Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v30i17.2750

HEMODIALYSIS CATHETER EXCHANGE WITH DOUBLE-WIRE GUIDANCE: SHOULD IT BE USED MORE WIDELY IN TUNNELED CATHETER REPLACEMENT?

Davut Azboy[1*], Zeki Temiztürk[2]

[1*]Elazığ Fethi Sekin City Hospital, drazboy@gmail.com,orcid: 0000-0001-5174-9378
[2]Başakşehir Çam Sakura City Hospital, Zekitmztrk5806@gmail.com, Orcid: 0000-0002-9357-6345

***Corresponding Author:** Davut Azboy
*Elazığ Fethi Sekin City Hospital, drazboy@gmail.com,orcid: 0000-0001-5174-9378

Abstract
Aim: To report the outcomes of using the same-access double wire (SA-DW) method for replacing tunneled hemodialysis catheters in cases of cuff extrusion or catheter insufficiency, through an approach which utilizes the same tunnel and venous insertion site over two guidewires.

Methods: This was a prospectively planned observational study conducted between January 2021 and July 2022. A total of 50 patients who underwent tunneled hemodialysis catheter exchange with the SA-DW method were included in the study. The outcomes of a total of 69 exchange procedures were evaluated. Each catheter exchange was considered an independent event (or, for simplicity, an independent patient). Patients' age, sex, comorbidity data, the duration of chronic renal failure, and catheter procedure-related events were recorded.

Results: Patients' ages ranged from 34 to 92 (mean: 65.18 ± 13.68 years), and 68.12% (n = 47) were female. A new catheter was inserted with the SA-DW method through the internal jugular vein in 42 (60.87%) patients, and in the femoral vein in 27 (39.13%) patients. Early (0-3 days), midterm (4-30 days), and late (>30 days) complication rates were 21.7% (n = 15), 2.9% (n = 2), and 44.9% (n = 31), respectively. Catheter-related hospitalization rate was 28.99%. Catheter exchanges were performed due to infection in 11.6%, and mortality rate due to catheter infection was 2.9%. Successful utilization of exchanged catheters was 62.3% during the follow-up period. Two patients (2.90%) died due to catheter-related infections.

Conclusion: Tunneled hemodialysis catheter exchange with the SA-DW method may facilitate easier application and better vascular protection in recurrent catheter exchanges.

Keywords: Tunneled hemodialysis catheter, catheter exchange, same access double wire method, end-stage renal disease, catheter insufficiency, cuff extrusion

INTRODUCTION
End-stage renal disease (ESRD) continues to be an important health problem worldwide (1). Hemodialysis is the best renal replacement modalities in patients with ESRD (2, 3). However, vascular access, which is required for hemodialysis applications, is one of the issues that patients with ESRD suffer most (2, 4).

National and international guidelines recommend the creation of arteriovenous fistulas (AVF) as the first line of vascular access for hemodialysis (5-8), and AVF is recognized as the best vascular access option today, especially in patients requiring long-term hemodialysis (9, 10). However, AVF has some disadvantages such as the need for maturation, which takes around 6 or more weeks (11), and also AVF may not be the most appropriate option for patients with heart failure, chronic respiratory problems, multiple co-morbidities and sclerotic vessels (12). Temporary or permanent (tunneled) hemodialysis catheters (T-HDC and P-HDC, respectively) are alternative vascular access options for these patients (3, 9). Because the relative risk of infection and dysfunction is higher with T-HDC than with P-HDC (13), T-HDC is only recommended in emergency situations and in patients who will need hemodialysis for a short period (often until AVF maturation) (9, 13-15). However, P-HDCs are not completely devoid of various disadvantages and may cause immediate, short-term or long-term complications such as central venous occlusions, arterial puncture, hematoma, pneumothorax, hemothorax and air embolism (14, 16-18). The most undesirable complication of P-HDC, due to long-term use and repeated catheter exchange, is stenosis and loss of the vascular access (4, 17). This situation is especially important for patients who do not have a chance for AVF (4, 17). Since patients with ESRD have limited vascular access options (18), each vascular access point must be valued as if there were no alternatives. Unfortunately, due to factors such as infection, stenosis, catheter dysfunction or cuff extrusion, P-HDCs may result in permanent stenosis, rendering the vessel unusable for hemodialysis (4, 17). For these reasons, researchers seek to minimize the negative effects of catheter exchange, and new methods continue to be presented (19, 20).

