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Original Article

Evaluation outcomes of temporary hemodialysis catheter implantation as long as permanent access prepared in patients with chronic hemodialysis in Gorgan-Iran 2021: A cross-sectional study.

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Abstract

Nowadays, the number of people who requires chronic hemodialysis has increased, and providing a suitable access method for these patients has become one of the main tasks of vascular surgeons. Arteriovenous fistulas are the best access method for hemodialysis; however, they require an average interval of two months from the implantation to the time of use. Several scientific sources recommend tunnels in this time frame for hemodialysis and advocate temporary catheters for fewer than two weeks, expected to sanctions, and economic and equipment limitations, in some cases, we have had to rely on temporary catheters until the arteriovenous fistula is able to use. Evaluation outcomes of temporary hemodialysis catheter implantation as long as permanent access prepared in patients with chronic hemodialysis. This cross-sectional study was conducted in 5th Azar and Sayad Shirazi hospitals in Gorgan, Iran, on 74 dialysis patients implanted with a temporary jugular dialysis catheter during arteriovenous fistula implantation. The patients followed up until their fistulas matured, then the function of the temporary dialysis catheter and the need for re-catheterization were investigated. Outcomes were collected prospectively and analyzed by appropriate statistical tests.

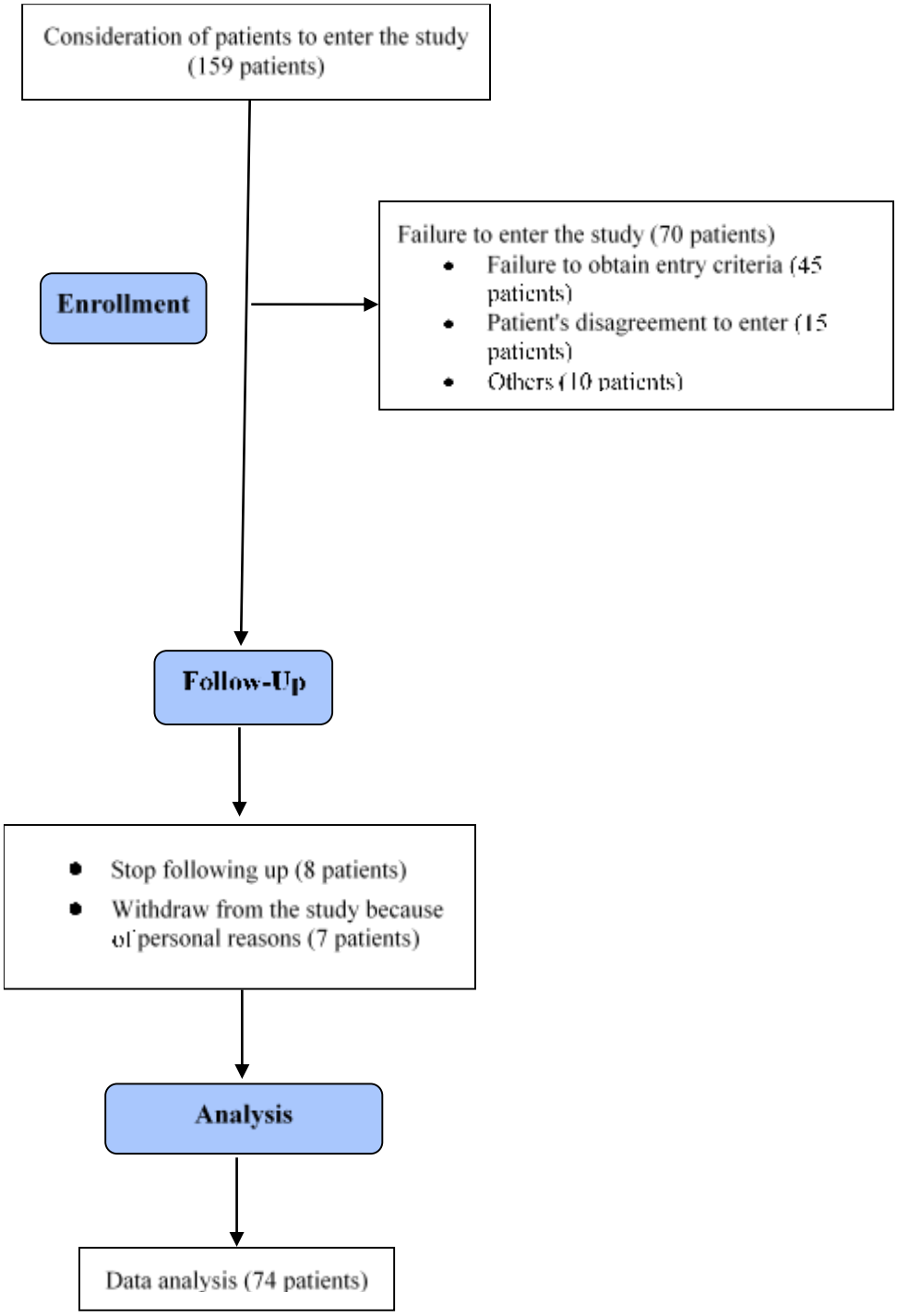
39 (52.7%) of the studied subjects were female, 35 (47.3%) were male. The average age of the subjects studied was 53.03 ± 14.79 years. The duration of the temporary dialysis catheter, Temporary Jugular catheter, in the studied patients was 46.41 ± 17.13 days. The longest duration of operation was 78 days. 47 of the investigated cases (63.5%) were still working appropriately at the time of arteriovenous fistula maturation. Although the duration of using temporary dialysis catheters reported to be limited in studies, it is possible to increase time of using them in patients depending on the conditions and considering some factors. In communities with limited financial resources in the healthcare system and unable to provide permanent catheters based on considerations, this can be a considerable temporary alternative procedure.

