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Cuffed-tunneled catheters in hemodialysis patients: problems and solution methods: A single-center retrospective cohort study

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Ethics Committee Approval
Ethical approval was obtained from Adıyaman University Non-Invasive Clinical Research Ethics Committee (date: 21/09/2021, number: 2021/07-31).
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
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Abstract

Background/Aim: Cuffed-tunneled catheter patients encounter various problems during their catheterization period. Early detection and resolution of these problems prolong the life of the catheter. The purpose of the present study was to investigate the problems and solution methods of cuffed-tunneled catheters in hemodialysis patients during their use in light of our experience and literature.
Methods: The study was designed as a retrospective cohort study. Twenty-four months of patient data who had a diagnosis of renal failure and who received cuffed-tunneled hemodialysis catheters between January 2013 and June 2021 in the Department of Cardiovascular Surgery of Adiyaman University Faculty of Medicine were analyzed electronically based on the hospital data recording system. The demographic characteristics, localization of the inserted catheter, and duration of catheter use were determined. Primary and secondary patency ratios were calculated and recorded along with the complications in the patients and our treatment approaches to these complications. Finally, the collected data were discussed with reference to the literature data.
Results: The data from 322 cuffed-tunneled catheters were collected in a total of 228 patients during the observation period. It was found that no revision procedure was applied to 73 patients (catheter) during the 24-month period, and a total of 204 revision procedures were applied to 155 patients. The revision procedure consisted of 110 thrombolytic treatments, 64 vein exchanges, 18 tunnel changes, and 12 catheter changes. Primary and secondary patency ratios at 6, 12, 18, and 24 months were calculated as 90.79%, 63.60%, 40.11%, and 32.02% and 96.05%, 89.91%, 72.37%, and 58.33%, respectively. The most common factors that affected primary and secondary patency ratios were determined to be gender (P<0.001 and P=0.056, respectively), body mass index (P<0.001 and P<0.001, respectively) and diabetes mellitus (P=0.018 and P=0.690, respectively).
Conclusion: Thrombolytic treatment is an effective and safe method in catheter thrombosis, which is one of the most important factors rendering the cuffed-tunneled hemodialysis catheters dysfunctional. Also, in tunnel infections, tunnel replacement is a salvage procedure in patients with vascular access problems.

Keywords: hemodialysis, cuffed-tunneled hemodialysis catheters, catheter thrombosis, patency ratios

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Introduction

Tunneled hemodialysis catheters (THC) have been produced with various designs since 1985 and have been used to present day due to ease of placement and use. They can be cuffed or uncuffed and constructed with polyurethane or silicone. In general, hemodialysis catheters act as a temporary bridge in dialysis-dependent patients until the time required for a permanent vascular access pathway, such as an arteriovenous fistula, to mature is complete. Indications to gain permanent access in patients with previously used permanent vascular access dysfunction or vascular access site depletion are usually present. They are produced in appropriate diameters and shapes to provide extracorporeal blood flow of 300 to 400 ml/min, which is necessary for an effective dialysis procedure [1,2].

During their usage period, all central venous catheters are subject various complications, which include immediate mechanical complications associated with insertion procedures or late complications, such as catheter-related infection, and longer-term complications, such as central vein thrombosis, catheter thrombosis, and fibrin sheath. The rates of procedure-related complications, such as catheter malposition, pneumothorax, arterial injury, arrhythmia, and venous air embolism, decreased considerably after the routine use of ultrasound guidance [2,3].

Although catheters can be placed in all central veins, the contralateral internal jugular vein (such as right internal jugular vein because of anatomical compatibility) should be preferred initially so that it does not affect the arteriovenous fistula that has been (or will be) created [4].

The purpose of the present study was to retrospectively examine the cuffed-tunneled catheters placed for hemodialysis in our cardiovascular surgery clinic, to examine related complications, insertion techniques, and factors that affect primary and secondary catheter patencies and to share our experience in the light of the literature data.

