Original Research Article

Insertion of Tunneled Hemodialysis Catheters by Exchange over the Guidewire and De novo Puncture

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Abstract

Background: This study evaluated the safety and efficacy of insertion of tunneled hemodialysis catheters by de novo insertion technique and over the wire exchange technique

Methods: This prospective study included 50 patients with ERSD in need for tunneled hemodialysis catheters insertion. Patients were divided into 2 groups (the first group) 22 de novo insertion of tunneled dialysis catheters and (the second group) 28 over the wire exchange. Patients were subjected to history taking, thorough clinical examination, routine preoperative investigations, preoperative and postoperative X-ray on the neck and chest and Duplex scan of neck veins on both sides.

Results: In the de novo group, 11 patients were inserted by ultrasound guide and 11 patients were inserted by blind anatomical landmark technique in which the ultrasound guided technique showed lower rate of complications, while all over the wire group were inserted ultrasound guided. The primary patency was higher in the over the wire group(after 1 month=96%, after 3 months=89.2%, after 3 months=85.7%) than the de novo group(after 1m, 3m, 6m equals 86.3%,81.8%, 77.2% respectively) with non-significant P value 0.43, hematoma formation was higher in the de novo group with non-significant P value, 3 patients (13.6%) had infected catheters in the de novo group while 4 (14.3%) patients were affected in over the wire group, with 4 (18.2%) cases were malfunctioning in the de novo group while 3 (10.7) malfunctioning catheters in over the wire group with statistically non-significant P value in these values . There was significant difference between the 2 techniques in the operative time, for de novo insertion of tunneled dialysis catheters mean operative time was = 27.78 ± 5.71 minutes and in over the wire group the mean operative time was = 15.07 ± 1.98 minutes with statistically significant P value <0.001*.

Conclusions: By comparison between the two methods of tunneled dialysis catheters insertion in ESRD patients (de novo insertion and over the wire exchange technique), we found that over the wire exchange technique can safe time, effort, reduce the rate of operative

complication especially hematoma formation and at the same time it showed higher patency rate in comparison to de novo insertion method.

Keywords: Tunneled Hemodialysis, Catheters, Guidewire, De novo Puncture.

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Introduction:

End-stage renal disease (ESRD) is an increasing problem worldwide. Renal replacement therapy (RRT) and kidney transplantation are the treatment strategies to compensate for lost kidney functions which increase the burden on national health systems. This condition is particularly serious in the developing countries where health resources are inadequate [1].

Patients with acute renal failure or end stage renal disease require renal replacement therapy, which includes peritoneal dialysis (PD), hemodialysis (HD) or kidney transplantation [2].

Tunneled dialysis catheters are valuable option for dialysis than non-tunneled ones, and indicated in certain situations: When there are contraindications of AVF creation (severe cardiac dysfunction with decreased ejection fraction, also patients with persistent hypotension not responding to blood pressure elevating drugs, and patients with vascular arterial disease (as progressive atherosclerosis in diabetic patients predisposing to premature closure of the fistula and autoimmune vasculitis patients). Also patients who do not have vein diameter suitable enough for creation of AVFs. In patients who have subclavian or innominate vein occlusion on one side, with the other side does not have suitable veins or subclavian vein on the other side is also occluded [3].

The United States Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines recommend that chronic hemodialysis access catheters (more than three months in the absence of a maturing permanent access) should be used in less than 10 percent of prevalent patients who do not have a contraindication for permanent arteriovenous (AV) access, and that AV fistulas should be used in more than 65% of prevalent patients [4].

Tunneled dialysis catheters are of great importance for the ESRD patients, and there is need for recurrent insertion or also permanent usage in some groups of patients, that led to the controversy about the technique of insertion of tunneled dialysis catheters either de novo insertion or over the wire exchange technique in patients who need the venous access sites for longer periods, and some authors assume that the exchange over the wire technique is predisposing for infection and thrombosis that's why this study was done to evaluate this assumption, which technique is preferred de novo insertion or over the wire exchange technique [5].