Keywords: Chronic hemodialysis, Catheter implantation, Permanent access, Fistula maturation, Temporary catheter

Introduction

Nowadays, in many countries, a significant number of people suffer from end-stage renal disease. Renal transplantation has the longest survival for this deliberate disease; however, transplantation is not suitable for about 60% of people [1]. In these cases, hemodialysis (HD) is the next desirable option [2, 3]. Hemodialysis requires pleasant vascular access sites with at least 350 mL/min blood flow. In the absence of satisfying vascular access, the quality of hemodialysis cuts down [2].

The use of temporary hemodialysis catheters has increased in recent years and includes approximately 25% of conventional dialysis in the United States [4]; The National kidney foundations recommend limiting cuffed catheters for HD access to less than 10% of dialysis patients owing to the higher morbidity and mortality[5]. Based on reported studies, long-term dialysis using cuffed and tunneled catheters increases



the risk of death 2-3 times and serious infection 5-10 times compared to dialysis using arterial fistula[6]. In addition, compared to the general population, dialysis patients are 100 times more at risk of death from sepsis. Also, mortality is higher in patients with catheters [7].

Using a temporary hemodialysis catheter is associated with complications occurring during the catheter operation, throughout the catheter's presence, and at the time of removal. Recognition and prevention of catheter-related complications are essential to ameliorate patient care[8, 9]. Common complications include displacement or failure of the catheter, blockage due to local or systemic infection, and thrombosis[8-10].

The reported incidence rate (IR) of catheter-related complications varies depending on terms and definitions of complications, patient population, units

Table 2. Demographic characteristics

Variables	Total population	sex		P value
		male	female	
Average age(standard deviation)*	74	35 (47.3%)	39 (52.7%)	
	53.03 (14.79)	52.77 (15.70)	53.26 (14.13)	0.889
Average BMI Kg/m^2 (standard deviation) *	25.70 (3.72)	25.05 (2.97)	26.28 (4.24)	0.160

*Independent Samples Test was used for statistical analysis

of measurement, duration of catheterization and follow-up, catheter location, insertion, care methods, and diagnostic methods [10]. Undergoing HD Patients may have different complications than non-HD patients; therefore, investigating complications is in need in patients with and without HD catheters to find IR in patient groups. The most common complication is catheter-related bloodstream infection (CRBSI), ,with an incidence of 0.46 to 30 per 1000 catheter days, or 4.3% to 26% of indwelling catheters [11-17]. Additionally, many central venous access devices (CVADs) develop a fibrin layer (usually within 24 h of insertion) that may impair CVAD function over time [18]. Catheter-related thrombosis was reported in 0.6-33% of catheters or 0.06-21 episodes per 1000 catheter per days[10, 12, 19-21] .

Half of the hospitalization costs in end-stage renal diseases are related to vascular complications [22]. The arterial fistula is the most suitable vascular access technique because of prolonged access however it is associated with various complications [23, 24], including thrombosis, upper limb ischemia, swelling, bleeding, aneurysm, carpal tunnel syndrome, and infection [2]. On the other hand, infection, jugular vein stenosis, and thrombosis are common hemodialysis side effects of temporary jugular vein catheterization [25].

