Efficacy of using non-tunneled dialysis catheters during Arteriovenous fistula till its maturation: a retrospective study

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ABSTRACT

**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 NTC till fistula maturation because of being easy and cheap implementation as well as similar complications compared to 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 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 61.44% 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 15.03%, 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.
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 (8,9,10). 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 (14,15,16,17).

In overall, other complications than infection is less common in NTC compared to TC. However, the following 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, since 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, etiology of ESRD had no effect on the study. Therefore, patients who had catheter before AVF creation 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 Statistics for Windows version 24 (Armonk, NY: IBM Corp). Clinical characteristics were reported as mean ± standard deviation and frequency (percentage) for continuous and categorical variables, respectively.

**RESULT**

After one year from recruitment, 153 patients have completed the study. Mean age of patients was 49.9 ± 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 \(^{19}\). 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 would be considered. Catheter location was at
right internal jugular in 61.44% of the patients. Out of 24 femoral cases, 18 was 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 is potential arterial and venous at either locations. About fifty percent of patients have 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 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 (15.03%). This result is greater in comparison to other studies in TC context (infection rate for TC: 13.6 %) \(^{(20)}\), 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 (than other study regarding to NTC (32.6%) \(^{(20)}\) 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 below 50% of replacement was 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 recovers 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 to 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), which the catheter insertion duration was over 80 days in all four cases. This incidence of central vein stenosis is less (4.3%) compared to other study (21). 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 in 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.

CONCLUSION

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.

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

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