

Efficacy of Using Non-tunneled Dialysis Catheters During Arteriovenous Fistula till its Maturation: A Retrospective Study

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Purpose: Due to high prevalence of diabetes mellitus and subsequent nephropathy, the need for access to start and continue dialysis has been increased. In this study, we aim to study the efficacy and complications of non-tunneled catheters (NTC) till fistula maturation because of being easy and cheap implementation as well as similar complications compared to tunneled catheters (TC).

Materials and Methods: In this retrospective observational study, 247 patients with first-time AVF creation referred to Vascular Surgery Centre of Mashhad University of Medical Sciences, Iran, were recruited since March 2016 to December 2017. Only 153 patients who have completed the study, and were monitored every two weeks in case of un-maturation along with the status of temporary catheters.

Results: Mean age of patients was 49.9 ± 7.74 years, and 75 (49%) were females, which was comparable with literature. Preference of NTC implementation was at right jugular because of the easy access to central vein and less chance of complications. Catheter location was at right internal jugular in 61.4% of the patients. Out of 24 femoral cases, 18 was done at femoral. AVF location was done at left/right cubital in most cases (52.3%). The rate of infection was 15.0%, which was less than NTC's infections reported in the literature.

Conclusion: Use of non-tunneled catheter in the form of outpatient in the period of AVF maturation time is recommended due to similar complication rate.

Keywords: AVF; catheter; CKD; dialysis; ESRD

INTRODUCTION

Chronic kidney disease (CKD) and end-stage renal disease (ESRD) are increasingly common diagnoses as the population age and the incidence of diabetes rise. Data from the United States Renal Data System (USRDS) showed that 117,162 new patients began therapy for ESRD in 2015, whereas the prevalent dialysis population reached 661,648⁽¹⁾. Central venous catheters play an important role in the treatment of patients with end-stage renal disease. Despite initiatives to improve fistula creation, more than 80% of patients initiated hemodialysis with a catheter⁽²⁾.

Hemodialysis catheters can be categorized into two groups: non-tunneled catheters (NTC) and tunneled (or cuffed) (TC). Non-tunneled catheters have been modified significantly over time. There are conflicting reports on what a safe duration for the use of these catheters is, and recommendations vary from one to few weeks. For example, the National Kidney Foundation (NKF) recommends <1 week as a safe duration and never advised to be >3 weeks. However, there are reports from certain parts of the world of much longer use and indeed using them for long-term dialysis as well⁽³⁾. NTC should be placed only in hospitalized patients and used for a short duration, usually less than 4 weeks⁽⁴⁾. The potential complications related to placement of NTC are similar to TC. However, because of short duration of TC usage, long-term complications are less

frequent but infectious complications are more common. Some complications of the catheters are: arterial puncture, venous laceration/perforation, myocardial injury, and the associated hemorrhage and hematoma (5% of patients). The risk of above complications seems to be similar between NTC and TC⁽⁵⁾. Cardiac arrhythmias are potentially serious complications of all central venous catheter insertions⁽⁶⁾. Air embolism is a rare but fatal complication. This is often observed in situations associated with difficulty in placing the catheter through the peel-away sheath and usually occurs in the interval between the removal of the dilators and the peeling away of the sheath. Therefore, this seems to be seen more frequently in NTC⁽⁷⁾. Central Venous stenosis usually occur after long-term placement of catheters specially in subclavian vein, duration of dialysis and number of catheter replacement⁽⁸⁻¹⁰⁾. Pneumothorax and hemothorax are developed after catheter insertion and are seen more often in subclavian placement^(11,12). Kinking or acute bends in the catheter were common in the past with catheters made with stiffer materials⁽¹³⁾. Infection is the most common complication of catheterization and observed more frequently in NTC than TC. Treatment is usually initiated with empiric antibiotics and some suggest that NTC should be removed immediately if there is catheter related blood-stream infection⁽¹⁴⁻¹⁷⁾.

In overall, other complications than infection is less common in NTC compared to TC. However, the fol-

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Table 1. Baseline demographics and clinical features (n=153)

Variable		Mean \pm SD / frequency (%)
Age (year)		49.9 \pm 7.74
Gender	Male	78 (50.98)
	Female	75 (49.02)
Diabetes		77 (50.33)
Catheter site	Right jugular	94 (61.44)
	Left jugular	29 (18.59)
	Right Femoral	18 (11.76)
	Left Femoral 6 (3.92)	
	Right Subclavian	2 (1.31)
	Left Subclavian	4 (2.61)
Catheter Replacement		63 (41.18)
Maturation time (day)		64 \pm 15.2
AVF site	Left Snuff Box	46 (30.06)
	Left Forearm	19 (12.41)
	Left Antecubital	67 (43.79)
	Right snuff Box	8 (5.22)
	Right Forearm	1 (0.6)
	Right Antecubital	13 (8.49)
Catheter infection		23 (15.03)

lowing should be added to difficulty of using TC: time of operation that sometimes needs to sedation, need for fluoroscope for proper insertion, and the total cost. This study aims to survey patients with AVF creation and simultaneously need dialysis, or because of need to urgency dialysis, NTC is inserted and they have been referred for AVF creation. We used NTC at this time until AVF maturation and analyzed the results. In this paper, we would like to assess using NTC over TC due to easy implementation and easy management procedure till fistula maturation. We aim to show the superiority of NTC over TC due to less complications.