Materials and methods

The study was designed as a retrospective cohort study and was initiated after the approval of the Non-Interventional Ethics Committee of Adiyaman University on 21/09/2021 with the decision number 2021/07-31. The data were collected in a digital medium using the patient data recording system. The data of patients who were referred to our Cardiovascular Surgery Clinic from the Nephrology Clinic between January 2013 and June 2020 and received a cuffed-tunneled hemodialysis catheter were analyzed. The patients who had two-year follow-up data were included in the study. Demographic data, catheter localizations, complications, and treatment approaches to these complications were determined from the file scan. Primary and secondary patency ratios of the catheters and factors that affected the patency ratios were recorded.

Definitions

Primary Patency Ratio: The primary patency ratio reflects the time from the insertion of the catheter to the first intervention for the same catheter. The initial intervention includes thrombolytic treatment, mechanical thrombectomy, and/or removal of the fibrin sheath [5].

Secondary Patency Ratio: The secondary patency ratio defines the time from the insertion of the catheter to the replacement or removal of the same catheter for any reason [5].

Infection Rate: The infection rate per 1000 catheter days=(the number of infected catheters)/(the total number of catheters X follow-up time) x 1000 [1].

Interventional Procedure: All procedures were performed on patients in the supine position in a sterile operating room setting. The patient was placed in the Trendelenburg Position for placement of the internal jugular and subclavian vein catheters. Local anesthesia was administered with a 22G tip injector after the area in which the catheter was placed was cleaned with povidone-iodine, and the patient was covered. The patient was positioned in the Slight Trendelenburg Position, facing the opposite side for the internal jugular vein (IJV) preferences. The puncture was performed from the top of the triangle, which was formed by the lateral and medial legs of the sternocleidomastoid muscle [6]. The artery was palpated with the other hand during the puncture and entered from the lateral side of the finger from which the pulse was taken. A 22G tip injector was used for the puncture. In this way, the formation of hematoma in possible arterial punctures was prevented. The IJV was punctured with a 10 Fr catheter insertion needle after the vein tracing was fixed with a 22G injector.

A direct catheter needle was used for a puncture in the subclavian vein (SCV) preferences because a 22G needle may be short after local anesthesia. Technically, the vein was punctured by stripping the bottom of the clavicle from the mid-lateral one-third point of the clavicle and advancing the needle horizontally towards the sternal notch or the opposite shoulder [6]. The guide wire was sent from the catheter needle to the vein lumen and the guide-wire entry site was enlarged with an incision of approximately 3 mm. The appropriate catheter length was calculated for the patient. The length between the third intercostal space (with the tip of the catheter at this point), the skin entry site of the guide wire, and the cuff of the catheter was marked. The skin entry area of the cuff was adjusted to be approximately 2–3 cm proximal over the breast. The catheter was passed through the subcutaneous tissue with the tunneler and the guide wire was removed from the entry area. The dilatator and the peelable sheath were inserted into the vein lumen using circular movements over the guide wire. The lock mechanism was opened with the Valsalva Maneuver, and the guide wire and dilatator were removed from the sheath. The catheter was directed through the sheath of the previously measured size. The sheath was removed from both sides. The catheter lumen was rinsed with heparinized fluid. The tunnel was fixed close to the exit site to prevent the cuff from exiting the skin, and a suture was placed on the skin so that it would not impede the catheter.

As the target vein, the right IJV was preferred. However, if the right IJV region was not suitable because of multiple interventions, left IJV, right SCV, or left SCV was the preferred vein for catheter localization. The lengths of the catheters used for the upper central veins were 19–28 cm, self-curved and constructed of silicone/silastic according to the condition of the patient.

Femoral veins were preferred in patients whose upper extremity venous structures were depleted or unsuitable.

Although similar in terms of the procedure and technique, the selected catheters were also in silicone/silastic structure and their lengths were between 27 and 35 cm (between tip and cuff).