The aim of this study is to evaluate safety and efficacy of insertion of tunneled hemodialysis catheters by exchange of previously inserted hemodialysis catheters with a newer one over the guidewire and insertion through de novo puncture in patients with ESRD.

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Patients and Methods:

This prospective study included fifty patients diagnosed as ERSD in need for tunneled hemodialysis catheters insertion and also patients in need for replacement of temporary hemodialysis catheters with a tunneled one at vascular and endovascular surgery department at Tanta University Hospitals in the period from May 2020 and May 2021. The study was done after being approved by the institutional ethical committee, Tanta University. Informed written consent was obtained from all participants included.

Inclusion criteria were: patients with ESRD who are unsuitable for fistula creation such as patients with severe persistent hypotension and unsuitable vein diameter or requiring urgent dialysis with no time for fistula maturation, or patients prepared for renal transplantation, patients with complicated vascular access in need for urgent access for hemodialysis, and patients in whom peritoneal dialysis was contraindicated.

Exclusion criteria were: Patients with functioning, non-complicated, mature fistulas, Patients with generalized sepsis or localized infection at site of insertion, central venous obstruction or thrombosis diagnosed by duplex ultrasound or CT venography and patients with bleeding tendency.

Each included case was subjected to the following: history taking, thorough clinical examination, Routine preoperative investigations, preoperative and postoperative X-ray on the neck and chest to exclude chest conditions predisposing to pneumothorax (COPD) and Duplex scan of neck veins on both sides.

All patients had been subjected to insertion of long-term tunneled dialysis catheters either into the internal jugular vein or the subclavian vein by de novo or over the wire exchange. Total number of catheters inserted through internal jugular vein route were 32, the number of catheters inserted by de novo technique were 15 catheters and by over the wire exchange were 17 catheters. Total number of catheters inserted through subclavian vein route were 18 catheters, 7 catheters were inserted by de novo technique and 11 catheters were inserted by over the wire exchange technique.

Technique of de novo tunneled hemodialysis catheters insertion: Under ultrasound guidance Philips Affinity 50G ultrasound machine, USA with L12-4 MHz linear probe) the vein was punctured, and guide wire was introduced into the central vein under the C-ARM machine: (Zhiem Vision 2) mobile C- arm; serial; 91043. max voltage; 110 K.V. It is manufactured by Ziehm Imaging GmbH, Donaustrasse, 3190451 Nuremberg, Germany. Type of cuffed tunneled catheter used in this study (TITAN HD™ long term hemodialysis catheter,

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Medical Components, Inc. Medcomp USA). The patient was optimally positioned with a 10◦ head down tilt (Trendelenburg position) with mild degree of rotation of the head away from the side to be cannulated, some head and neck extension is helpful (in internal jugular or subclavian routes). U/S was used for screening of neck veins before the procedure to confirm the patency of the central veins. Sterilization of the skin at the site of insertion with povidone-iodine solution was done. A sterile drape was placed over the patient ensuring coverage from head to toe and generous use of local anaesthetic was injected locally. Application of the ultrasound superficial probe is done by insertion of the probe in sterilized sheath filled with gel. Using the ultrasound probe in transverse view with application of saline as a lubricant between the probe and patient's skin. Application of the needle to the middle point of the probe and visualizing the tip of the needle on the ultrasound monitor.

Cannulation of internal jugular vein: Using ultrasound, the cannulation needle was introduced into the IJV and angled downwards at about 30–40◦.The needle was directed outwards towards the ipsilateral nipple. Recognition that a needle is in the vein was made by observing the dark colour of venous blood and non-pulsatile nature of the filling of the syringe. When a flashback is seen and venous blood was aspirated freely, the needle was kept still until the guidewire has been threaded and followed by C-ARM to see its course through the following (SVC, right atrium, IVC) to make sure it is in the right course of the vein.