The best hemodialysis access is an arteriovenous fistula (AVF) with few complications in long-term use. Patients whom AVF implantation is not possible or who need dialysis during AVF maturation, a hemodialysis catheter in the central arteries is a suitable option [26]. According to the recommendation of KDOQI, the best hemodialysis method for AVF, then AVG, is finally a permanent catheter, therefore, when GFR reduces below 30, diabetic patients should take appropriate measures to

Table No. 3 past medical histories and duration of dialysis

variables	Total population	sex		P value
		male	female	
	74	35 (47.3%)	39 (52.7%)	
Cardiovascular disease history(frequency percentage)*	50 (67.6%)	23 (65.7%)	27 (69.2%)	0.807
Diabetes history (frequency percentage)*	44 (59.5%)	21 (60%)	23 (59%)	1.000
Duration of chronic kidney disease, months (standard deviation)**	24.58 (35.75)	24.94 (35.00)	24.26 (36.86)	0.935
Duration of starting dialysis, months (frequency percentage)**	22.30 (35.37%)	22.49 (34.52%)	22.13 (36.56%)	0.966

* Chi-Square test was used for statistical analysis

** Independent Samples Test was used for statistical analysis

establish vascular access and start dialysis preferably through a fistula. Fewer (less than 10%) start their dialysis through a catheter. Despite this recommendation, because of late referring or inappropriate follow-up, most patients need a catheter until adequate vascular access is available.

Despite all the complications, applying dialysis catheters is still common. According to the annual report of the United States Renal Data System (USRDS), about 63% of patients use a vascular catheter for their first dialysis treatment in the United States. Only 16% of patients use AVF for vascular access for the first dialysis. 81% of patients use dialysis

catheters and consider it the only vascular access method while waiting for AVF maturity [27, 28].

Table No. 4 Duration of temporary dialysis catheter functioning according to gender

Characteristics	Average	Standard deviation	min	max	p-value
male	50.83	16.99	7	78	0.033
female	43.36	16.57	6	68	
total	41.46	17.13	6	78	

*Independent Samples Test was used for statistical analysis
**It is based on the number of months

At first, hemodialysis catheters are prepared for short-term and medium-term hemodialysis access for AVF maturation required permanent access. In the late 90s, using these semi-permanent catheters as permanent access in chronic hemodialysis patients increased[29]; because of benefits include: the ease of implantation, the increase in the proportion of elderly and diabetic patients with unsuitable vessels for AVF implantation, and patient personal choice [30].

As mentioned, the number of patients requiring chronic hemodialysis increases every day, and preparing the appropriate access method for these patients is one of the most important tasks of vascular surgeons. Arteriovenous fistulas are the best access

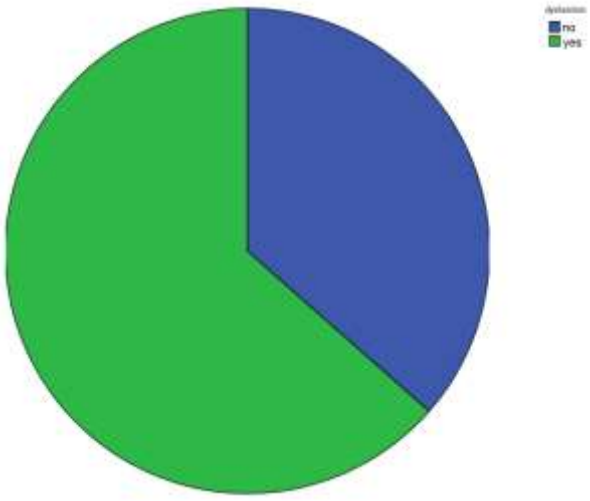


Figure1. The number of effective temporary dialysis catheters until the preparation of arteriovenous fistula

method for hemodialysis; however, they require an average interval of two months from the time of implantation to the time of use. Although most scientific sources recommend the use of tunneled catheters for hemodialysis in this period and recommend temporary catheters for fewer than 2 weeks, these economic restrictions and lack of equipment, due to sanctions in many cases, forced us to rely on temporary catheters until the arteriovenous fistula can be used. This study aimed to determine the success rate of temporary dialysis catheters in this period until the maturation of the arteriovenous fistula and the affecting factors.