Creating A New Tunnel: Creation of a new tunnel is a method that preserves the existing venous access route in patients who have minimal symptoms, catheter tunnel, or exit site infection. Local anesthesia was applied to the venotomy site after the standard skin and catheter site are prepared and covered with the povidone–iodine scrub. A small incision was made to access the catheter. The catheter was transected, and the peripheral tip was removed and discarded. A guide wire was sent from the segment of the catheter in the vein. The old catheter was removed and discarded so that it does not touch the surgical field. The guide wire in the vein was wiped with sterile saline and an antiseptic solution. The surgeon changed sterile gloves. A new exit point and tunnel were then created in a suitable area lateral to the first tunnel. The new catheter was passed through the new tunnel and tunneled to the old venotomy site using the standard technique [7].

Thrombolytic Treatment with Alteplase: The procedure was performed in the intensive care unit under patient monitoring. Five ml (5 mg) of Alteplase was administered into each lumen of the thrombosed catheters, and this process was repeated three times at an interval of half an hour. After this procedure, which was applied at 0, 30, and 60 min, the patient was followed for about half an hour. The administered dose was as much as the recommended accelerated loading dose for acute myocardial infarction [8]. The patients who did not develop complications were followed in the ward.

Statistical analysis

Statistical analyses were performed using Graphpad Prism 8.0.2 (La Jolla, CA: Retrieved from GraphPad Software, Inc. http://www.graphpad.com/scientific-software/prism/). The survival rate of the catheter was calculated using the Kaplan–Meier analysis. The conformity of the variables to the normal distribution was evaluated with the Kolmogorov–Smirnov analysis. The homogeneity of the variances was evaluated with Levene's Test. Nonparametric data were compared by using the Mann–Whitney U-test. The equality of survival profiles between patients with and without potential predictors of thrombosed catheters was examined using the log rank test. The Multivariate Regression Analysis was used for the predictors of the Patency Ratios. The categorical variables were compared by using the chi-squared Test. Results are presented as mean values (standard deviation) and the comparisons with a *P*-value below 0.05 were considered significant.

Results

It was determined that 322 cuffed-tunneled catheters were placed in 228 patients. The mean age of the patients was 59.92 (8.52) at the time of the procedure. Among the patients, 36.40% were female, and 63.60% were male. The demographic data of the patients are given in Table 1. The right internal jugular vein (RIJV) with 104 (45.61%) catheters was the most common venous access route. It was understood from the file scan that 50 (21.93%) catheters were inserted into the right subclavian vein (RSCV), 32 (14.03) into the left subclavian vein (LSCV), 14 (6.14%) into the right femoral vein (RFV), and six (2.63%) into the left femoral vein (LFV) as shown in Table 1.

Table 1: Demographic data of the patients during the follow-up period

	Revised catheter n=155	Unrevised catheter n=73	*P*-value
Age of follow-up means (SD)	60.05 (8.86)	58.6 (7.64)	0.018[a]
Gender n(%)			
Male	92(59.36%)	53(72.60%)	<0.001[a]
Female	63(40.64%)	20(27.40%)	
BMI	27.57 (4.36)	21.93 (3.32)	<0.001[a]
CRF etiology n(%)			
HTN	49 (31.61%)	23 (31.51%)	0.987[b]
DM	81(52.26%)	41 (56.16%)	0.581[b]
GLN	5 (3.22%)	1 (1.37%)	0.414[b]
PRD	5 (3.22%)	1 (1.37%)	0.414[b]
VASC	31 (20%)	13 (17.81%)	0.410[b]
DRG-IN	2 (1.3%)	3 (4.11%)	0.175[b]
Unknown	24 (15.48%)	10 (13.70%)	0.724[b]
Use of drug n(%)			
Acetyl salicylic acid	49 (31.61%)	26 (35.62%)	0.548 [b]
Clopidogrel	22 (14.19%)	10 (13.70%)	0.920 [b]
Antihypertensive	54 (34.84%)	33 (45.21%)	0.133[b]
Beta-blocker	69 (44.52%)	44(60.27%)	0.026 [b]
Access zone n(%)			
RIJV	56 (36.13%)	48 (65.75%)	0.001[b]
LIJV	17 (10.97%)	5 (6.85%)	
RSCV	40(25.81%)	10 (13.70%)	
LSCV	22 (14.19%)	10 (13.70%)	
RFV	14 (9.03%)	0(0%)	
LFV	6 (3.87%)	0(0%)	