MATERIALS AND METHODS

In this retrospective observational study, 247 patients with first time AVF creation referred to Vascular Surgery Centre of Mashhad University of Medical Sciences, Iran, from March 2016 to December 2017 were recruited. Only 153 patients have been monitored routinely for a duration of 6-month since AVF creation. Clinical characteristics were measured at baseline, one-week after surgery, three-week after surgery and 5-6 weeks after surgery. The patients were monitored every two weeks in case of un-maturation. The status of temporary catheters were checked at various time points. The patients and dialysis centers have been trained of needed actions to be taken to send the patients to emergency unit in case of infection symptoms or issues with catheters functioning.

The placement of AVF in forearm or antecubital, and etiology of ESRD had no effect on the study. Therefore, patients who had catheter before AVF creation were also included in the study. Exclusion criteria were: history of neck surgery or neck radiotherapy, history of anticoagulant consumption, history of previous AVF, age under 14 years, history of pulmonary and mediastinal pathology, presence of remote infection, history of steroid and immunosuppressive medications, issues with catheters functioning and un-maturation of IVF, patients' preference for tunneled cuff catheter, and death or immigration. Routine approaches including appropriate filter, proper length and speed of the dialysis and patient's general health were used to have a successful dialysis while using NTC instead of KT/V⁽¹⁸⁾.

Data analysis was performed using IBM SPSS Statis-

tics for Windows version 24 (Armonk, NY: IBM Corp). Clinical characteristics were reported as mean \pm standard deviation and frequency (percentage) for continuous and categorical variables, respectively.

RESULTS

After one year from recruitment, 153 patients have completed the study. Mean age of patients was 49.9 \pm 7.74 years, and 75 (49%) were females, which was comparable with the reported numbers in literature as the age in our paper was reported at the start date of dialysis. Catheter location determination was right internal jugular and left internal jugular based on priority, and if it was not successful, left/right subclavian or left/right femoral were considered. Catheter location was at right internal jugular in 61.4% of the patients. Out of 24 femoral cases, 18 were done at femoral because temporary catheter placement was not possible at left/right jugular. AVF location was done at left/right cubital in most cases (52.3%). However, preference of AVF location was at either snuff box or forearm if there was potential arterial and venous at either locations. About fifty percent of patients had DM, most of AVF was in left upper extremity, and average time to maturation was 57 days. The rate of infection was 5.03% (Table 1).

DISCUSSION

One of the ways to do hemodialysis is catheter insertion either TC or NTC. As mentioned, it seems that the risk of complication is more in the TC due to longer use of catheter, however the infection rate is higher in NTC. In this study, incidence of infection was 23 cases (15.0%). This result is greater in comparison to other studies in TC context (infection rate for TC: 13.6%)⁽¹⁹⁾, but the change was not significant in period of maturation time. However, it seems that the risk of infection would increase if a longer period of catheter is used. Although the lower incidence of infection (compared to another study regarding NTC (32.6%)⁽¹⁹⁾) may be due to use of aseptic field and procedure in operation room, catheter care instructions at dialysis center and better homecare could be other reasons. Total number of catheter change was 63 (41.18%) that interestingly is below 50% of replacement due to catheter infection. Other reasons included: dysfunction, catheter base fracture due to change of neck position, catheter spontaneous coming out; and 2 cases for intentional catheter removal because of psychological attacks. The symptoms for diagnosis of infection were fever and chill in dialysis time and puss discharge from TC exit site. Unlike TC, we did not rule out other etiology for fever in NTC, and only fever started after dialysis onset was considered as catheter related infection and catheter replacement was done. After replacement, fever recovered in all cases without need to prescribe antibiotics. This result can confirm the accuracy of our approach in NTC insertion efficiency to some extent.

Other important complication of catheter insertion is central vein (brachiocephalic and superior vena cava) stenosis. After developing of stenosis of near to total occlusion, the symptoms begin to appear. The most common symptoms are limb and neck swelling, and arm, shoulder and chest wall collateral veins become prominent. This is confirmed by venography. The incidence of symptomatic central vein stenosis was 2.6% (4 cases), in whom the catheter insertion duration was over

80 days in all four cases. This incidence of central vein stenosis was less (4.3%) compared to another study⁽²⁰⁾. The reason can be shorter duration of NTC used compared to TC, insertion of NTC in internal jugular vein as first choice and lesser NTC diameter than TC. Also, the incidence of 4.3% in other study is the result of all central vein accesses insertion, such as PICC, which may be inserted from subclavian vein. The cost of TC is far more expensive than NTC. Also because of using ultrasound for catheter insertion and distal jugular vein insertion, no complications such as pneumothorax are found. Average time for AVF maturation in our study was 54.3 days, and we had maximum of two catheter replacements without pneumothorax or hemothorax over this time period.