The dilator was passed over the guidewire and the track firmly and smoothly dilated by rotating the dilator between thumb and forefinger (screw like movement) as it is advanced under C-ARM, this dilatation was repeated by using increasing dilator diameters for gradual dilatation. The peel-away sheath (valved to air and blood) was introduced under C-ARM visualization, over the guidewire into the central vein slowly. Then the catheter tip was placed through the valved peel-away sheath into the vein and advanced under C-ARM to the desired position in the right atrium and during this step the patient did valsalva maneuver for protection from air embolism. The peel-away sheath is removed, and the catheter is adjusted for position of the catheter tip (5cm below the level of tracheal bifurcation) and keeping a smooth curve of the catheter in the tunnel and at the entry site through the skin to the vein under fluoroscopic guidance.

Then confirmation of catheter tip position and smooth curve of the catheter was done under C-ARM before the final fixation of the catheter to the skin. Fixation of the catheter to the skin is done till fibrosis occur in the tunnel around the cuff. Anticoagulant locking of the catheter with heparin 1000u/ml needed to occupy the lumen of the catheter from the distal tip of the

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catheter to the hub following the instruction for usage, it is also written on the lock of the catheter hub. In catheter used in our study it was 2.3cc).

Technique of insertion of subclavian tunneled dialysis catheter: the same preoperative preparation as before with some differences in steps. The first difference was the technique and site of insertion of the catheter, the subclavian vein was cannulated by the infra-clavicular cannulation approach in which: we determined the site of cannulation by landmark technique (ultrasound has limited role in subclavian vein cannulation due presence of overlying clavicle) by the index finger on the supra-sternal notch and the thumb on the angle of the clavicle approximately two-thirds of the way lateral from the sternal notch the puncture needle was advanced at this point below the thumb and angled towards the sternal notch. Then the steps as mentioned in internal jugular vein cannulation except some steps.

Technique of already inserted catheter replacement with newer one over the wire:

Positioning of the patient and sterilization of the patient is done as previously described. Under the C-ARM machine, a guide wire was introduced through the blue hub of the old catheter into the vein as the blue hub is continuous with the opening at terminal end of the catheter. The catheter was pulled out while direct compression to avoid hematoma formation. Creation of new tunnel for the new tunneled hemodialysis catheter as described before then ante-grade passage of the new tunneled catheter with the tunneller accompanying the catheter under the skin to reach the guidewire. Dilatation by dilators of the new tunneled catheter was done to dilate the track and overcoming multiple adhesions present due to the previous catheter with compression over the puncture site each time when removing each dilator. Insertion of the valved peel-away over the guidewire was done. Removal of the guidewire done with the peel-away remaining insitu and sometimes we introduced the catheter over the guidewire inside the peel-away. Introduction of the catheter tip through the peel-away into the central vein under guidance of the C-ARM machine with attention and remodeling of any appearing kinks or mal-positioning to the tip of the catheter. (Sometimes introduction of the catheter tip was not done only through the peel-away but also over the guidewire present inside the peel-away). aspiration and injection of blood through both lumens to ensure both lumens are working properly. Fixation of catheter to the skin by sutures and application of sterile dressing. Anticoagulant locking of the catheter with heparin 1000u/ml needed to occupy the lumen of the catheter from the distal tip of the catheter to the hub following the instruction for usage, it is also written on the lock of the catheter hub. In catheter used in our study it was 2.3cc).

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Every patient in the study was evaluated as regard to: Safety of the procedure and occurrence of complications during or shortly after the insertion technique such as: Failure to puncture, Accidental puncture: in subclavian or carotid arteries, Hematoma formation at site of puncture, Hemothorax, Infection, Pneumothorax, Patency of the catheter after operation to meet the need of the patient for dialysis. Efficiency of the catheter on the dialysis machine as the catheter should provide dialysis flow rate about 300-500 ml/minute.

Follow up: The minimal follow up period should be at least six months. Each patient in the study was subjected to regular follow up visits: every two weeks for the first two months and every month for the rest four months.