CRF: Chronic renal failure, HTN: Hypertensive nephropathy, DM: Diabetes mellitus, GLN: Glomerulonephritis, PRD: Polycystıc renal dısease, VASC: Vasculitis, DRG-IN: Drug İnduced, RIJV: Right internal jugular vein, LIJV: Left internal jugular vein, RSCV: Right subclavian vein, LSCV: Left subclavian vein, RFV: Right femoral vein, LFV: Left: femoral vein, SD: standard deviation, a: Mann–Whitney U test, b: Chi-squared test

It was found that all catheters were placed by one single surgical team. Routine ultrasound (USI)-guided catheter placement was not performed because of difficulties in accessing USI, and catheters were placed in only four (1.75%) patients under USI guidance (multiple catheter intervention or obese patient).

It was found that no revision was applied to 73 patients during the two-year follow-up period, and a total of 204 revisions were performed on 155 patients. It was also understood from the file scan that the most common revision procedure was the application of thrombolytic treatment with Alteplase to 99 catheters, 110 times, in addition to revision procedures (64 vein exchanges, 18 tunnel changes, and 12 catheter changes). Also, it was found in the file that 11 patients had been treated with thrombolytic treatment twice at different times (Table 2). The most common complication was catheter thrombosis (43.42%) followed by 27% catheter-associated infection (1.37% infection rate per 1000 catheter days) and 7.89% tunnel infection (0.11 infection rate per 1000 catheter days). Other complications and their rates are summarized in Table 2.

Primary patency ratios of the catheters in the sixth, 12th, 18th, and 24th months were calculated as 90.79%, 63.60%, 40.11%, and 32.02%, respectively, and secondary patency ratios were 100%, 89.91, 72.37, and 58.33%, respectively (Figure 1). Multivariate logistic regression analysis was used to determine the factors that affected the primary and secondary patency ratios of the catheters (Table 3). According to this analysis, a significant regression model was found for the primary dependent variable, $F(10, 216)$ 24.21, $P<0.001$, and 51% of the variance in the variable (R^2 adjusted=0.51) was explained by the independent variables. In this respect, the gender independent variable predicted the primary dependent variable positively and significantly, body mass index (BMI) predicted the primary dependent variable negatively and significantly, diabetes predicted the primary dependent variable negatively and significantly, the localization predicted the primary dependent variable negatively and significantly ([ß=–0.179, t [216]=3.62, P<0.001, pr2=0.057], [ß=–0.548, t[(216]=–10.846, P=0.012, pr2=–0.292], [ß=–0.114, t[216]=–2.376, P=0.018, pr2=–0.0256], and [ß=–0.177, t[216]=–3.079, P=0.002, pr2=0.042, respectively]). Also, a significant regression model in the multivariate linear regression analysis that was constructed to predict the secondary dependent variable using independent variables showed that F(10, 216) 8.762, P<0.001, and 26% of the variance (R^2 adjusted 0.26) in the second dependent variable was determined by the independent variables. In this respect, BMI predicted the secondary dependent variable as negative and significant, localization predicted the secondary dependent variable as negative and significant ([ß =–0.308, t[216]=–4.962, P=0.012, pr2=0.1024] and [ß=–0.322, t[216]=–4.557, P<0.001, pr2=0.088, respectively]). As a result of this analysis, BMI and localization were found to be the factors that affected both primary and secondary patency ratios, and female gender and the presence of diabetes significantly affected primary patency ratios (P<0.001 and P=0.018, respectively) as shown in Table 3. Primary and secondary patency rates according to localization in diabetic patients are summarized in Table 4.

Table 2: Complications and revision procedures

Procedural	n (%)
Bleeding	2 (0.88%)
Pneumothorax	1 (0.44%)
Arrhythmia	17 (7.45%)
Malposition	2 (0.88%)
Air embolism	5 (2.19%)
Catheter dysfunction n (%)	
Thrombosis	91 (39.91%)
Fibrin sheath	13 (5.70%)
Central vein stenosis	11 (4.82%)
Catheter-related infection n (%)	
Catheter-related blood infections	42 (18.42%)
Tunnel infection	18 (7.89%)
General complications n (%)	
Deep venous thrombosis	7 (3.07%)
Pulmonary embolism	2 (0.88%)
Limb ischemia	4 (1.75%)
Revision procedures n	
Thrombolysis with alteplase*	110
Vein exchange	64
Change of tunnel	18
Change of catheter	12

* Thrombolysis was applied to 11 catheters twice at different times.