A limitation of this retrospective study is the lack of a comparison group where the efficacy of NTC could be compared with alternative approaches. Hence, more investigation for this matter is needed using prospective studies.

CONCLUSIONS

In our practice, use of NTC for temporary dialysis until the maturation of the AVF has not been accompanied by significant major complications. If there are available possibilities such as ultrasound in operation room, employment of complete aseptic field when inserting a catheter and proper training for dialysis centers and patients for catheter maintenance, we recommend that NTC is used over TC in period of AVF maturation time. Also, we recommend that right internal jugular vein is considered as a catheter insertion site.

CONFLICT OF INTEREST

The authors report no conflict of interest.

REFERENCES

1. Sidawy AP, Preler BA. Rutherford's vascular surgery and endovascular therapy, vol 2, 9th edition. ELSEVIER; 2018. p. 175-2288
2. U.S. Renal Data System: USRDS 2011 Annual Data Report: Atlas of End-Stage Renal Disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2011. Available at: <http://www.usrds.org/2011/view/default.asp>. Accessed April 2, 2012
3. National Kidney Foundation K/DOQI clinical practice guidelines for vascular access: Update 2000. *Am J Kidney Dis.* 2001;37:S137-S181. Available at: http://www.kidney.org/professionals/KDOQI/guideline_upHD_PD_VA/index.htm. Accessed April 2, 2012.
4. Vascular Access 2006 Work Group. Clinical practice guidelines for vascular access. *Am J Kidney Dis.* 2006; 48:S176-S273.
5. Vats HS. Complications of catheters: tunneled and non-tunneled. *Adv Chronic Kidney Dis.* 2012;19:188-194.
6. Fiaccadori E, Gonzi G, Zambrelli P, Tortorella G. Cardiac arrhythmias during central venous catheter procedures in acute renal failure: a prospective study. *J Am Soc Nephrol.* 1996;7:1079-84.
7. Bessereau J, Genotelle N, Chabbaut C, et al. Long-term outcome of iatrogenic gas embolism. *Intensive Care Med.* 2010; 36:1180-7
8. Levit RD, Cohen RM, Kwak A, et al. Asymptomatic central venous stenosis in hemodialysis patients. *Radiology.* 2006;238:1051-6.
9. Khwaja A. KDIGO clinical practice guidelines for acute kidney injury. *Nephron Clin Pract.* 2012;120:c179-c184.
10. Barrett N, Spencer S, McIvor J, Brown EA. Subclavian stenosis: a major complication of subclavian dialysis catheters. *Nephrol Dial Transplant.* 1988; 3:423-5
11. Borja AR. Current status of infra-clavicular subclavian vein catheterization: Review of the English literature. *Ann Thorac Surg.* 1972;13:615-24
12. Farrell J, Walshe J, Gellens M, Martin KJ. Complications associated with insertion of jugular venous catheters for hemodialysis: the value of post procedural radiograph. *Am J Kidney Dis.* 1997; 30:690-2.
13. From Division of Nephrology, Department of Medicine, University of Wisconsin School of Medicine and Public Health, Madison, WI. *Advances in Chronic Kidney Disease, Vol 19, No 3 (May), 2012: pp 188-194*
14. Chan MR. Hemodialysis central venous catheter dysfunction. *Semin dial.* 2008;21:516-21.
15. Maya ID. Antibiotic lock for treatment of tunneled hemodialysis catheter bacteremia. *Semin Dial.* 2008; 21:539-41.
16. Lok CE, Mokrzycki MH. Prevention and management of catheter-related infection in hemodialysis patients. *Kidney Int.* 2011; 79:587-98.
17. Oliver MJ, Callery SM, Thorpe KE, Schwab SJ, Churchill DN. Risk of bacteremia from temporary hemodialysis catheters by site of insertion and duration of use: a prospective study. *Kidney Int.* 2000;58:2543-45.
18. Barzegar H, Moosazadeh M, Jafari H, Esmaeili R. Evaluation of dialysis adequacy in hemodialysis patients: A systematic review. *Urol J.* 2016; 13(4):2744-9.
19. Stevenson KB, Hannah EL, Lowder CA, Adcox MJ, Davidson RL, Mallea MC, et al. Epidemiology of hemodialysis vascular access infections from longitudinal infection surveillance data. *Am J Kidney Dis.* 2002;39:549-55.
20. Lee AY, Levine MN, Butler G, Webb C, Costantini L, Gu C, et al. Incidence, risk factors, and outcomes of catheter-related thrombosis in adult patients with cancer. *J Clin Oncol.* 2006;24:1404-8.