Statistical analysis:

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing unpaired Student's t- test. Qualitative variables were presented as frequency and percentage (%) and were analysed utilizing the Chi-square test or Fisher's exact test when appropriate. Kaplan Meier curve was performed. A two tailed P value < 0.05 was considered statistically significant.

Results:

Table 1 illustrates patients' characteristics, risk factors and mean values for age, duration of dialysis, platelet count and INR.

Table 1: Patients characteristics, risk factors and mean values for age, duration of dialysis, platelet count and INR:

	Study patients (50)
Males	18 (36%)
Females	32 (64%)
DM	19 (38%)
Hypertension	10 (20%)
Hypotension	32 (64%)
Cardiac	18 (36%)
Mean age	53.78
Mean duration of dialysis (ms)	30.31
Mean platelet count (mm3)	178720
Mean INR	1.252

Patients' characteristics among were insignificant between both studied groups except for platelet count, it was significantly higher in de novo group than over the wire group (p value=0.001). Table 2

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Table 2: patient characteristics among the 2 groups:

	De novo group	Over the wire group	P value
Number	22 (44%)	28 (56%)	-
Male	8 (36.4%)	10 (35.7%)	1.00
Female	14 (63.6%)	18 (64.3%)	1.00
DM	8 (36.4%)	11 (39.3%)	1.00
Age (years)	54.45±16.87	53.25±14.84	0.79
Hypertension	5 (22.7%)	5 (17.9%)	0.73
Cardiac	9 (40.9%)	9 (32.1%)	0.57
Mean duration of dialysis before TDCs insertion (months)	18.5	39.51	0.239
Platelet count (mm3)	219454.55±66433.45	146714.29±72924.04	**0.001***
INR	1.20±0.30	1.30±0.32	0.26
Hemoglobin	8.96±1.63	7.91±1.18	0.85

The most common cause of insertion of long-term tunneled dialysis catheters in this study is hypotension 26 cases (52%) followed by unsuitable veins 12 cases (24%) then heart failure 9 cases (18%), then cases with peripheral arterial diseases like vascuilitis 3 cases (6%). Causes of tunneled dialysis catheter insertion were insignificant between both studied groups. **Table 3**

Table 3: Causes of tunneled dialysis catheter insertion in this study

	De novo (22)	Over the wire (28)	P value
Hypotension	12 (54.5%)	14 (50%)	0.75
Heart failure	4 (18.18%)	5 (17.85%)	
Unsuitable veins	4 (18.18%)	8 (28.5%)	
Vascuilitis	2 (9.09%)	1 (3.5%)	

The observation of hematoma formation was more frequent with blind anatomical landmark technique 3 cases (13.63%) while in the ultrasound guided technique only 1 case (4.54%) developed hematoma but with statistically non- significant P value. Table 4

Table 4: Number of catheters in the de novo group inserted via blind anatomical landmark technique and ultrasound guided technique and associated hematoma

	De novo insertion of tunneled catheter (22) (100%)		P value
	Blind anatomical landmark (11) (50%)	**Ultrasound guided insertion (11) (50%)**	
Hematoma formation (4) (18.18%)	3 (13.63%)	1 (4.54%)	0.587

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In this study, time taken for insertion by over the wire technique was much shorter than time taken for de novo insertion of tunneled dialysis catheters with mean = 27.78 ± 5.71 minutes in the de novo group, and a mean = 15.07 ± 1.98 minutes with statistically significant P value <0.001*. Table 5

Table 5: Time taken in the 2 techniques

	De novo	Over the wire	P value
Operative time (minute)	27.78±5.71	15.07±1.98	<0.001*