Table 3: Multivariate regression analysis to identify predictors of primary and secondary patency rates

Variables	Beta	t	P-value	95.0% CI for B		Correlations		
				Lower	Upper	Zero-order	Partial	Part
Age Primary	-0.002	-0.028	0.978	-0.099	0.096	–0.171	-0.002	-0.001
Secondary	0.035	0.515	0.607	-0.067	0.115	–0.163	0.035	0.030
Gender Primary	0.179	3.625	0.000	1.300	4.396	0.358	0.239	0.169
Secondary	0.116	1.923	0.056	-0.036	2.858	0.255	0.130	0.110
BMI Primary	-0.548	-10.85	0.000	-1.556	-1.077	–0.663	–0.594	-0.507
Secondary	-0.308	-4.962	0.000	-0.786	-0.339	–0.421	–0.320	–0.285
DM Primary	-0.114	-2.376	0.018	-3.197	-0.298	–0.195	–0.160	–0.111
Secondary	-0.023	-0.399	0.690	-1.628	1.080	–0.086	–0.027	–0.023
HT Primary	-0.003	-0.053	0.957	-1.626	1.540	–0.015	–0.004	-0.002
Secondary	0.045	0.746	0.456	-0.919	2.039	0.010	0.051	0.043
GLN Primary	-0.050	-1.045	0.297	-6.846	2.103	-0.060	–0.071	-0.049
Secondary	0.067	1.148	0.252	-1.747	6.615	0.050	0.078	0.066
PRD Primary	-0.040	-0.821	0.412	-6.517	2.683	–0.135	–0.056	-0.038
Secondary	0.035	0.590	0.556	-3.012	5.584	–0.063	0.040	0.034
VASC Primary	-0.073	-1.506	0.134	-3.150	0.421	–0.053	–0.102	-0.070
Secondary	-0.039	-0.656	0.512	-2.224	1.113	–0.027	–0.045	-0.038
DRG-IN Primary	0.004	0.082	0.935	-5.235	5.688	–0.009	0.006	0.004
Secondary	-0.027	-0.463	0.644	-6.302	3.904	–0.057	–0.031	-0.027
LOC Primary	-0.177	-3.079	0.002	-1.540	-0.338	–0.377	–0.205	-0.144
Secondary	-0.322	-4.557	0.000	-1.860	-0.737	–0.400	–0.296	-0.262

BMI: Body Mass Index, DM: Diabetes mellitus, HT: Hypertension, GLN: Glomerulonephritis, PRD: Polycystıc renal dısease, VASC: Vasculitis, DRG-IN: Drug induced, LOC: localization, CI: confidence interval

Both primary and secondary patency ratios were found to be higher in non-diabetic patients based on the Kaplan–Meier analysis between diabetic and non-diabetic patients (Figure 2). Based on the Kaplan–Meier analysis that was constructed according to gender, primary (P<0.001) and secondary (P=0.002) patency ratios were found to be high in males (Figure 3). During the two-year follow-up, the primary patency rates for the 64 patients (followed for 12 months) who underwent thrombolytic therapy with Alteplase at three, six, nine, and 12 months were 95.31%, 81.25%, 70.31%, and 53.13%, respectively (Figure 4).

