBI occurred (Fig. 2).

Discussion

Although the guidelines recommend restricted use of non-tunneled catheters [3,4], these continue to be the commonly used vascular accesses for hemodialysis. The Dialysis Outcomes and Practice Patterns Study (DOPPS) reported the use of CVCs for hemodialysis in 23% of prevalent and 58–73% of incident patients [7]. This high usage is due to variety of reasons like late diagnosis of kidney disease, late referral to nephrologist, delayed plan for access, and financial or logistical reasons [2].

The present study documented the insertion complications in 12.8% cases. Failed catheterization was noted in 4.2% of the patients, while traumatic complications were noted in 10.7% of patients (Table 6). Lin et al. reviewed various studies of blind insertion of CVCs in the IJV and observed insertion complications in 3.9–14.3% and failed catheterization in

4.7–17.6%. [8], while Vanholder et al. noted traumatic complications like hematoma, hemothorax, arterial puncture, pneumothorax in 3.7% patients [9]. In a comparative study of ultrasound guided IJV catheterization with landmark technique, a higher success rate of cannulation, fewer attempts to cannulation and no arterial puncture were noted in guided insertion as compared to 7.7% carotid punctures in anatomical technique [10]. In a pooled analysis by the National Institute of Clinical Excellence noted a relative risk reduction of 86% for failed catheterization and 57% for catheter placement complications [11]. However European Renal Association finds no contraindication to the use of landmark technique by skilled operators [12]. The rates of traumatic complications in our study are comparable to other studies using blind insertion, while slightly more than with guided insertion.

In present study, the mean duration of catheter usage was 22 ± 11.7 days, and 47% catheters were used beyond 3 weeks, while it is recommended to restrict their usage to less than three weeks [3]. This may reflect the failure to follow up with the study centre, reluctance of patients in getting the catheter replaced and variable practice patterns at certain non-clinic based dialysis centres.

Infections including CRBI are the commonly reported cause of death in hemodialysis patients [13]. In a study, the rate of CRBI was 6.5 per 1000 catheter days [14], while in another study; the incidence was 3.8 per 1000 catheter days [15]. Our study showed an incidence of 8.7 per 1000 catheter days, including probable and possible cases. Definite blood stream infections could be identified in only 14.3% of all CRBI. Empirical use of antibiotics for unrelated reasons, timing of obtaining blood cultures and unavailability of blood cultures in all cases could have led to a low rate of bacteremia. In a study from Australia, routine post-removal tip cultures grew coagulase negative *Staphylococcus* (CONS, 46%), negative culture (33%), MRSA (9%), *S. aureus* (9%), or other uncommon organisms (2%) [16], while in our study MSSA and CONS were the most common.

We observed that the blind insertion of CVCs for hemodialysis had slightly higher rate of insertion complication, while

Table 5 – Cox hazard analysis of factors associated with CRBSI.

Characteristic	CRBSI (n)	No CRBSI (n)	HR	95% CI	P Value
Age, yrs (Mean \pm SD)	42.36 \pm 15.5	42.13 \pm 16.6	1.003	0.982–1.025	0.77
Sex			0.773	0.393–1.522	0.46
Male	26	120			
Female	16	71			
Diabetes status			1.481	0.564–3.889	0.425
Non diabetic	36	152			
Diabetic	6	25			
Indication					
Acute renal failure	14	104	2.005	0.235–17.132	0.525
Incident CKD	4	16	1.317	0.378–23.212	0.813
Prevalent CKD	23	51	2.962		0.301
Post transplant graft dysfunction	1	6			
Prior catheterization			0.801	0.385–1.668	0.553
Yes	12	32			
No	30	145			
S. Albumin gm/dL (mean \pm SD)	3.15 \pm 0.60	3.13 \pm 0.64	0.969	0.567–1.657	0.908

Abbreviations: CRBSI: catheter related blood stream infection; HR: hazard ratio; CI: confidence interval.

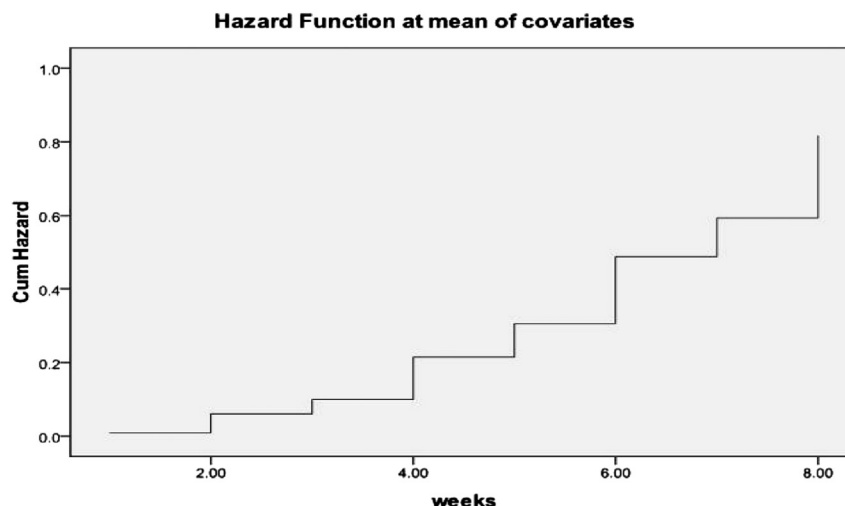


Fig. 2 – Cumulative hazard of CRBI.

Table 6 – Comparison of complications.

	Farrell et al. [10] Land mark technique	Farrell et al. [10] Ultra sound guided	Present study
Successful cannulation	82.0%	96.67%	94.7%
Successful first attempt	35.9%	83.3%	78.96%
No. of passes (mean \pm SD)	2.05 \pm 1.00	1.17 \pm 0.38	1.37 \pm 0.70
Arterial puncture	7.7%	0%	5.2%

the long term outcomes were similar to that of guided insertion. The blind method thus may be an acceptable alternative way to set up the catheter; however, it is not for routine practice.

The limitations of the study are small sample size, single centre study, absence of a control group and the fact that most of our patients received hemodialysis from some other centre. This might have influenced the rate and severity of infection and the probability to confirm the infection by cultures before starting antibiotics.

Conclusion

Non-imaging assisted insertion of non-tunneled uncuffed hemodialysis catheter was associated with slightly more incidence of insertion complication with comparable rate of infection and duration of use; thus making landmark technique an acceptable alternative method of IJV catheter insertion in circumstances where imaging guidance is not available.

Source(s) of support

Nil.

Conflicts of interest

None.

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