In the study the most frequent intraoperative complication was hematoma formation either due to puncture or due to tunneling it occurred in 4 cases (18.18%) in the de novo group and in the over the wire group occurred in 2 cases (7.1%), no recorded cases of pneumothorax in the 2 groups,in the de novo group3 cases (13.6%) developed catheter related infections, 4 cases (14.3%) of infection in the over the wire group, while catheter malfunction occurred in 4 cases (18.2%) in the de novo group and 3 cases (10.7%) in over the wire group with no statistically significant P value. Table 6

Table 6: Comparison between rate of immediate complications and late complications in the 2 groups

		De novo group (n.22)	Over the wire group (n.28)	P value
Immediate complications	Hematoma formation	4 (18.18%)	2 (7.1%)	0.1
	Pneumothorax	0	0	1
Late complications	Catheter related infection	3 (13.6%)	4 (14.3%)	1
	Catheter malfunction	4 (18.2%)	3 (10.7%)	0.68

Infection in diabetic patients was insignificant different between both groups. Table 7

Table 7: Infection in diabetic patients in both groups

	Diabetics in de novo group 8 (36.4%) of 22 patient	Diabetics in over the wire group 11 (39.3%) of 28 patients	P value
Infection	3 (13.6%)	1 (3.5%)	0.255

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As regard to the primary patency of the catheter in the de novo group, its recorded after 1 month, after 3 months, after 6 months of catheter insertion respectively as follows 20 (86.3%) primary patent catheters,19 (81.81%), 18 (77.2%) respectively. While in the over the wire group it was 27 (96.4%) primary patent catheters, 26 (89.28%) and 25 (85.7%) respectively. 3 catheters in the over the wire group were malfunctioning, 2 catheters regained patency after intervention (assisted patency), 1 catheter was removed. 4 catheters in the de novo group were malfunctioning, only 1 catheter regained patency after intervention (assisted patency), 1 catheter was removed, and the remaining 2 catheters lost follow. Table 8

Table 8: Comparison between primary and assisted patency in the 2 groups

		De novo group (22)	**Over the wire group (28)**
Primary patency	After 1 month	20 (86.3%)	27 (96.4%)
	After 3 months	19 (81.81%)	26 (89.28%)
	After 6 months	18 (77.2%)	25 (85.7%)
Assisted primary patency (no. of functioning catheters)	After 1 month	20 (90%)	28 (100%)
	After 3 months	19 (86.3%)	28 (100%)
	After 6 months	19 (86.3%)	27 (96.4%)

Kaplan Meier curve was done to evaluate the primary patency of the catheters in the 2 groups which was in favor of the over the wire exchange group with higher primary patency rate after 1, 3 and 6 months after catheter insertion but without statistically significant P value (0.33). Figure 1

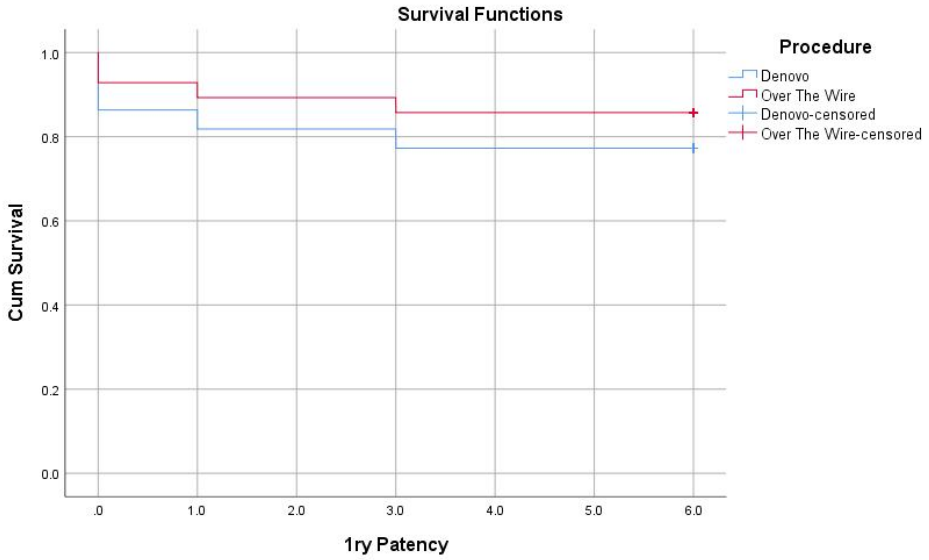

Figure 1: Kaplan Meier curve for the primary patency of the 2 groups.