Table 4: Primary and secondary patency rates by localization in diabetic patients

Time (month)		RIJV	LIJV	RSCV	LSCV	RFV	LFV
6	**Primary**	98.11	88.89	78.26	82.61	55.56	20
	Secondary	100	100	100	100	100	5-100
12	**Primary**	64.15	55.56	39.13	52.17	0	0
	Secondary	98.11	100	59.56	82.61	77.78	60
24	**Primary**	56.60	22.22	17.40	26.09	0	0
	Secondary	86.68	66.67	43.48	47.83	0	0

Figure 1 : Primary and secondary patency rates independent of risk factors

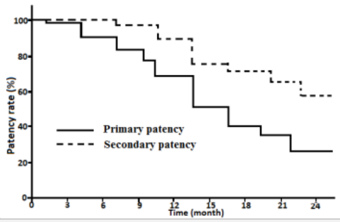


Figure 2: Primary and secondary patency rates in diabetic and non-diabetic patients

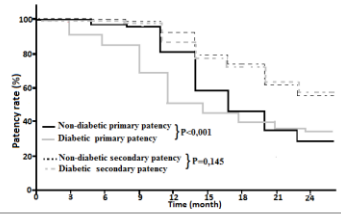


Figure 3: Primary and secondary patency rates of catheters by gender

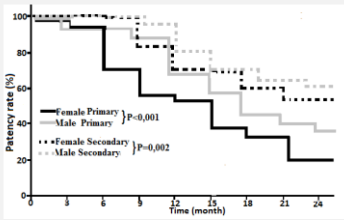


Figure 4: 12-month primary patency rates in patients undergoing thrombolytic therapy with Alteplase

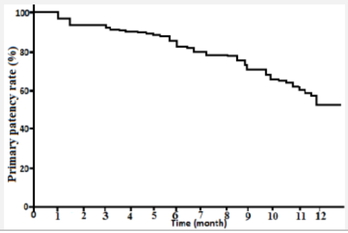
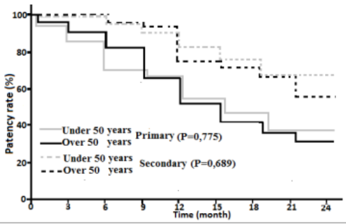


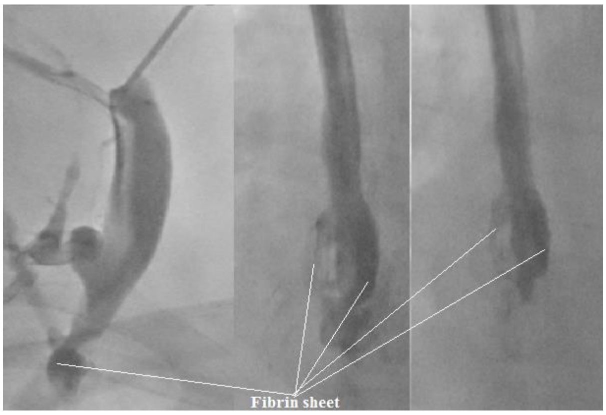
Figure 5: Primary and secondary patency rates in patients younger than and over 50 years old



It was observed that age did not affect the primary and secondary patency rates. Patency rates of patients under 50 and over 50 years of age are shown in Figure 5.

Fibrin sheets were detected in 13 patients who underwent thrombolytic treatment (Figure 6). It was determined that no problems in the routine dialysis of these patients after the procedure existed.

Figure 6: Fibrin sheet



Discussion

Arteriovenous fistulas are the best vascular access routes for patients whose life depends on hemodialysis. However, tunneled hemodialysis catheters are the best alternative for patients who have a history of multiple failed fistula attempts [9]. A recent study argued that approximately 80% of patients who had renal failure would require hemodialysis catheters at some point in their lives. The current National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI) recommendations indicate that the RIJV is the preferred insertion site for THC because of its more linear route compared to the left side [10].

Although IJVs are generally preferred for tunneled catheter placement, SCVs are preferred less frequently. SCVs are not generally preferred because they eliminate the chance of central vein thrombosis and fistula opening in the ipsilateral upper extremity and/or graft [9].

Although the use of USI during catheterization was recommended (Level of Evidence B), its routine use has not been established yet. Also, it was shown that blind catheter placement without the use of USI can reduce complications if it is performed repetitively by the same surgical team [11,12]. In the current study, no serious complications related to the procedure developed in the series except pneumothorax in one patient and malposition in two patients out of 228 patients. We associate this result with the fact that all catheter procedures were performed by the same surgical team.