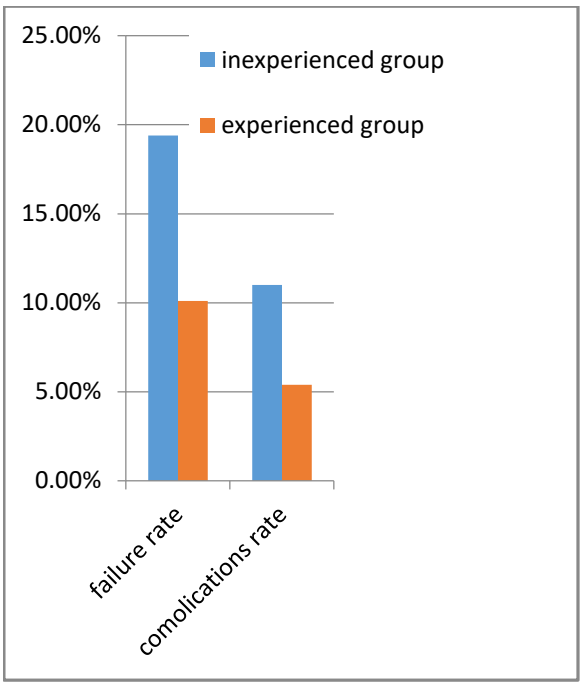


Figure 2. failure rate and complications rate in experienced and inexperienced groups

Materials and Methods

Design

This study was conducted as a descriptive, cross-sectional study on all eligible patients who were candidates for hemodialysis catheter placement referring to 5 Azar and Sayad Shirazi hospitals in Gorgan-Iran in 2021. Patients who did not need permanent dialysis, underwent catheter insertion or replacement more than once, died before the end of the catheter's effectiveness period, did not follow up, and did not have functioning or maturity of the fistula; were excluded.

According to the information available in the medical centers of Gorgan city, it is predicted we were facing an average frequency of 100 patients, and after

the completion of the study period, 74 patients were considered.

Data collection tools and methods

The data were collected by reviewing the medical records of the patients. For all patients, vascular access from the right internal jugular vein was implanted by a vascular surgeon or a fourth-year general surgery assistant to perform hemodialysis, and an arteriovenous fistula was implanted by a vascular surgeon. Patients were monitored and followed up during the study period, and necessary standard treatments were performed according to the conditions of each patient. Patients with a history of long-term complications occur such as infection, thrombosis, closure of the catheter path, catheter removal, and catheter failure, and the information of each patient is recorded and the catheter was removed. Patients were evaluated and examined until the maturity of the arteriovenous fistula happened, and during this period, the fate of the temporary dialysis catheter (either working or not working for any reason) was recorded. The results were analyzed after being entered into the statistical software.

The collected data included: demographic characteristics, medical history, medication use, and duration of catheter use, duration of end-stage renal disease and hemodialysis, and possible long-term complications from catheter implantation.

Data analysis method

The collected data were analyzed by SPSS-16 statistical software. The Chi-square test was used to compare qualitative variables between different groups, and the Student t-test or Way ANOVA was used to compare quantitative variables between groups. P-values less than 0.05 are considered significant.

Ethical considerations

The permission of all patients was obtained after a full explanation of the study. The names and information of the people studied were completely confidential and the information of the people did not use together with the identity information. All patients were under the direct and continuous supervision of the doctor, and any possible side effects were monitored, and in case of serious side effects, (although very rare and with very low probability), the standard treatment was started for the patient. Patients were free to withdraw from the study at any time if they did not want to continue the study, and coercion or cost did not impose on them. All information was kept confidential by the researcher after obtaining informed consent from the participants. An intervention was carried out completely according to international standards and guidelines without any harm to the study subjects.

Results

Demographic factors

In this study, 74 eligible people were considered, based on predetermined goals and study methodology. 39 (52.7%) of the studied people were female and 35 (47.3%) were male. The average age was 53.03 ± 14.79 years, the lowest age was 18 and the highest age was 85 years. The average age of male and female was 53.26±14.13 and 52.77 ± 15.70 years respectively.

Based on the extracted data, the body mass index (BMI) was (mean ± standard deviation) 25.70 ± 3.72 kg/m2, these values for female and male patients, respectively were 26.28 ± 24 and 2.97 ± 25.05 kg/m2, which had no statistically significant difference.

Additional information is available in Table No. 2.

Past medical history, duration of chronic renal disease and duration of dialysis in examined patients

The disease records, the duration of chronic kidney disease and the duration of dialysis of the patients were carefully examined and evaluated.

50 patients (67.6%) had a history of cardiovascular diseases in their past medical histories, which included 69.2% of women (27 out of 39) and 65.7% of men (23 out of 35). This difference did not indicate a statistically significant difference between the two sexes.