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In the de novo group 10 cases (45.4%) had their catheters in the right internal jugular vein, 7 cases (31.8%) in the left internal jugular vein, 4 cases (18.18%) in the right subclavian vein, 1 case (4.5%) in left subclavian vein. In over the wire group, 20 cases (71.4%) in the right internal jugular, 5 cases (17.8%) in the left internal jugular vein, 2 cases (7.14%) in the right subclavian vein and 1 case (3.5%) in the left subclavian vein. Table 9

Table 9: Different site for insertion of tunneled catheters in the 2 groups

Site of insertion	De novo (22)	Over the wire (28)
Right internal jugular	10 (45.4%)	20 (71.4%)
Left internal jugular	7 (31.8%)	5 (17.8%)
Right subclavian vein	4 (18.18%)	2 (7.14%)
Left subclavian vein	1 (4.5%)	1 (3.5%)

Discussion

Tunneled central venous catheters have widely used as long-term or permanent central venous access. These tunneled catheters provide a low rate of infection compared with non-tunneled catheters, partly because of the protective effect of the subcutaneous tunnel, and also partly because of the barrier effect of the fibrin cuff that become fixed to the subcutaneous tracts [6].

Many tunneled dialysis catheters fail because of either fibrin sheath formation at the tip of the catheter or infection. Infections may become frequent in dialysis catheters possibly because of their more frequent use and handling. The dysfunctional catheter is removed and a new catheter is inserted at a new access site [6].

These complications led the researchers to evaluate over-the-wire catheter exchange technique and comparing it to the de novo technique to restore catheter function while preserving the existing venous access site and tunnel with keeping the technique safer and the catheter function efficient during dialysis sessions [7].

As regard to the age factor in the 2 groups, the mean age in the de novo group 54.45 ± 16.86 and mean age in over the wire group 53.25 ± 14.84 with slightly older age group in the de novo group, and there was female predominance, 14 females (63.6%) in the de novo group and 18 females (64.3%) in the over the wire group but with statistically insignificant P value for both demographic factors which is in context with a study done by Park et al.2017 [8].

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Also there were 8 diabetics (36.4%) in the de novo group and 11 diabetics in the over the wire group (39.3%), the number of patients presented with catheter infection in the de novo group were 3 patients and all of them were diabetics where as in this study 4 cases were infected in the over the wire group, only one of them was diabetic, this indicates that over the wire exchange is not predisposing to infection with no increase in the infection rate than the de novo patients.

Aboul Hosn et al. [9] performed a study for comparing the switching of temporary dialysis catheters to permanent dialysis catheters by over the wire exchange technique and by de novo puncture technique concerning occurrence of infection, this study postulated that there is no significant difference of occurrence of infection in tunneled catheters inserted by de novo or over the wire in diabetic patients with statistically insignificant P value.

Total incidence of infected catheters occurred in 3 cases (13.6%) in the de novo group, and 4 cases (14.3%) in over the wire group with P value =1 that is statistically non-significant that go forward with Falk et al, [10] who made a retrospective study about catheter replacement over the wire versus de novo insertion and postulated that, the overall infection rate was 0.30 per 100 catheter-days in over the wire group and 0.36 per 100 catheter-days in de novo group and confirmed that over the wire exchange is safe technique and does not increase the risk for infection.

As regard to the platelet count in the 2 groups, the mean platelet count in patients with over the wire group = 146714.29 ± 72924.04 , which is lesser in value than the mean platelet count in de novo group =219454.55 ± 66433.45 , with a statistically significant P value = 0.001*, this strengthens the recommendation of using the over the wire technique in critically ill patients with multiple co-morbidities that may lead to bleeding tendency this agree with the study done by Park et al. [8] who recommended the over the wire technique in critically ill patients in the ICU.