Although THCs provide the clinician with a chance for immediate vascular access, several factors limit their use and affect their survival. Those factors related to the placement procedure include catheter-related bloodstream infections, catheter thrombosis, and venous thrombosis [2]. For these complications, catheter-saving or venous access-saving interventions are important in terms of preserving the already limited venous access tract in patients. In this context, a chance for intervention must be given to every dysfunctional catheter. Thrombolytic treatment with alteplase was used in our series in acute thrombosis of the catheter and venous access route. In the United States, Alteplase is currently used in the standard treatment of catheter thrombosis [13]. No additional complication was detected in any of our patients with this application. A total of 110 thrombolysis protocols were performed on 99 catheters. Primary patency ratios at three, six, nine, and 12 months were 95.31%, 81.25%, 70.31%, and 53.13%, respectively, of the 64 patients who were followed up for 12 months and underwent thrombolytic treatment with alteplase. These rates can be considered quite successful in the patients for whom the protection of the venous access route is very important.

Catheter or tunnel infections are another cause of catheter or venous access route losses [2]. Catheters can become occluded secondarily to a thrombotic process (such as the fibrin sheath around the catheter tip or an intra-luminal blood clot). A fibrin sheath is one of the most common causes of thrombotic obstruction. It can occur within 24 h of catheter insertion and usually develops within two weeks. The fibrin sheath usually does not affect catheter function, but may create a one-way valve on the catheter tip, causing partial occlusion. The negative pressure created when attempting to aspirate blood creates a suction that pulls the fibrin sheath over the catheter tip, preventing blood from being withdrawn. The blockage dissolves when negative pressure is eliminated (such as during infusion or catheter flushing), allowing fluids to pass through easily with THC. Although a fibrin sheath usually does not cause any clinical symptoms, a slight risk of embolization of the fibrin material is present [13].

In the population of the present study, a fibrin sheath was detected in 13 patients. Full patency was achieved in all patients in our thrombolytic treatment procedure, which was performed with Alteplase at an interval of half an hour. No problems were detected in the following dialysis sessions.

Catheter-related blood infection was observed in 42 patients and tunnel infection was observed in 18 patients in the current study. Antibiotic treatment and catheter and vein replacement were required according to the results of the culture antibiogram in blood infections. The vascular access route was preserved in tunnel infections and tunnel replacement was performed.

Diabetic patients have a high risk for catheter-related thrombosis [14]. In the present study, when primary and secondary patency ratios were examined according to localization in diabetic patients, the one-year primary patency ratio was the highest in terms of RIJV (64.15%), and the lowest was in terms of the RSCV. The one-year secondary patency ratio was highest in the left internal jugular vein at 100%. Based on these results, the first preferred venous access site in diabetic or non-diabetic patients must be the internal jugular veins. Ideally, the catheter must be placed on the opposite side of the planned or maturing arteriovenous fistula (AVF). Subclavian veins must be avoided whenever possible because of the risk of venous stenosis and AVF compromise. Femoral veins are less preferred because of low catheter survival, deep vein thrombosis, and related complications [15, 16]. Internal jugular veins were preferred most frequently and subclavian veins were the preferred second choice in the current study. The femoral vein region was used to increase the chance of survival in obese patients and patients with upper vein depletion.

The primary and secondary patencies of the catheters provide a wide range of variations, ranging from 25% to 75% per year. This range variation is probably due to the lack of aseptic environment maintenance, level of general catheter care, management level of catheter dysfunction, and treatment of infection [16]. In our series, the one-year primary patency ratio of the catheters was 63.60%, and the secondary patency ratio was 89.91%, which was above values in the literature. We think that the insertion and follow-up of all catheters by a single surgical team is the most important reason for this high rate.

Catheters sometimes rupture at the insertion site because of their manipulation during dialysis. In such a case, the catheter must be changed by maintaining the venous access route [17].

Limitation

The only limitation of our study is its retrospective nature.

Conclusion

Catheter and vein-sparing procedures must be tried in hemodialysis patients whose vascular access path is very important and limited. Especially, thrombolytic treatment in catheter thrombosis and tunnel replacement, which is a vein-sparing method in tunnel infections, are the methods that can be used.

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