Also, 44 patients (59.5%) had a history of diabetes in their past medical histories, included 59% of women (23 out of 39) and 60% of men (21 out of 35). This difference also did not indicate a statistically significant difference between the two sexes. More details can be seen in table 3.

Examining the duration of operation of the jugular Shaldon in the examined patients

Based on the findings, the duration of operation of the temporary dialysis catheter, Shaldon Jugular was 46.41±17.13 days in the studied patients, the minimum duration was 6 and the maximum was 78 days. The

Table 5. Duration of temporary dialysis catheter functioning based on underlying disease

p-value	95% Confidence Interval of the Difference		Standard deviation	Average	Frequency		variables	
	Lower	Upper						
0.005	-18.64 -19.93	-5.07 -3.79	10.79 18.33	42.56 54.42	24 50	no yes	Cardiovascular disease	Underlying disease
0.533	-10.12 -10.73	4.99 5.60	13.32 19.26	47.97 45.4	29 45	no yes	diabetes	
0.686	-8.63 -9.51	13.03 13.91	17.51 17.17	48.25 46.05	12 62	2times 3times	Number of dialysis per week	
0.654	-5.78 3.59	13.44 13.63	15.22 14.17	57.11 50.68	27 47	functional dysfunctional	Age (years)	
0.138	-0.15 -0.34	3.37 3.56	4.40 3.17	26.72 25.11	27 47	functional dysfunctional	BMI، Kg/m^2	

*Independent Samples Test was used for comparison

Shaldon jugular operations duration for male and female patients studied was 50.83 ± 16.99 and 43.36 ± 16.57 days respectively, which showed a statistically significant difference based on statistical analysis (Table No. 4). Also, the duration of temporary dialysis catheter efficiency based on the underlying disease, the duration, and times of dialysis per week was also analyzed, and additional information is available in Table No. 5.

Investigating the number of efficient temporary dialysis catheters until the preparation of arteriovenous fistula in the patients

Based on the findings of the study, out of 74 studied patients, 47 patients (63.5%) were implanted with a temporary jugular dialysis catheter until the maturity of the arteriovenous fistula, without complications, and 27 patients (36.5%) needed re-implantation to continue dialysis until the maturity of the arteriovenous fistula. The time required for the maturity and readiness of the arteriovenous fistula was reported 57 ± 9.48 days.

Discussion

Early symptoms

Complications that occur during or near the time of central venous catheter insertion are called early complications. Complications are categorized as cardiac, vascular, pulmonary, and catheter complications [29]. These problems are caused by difficulties that occur during a central venous catheter insertion procedure. Therefore, to reduce the occurrence of these complications, it is important to deal with these errors, how to create complications and how to manage them. In 1986, a group of physicians conducted a prospective study and recorded 714 attempts at central venous catheterization during eight months in the intensive care unit (ICU) [31]. The frequency of catheterization failure and early complications (among three common sites) were determined. The procedures were performed by two groups, the first group was experienced doctors and assistants and the second group included inexperienced trainees and assistants. The overall failure rate was 10.1% for the experienced group and 19.4% for the inexperienced group. The rate of complications was 5.4% for the experienced group and 11% for the inexperienced group [31]. (figure2)

Late symptoms

Delayed complications of central venous catheter insertion include infection and device dysfunction blurt more gradually and take weeks to months after central venous catheter placement [29].

Infection: Central venous catheter infection can lead to sepsis, shock, and death. The incidence of central venous catheter-related infection is 80-189 per 100,000 patients-years. The average additional cost of

each infection is about $16,550. The reported patient mortality is also between 12 and 25% [32]. Infections are associated with biofilm formation on venous catheters, and Staphylococcus Aureus and Staphylococcus Epidermidis bacteria are two common pathogens [29, 31-34]. If a central line bloodstream infection is suspected, two blood cultures should be obtained from separate sites before starting broad-spectrum antibiotics [29]. Broad-spectrum antibiotics should be cultured based on their sensitivity [35].

Catheter Malfunction: Catheter Malfunction is when there is a problem with the mechanical parts of the central venous catheter. A malfunction of one of them can lead to delayed complications such as fibrin sheath, catheter breakage, thrombosis, stenosis, or infection. The catheter dysfunction is directly related to the placement of the central vein, the duration, and the patients underlying diseases. Formation of a fibrin sheath can occur within the first week of central line insertion and can obstruct distal openings. This reduces the ability to eject blood from the catheter. For treatment, fibrinolytic such as Alteplase can be administered to dissolve the fibrin sheath, and in cases where fibrinolytics are unsuccessful, stripping can be performed[15, 31, 36-43].