The frequency of hematoma formation among de novo group was 4 cases (18.18%) while in the over the wire group it was 2 patients (7.1%) although coagulation profile was better in the de novo group, yet hematoma occurred more in the de novo group possibly due to the creation of a new puncture into the vein, this makes the over the wire group superior in safety as regard the bleeding complication with statistically non-significant P value, hematoma formation was also affected by either ultrasound was used or not during vein puncture.

All of over the wire cases in the study were inserted under ultrasound guidance and showing the catheter inside the vein and the wire passing through the vein to reach right atrium, but de novo puncture cases are divided into 2 groups each group includes 11 patients the first group

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were inserted under ultrasound guidance and the second group were inserted by anatomical landmark technique with more hematoma complicated cases occurring with the anatomical landmark blind technique, all hematoma cases in the de novo group were 4 cases, 3 cases occurred in the blind anatomical landmark technique and 1 case occurred in the ultrasound guided technique, this strengthen the superiority of the ultrasound technique over the blind anatomical technique in prevention of complications due to puncture of the vein under visualization with ultrasound with less trials for cannulation.

In a recent study by Sazdov et al. [11] comparing ultrasound-guided central vein catheterization with landmark technique, the hematoma formation rate was also lower with ultrasound guided catheterization, 4% versus 10%.

Catheter malfunction is a common complication occurring with central venous catheters mostly due to formation of fibrin sheath or central vein stenosis due to continuous contact between the catheter and the central vein, although this is a common cause of central vein stenosis, there are some patients suffering from central vein stenosis without previous history of catheter insertion due to previous creation of arteriovenous fistula , and the arterialized bood flow leads to thickening and fibrosis of the venous valves [12].

Catheter malfunction occurred in 4 cases (18.2%) in the de novo group and 3 (10.7%) cases in over the wire group. In patients with high susceptibility for central venous stenosis either due to previously inserted catheters which are malfunctioning or due to previous arteriovenous fistula it is better to preserve the preformed pathway of the previously inserted catheter in the vein as there is higher failure rate to perform the de novo insertion, that was encountered in one case (presented in the chapter of results) who had inserted porta-cath for administration of chemotherapy in the right internal jugular vein 8 months before the de novo puncture of the left IJV, that led to stenosis of the SVC at the confluence of right and left innominate veins, that led to resistance during passage of the wire to reach the right atrium and early occurrence of catheter malfunction which needed intervention and repositioning to regain the patency.

Patency rates in the de novo group was 86.3% during the first 30 days and in the over the wire group was 96.4% , after 3 months patency rate was 89.2% in the de novo group and 85.7% in the over the wire group and after 6 months it was 77.2% in the de novo group and 85.7% in the over the wire group, this is in context with Falk et al. [10] who noticed the mean patency rate in the 2 groups in 30 days: in the de novo group 83% and 72% in the over the wire group.

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Operative time during over the wire exchange (15.07 ± 1.98) minutes was markedly less than de novo technique (27.78 ± 5.71) minutes with a statistically significant P value < 0.001* that may be due to the already formed puncture and catheter track to the vein and also lesser pain to the patient as there is no puncture or repeated trials for cannulation, no need for hemostasis as the operation is often bloodless. This agree with Park et al. [8].

Conclusions:

By comparison between the two methods of tunneled dialysis catheters insertion in ESRD patients (de novo insertion and over the wire exchange technique), we found that over the wire exchange technique may provide additional benefits for patients with ESRD. The lower rate of complications during catheter insertion like hematoma and also lower rate of malfunction and higher primary patency rates with non-significant P value and also the shorter operation time in over the wire exchange technique with significant P value and access site preservation, make the over the wire exchange technique superior to the de novo insertion technique.

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