Central venous stenosis or occlusion (CVS/O), a complication of central venous access devices (CVADs), may compromise future venous access and lead to venous stasis [43-46]. CVS/O may result from injury. During central venous catheter placement or central venous catheters placed with turbulent flow, repeated trauma, intimal hyperplasia, endothelial denudation, and adherent thrombosis occur [47-49] and may be asymptomatic or symptomatic (e.g., ipsilateral limb or neck edema) and with thrombosis. According to studies, the most common risk factor for venous thromboembolism in children is CVAD [46-52].

Venography is not routine during CVAD implantation. In patients, stenosis, obstruction, and venous collateral vessels often occur in venography performed during the placement of a peripheral central venous catheter (PICC) problem [28]. It is unclear what prior vascular access events lead to CVS/O, for example, CVAD variants, infection, or thrombosis. It is also unclear what the clinical implications are for patients' future vascular health if CVS/O is found (e.g., risk of future thrombosis, post-thrombotic syndrome, loss of central venous access)[52-54].

The mentioned symptoms cause the use of temporary dialysis catheters to have more time limits, therefore, in most studies, a limited use time should be considered for them. For example, femoral catheters are limited to use for emergency dialysis or during a limited period of hospitalization [55-58]. In some studies, the efficacy and side effects of femoral catheters have been reported to be similar to jugular catheters [59], however, in many references; jugular catheterization is still the first choice in the implantation of dialysis catheters, whether temporary or permanent. However, in general, the use of tunnel-less catheters for hemodialysis for less than two weeks, even for patients with acute kidney injury, is practiced and recommended due to the increased risk of infection compared to tunneled hemodialysis catheters. While recovery from acute kidney injury requiring hemodialysis is very difficult to predict, only a small number of patients requiring dialysis recover renal function in less than one week [60].

The recent study proved that more than 60% of the temporary jugular dialysis catheters implanted at the time of arteriovenous fistula implantation for the studied patients were functional at the time of fistula maturity and efficiency, and the patients needed re-implantation of the temporary or tunneled catheter. They did not find the direction of dialysis.

According to the findings of recent research, Shaldon's dysfunction is more associated with increasing age, female gender, and having no history of cardiovascular disease, and these people, during the waiting period for fistula maturation, needed re-catheterization, on the other hand, in people with history They had cardiovascular disease, the duration of the temporary dialysis catheter was longer than the others with a statistically significant difference, the use of antiplatelet drugs and statins can justify the increase of the catheter in this category of patients[26-31, 33].

Also, the results of our research showed that if the factors affecting the dysfunction and inefficiency of the catheter are limited in the use of the temporary jugular dialysis catheter, the useful life of the use of the mentioned catheters will be increased and this in the conditions of limited financial resources and We are faced with the political problem of providing long-term dialysis catheters, it is necessary to solve the problems of the patients. It should be mentioned that

some patients were studied due to the two-week nature of Shaldon and referral to colleagues outside the research plan, which as usual The temporary catheter is expected to be replaced after two weeks, thinking that they feel more comfortable with a tunneled catheter or thinking that the catheter must be replaced, even before a simple manipulation, they removed and inserted a permanent catheter, which increased the statistics from the level The expectation of the research team was lower. On the other hand, the patients who were excluded from the study due to the failure of the fistula were mostly those who could increase the average life of Shaldon, because they were dialyzed for months with the same initial Shaldon.

In overall although the duration of temporary dialysis catheter use has been reported to be limited in other studies, it is possible to increase the time of their use in patients depending on the conditions and considering some factors. These factors include careful selection of the patient and Observing factors such as the history of heart disease, ASA and statin use, young age, male gender, and low BMI. In communities with limited financial resources in their healthcare system and the inability to provide permanent catheters based on some considerations, this can be a considerable temporary alternative procedure.

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Author contribution

P.K: designing the study, editing the manuscript, reading and approving the final version of the manuscript before submission

D.M: Data collection, data analysis, literature review.

A.A and I.S: Writing the first draft of the article, literature review, editing the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest in the present study.

Ethical declaration

This study has been evaluated and accepted by Biomedical Research Ethics committee with ethical code number of IR.GOUMS.REC.1400.353 (https://ethics.research.ac.ir/IR.GOUMS.REC.1400.353)

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