It is generally accepted that insertion of a new catheter from the same vein (from a different site) or from a different vein both increase the risk of vessel loss (17, 21). For this reason, many physicians have adopted over guidewire exchange (OGWE) methods with use of stiff wires to place the new catheter in the same vascular access (18, 21). Although some authors have reported OGWE performed using two guidewires in patients who had difficulty or thrombosis (4, 21), to our knowledge, no research has been conducted to examine the impact of this approach to tunneled P-HDC exchange on the outcomes of new catheters (using the same tunnel and venous insertion site with two guidewires), when it is performed for reasons other than thrombosis or infection. Therefore, in this study, we aimed to present the outcomes of using the same-access double wire (SA-DW) method for replacing tunneled hemodialysis catheters in cases of cuff extrusion or catheter insufficiency, through an approach which utilizes the same tunnel and venous insertion site over two guidewires.

MATERIAL AND METHODS

Ethical issues

The study was initiated with the approval of the Ethics Committee of Firat University Faculty of Medicine with date: 12.01.2023 and no: 2023/01-14. The principles outlined in the Declaration of Helsinki were followed. All patients included in the study provided written informed consent for participating in the study and the use of their data.

Study design, setting and population

This was a prospective, observational, single-center study conducted between January 2021 and July 2022 at the Department of Cardiovascular Surgery, Fethi Sekin City Hospital Elazığ, Turkey.

A total of 50 patients who underwent tunneled hemodialysis catheter exchange with the SA-DW method were included in the study. Patients younger than 18 years, those undergoing catheter exchange due to catheter infection or total thrombosis, patients treated for catheter infection in the last month or more than two catheter infections in the last year, and patients being changed from a temporary catheter to a permanent catheter were excluded from the study. A total of 69 catheter replacement procedures who met the inclusion criteria on these 50 patients were included.

Data collected
Patients' age, sex, and comorbidity information, duration of chronic renal failure (CRF), and data on previous catheter procedures were noted.

The tunneled P-HDC exchange procedure
Before making the decision for the procedure, the basic blood and coagulation parameters of the patients were checked. The procedure was planned for patients with a platelet level of 50000 and above and those without a risk of bleeding in coagulation tests. All patients were operated under sterile operating room conditions, in the hybrid operating room, by the same surgeon. After the patients were placed on the operating table catheter dysfunction was evaluated with imaging. The area to be operated was thoroughly cleaned with povidone iodine solution and covered with sterile drapes. First, lidocaine was applied locally to the exit site of the dysfunctional HDC and the subcutaneous tissue surrounding the catheter. Next, the cuff of the dysfunctional catheter was explored using scissors and a clamp, and the fibrin sheath was removed. The 0.38 guidewire from the new HDC set (14.5-Fr and lengths of 19, 23, 28, 33, and 55 cm) was inserted separately into the vein cannula and the 0.35 hydrophilic wire was inserted separately into the arterial cannula of the dysfunctional HDC. Using a scope, the ends of both guidewires were advanced through the dysfunctional HDC, with a preference for reaching the vena cava inferior (VCI) to avoid cardiac arrhythmia. Once confirmed that the guidewires had passed beyond the VCI, the dysfunctional HDC was removed with the guidance of the wires. The ends of the wires outside the skin were cannulated separately through the artery and vein cannulas of the new HDC, which was then advanced under the guidance of the wires, starting from the old tunnel entrance until it reached the appropriate position in the right atrium. The wires were then removed, and blood flow through the new HDC was checked using a 20cc syringe from two separate inlets. A sufficient amount of heparinized saline solution was flushed from both ports to ensure proper functionality. The entry site of the new HDC in the skin and the tunnel were washed with an ampoule of rifampicin using an intravascular branul, and the catheter was secured with 2/0 prolene at the exit site. Finally, appropriate closure was achieved with a pressure dressing.
The patients who did not experience any problems during or after the procedure were discharged safely 2 hours after the procedure. Patients with bleeding or leakage at the catheter site were followed up with pressure dressing and appropriate weight on the tunnel until the leakage or bleeding stopped. After discharge, the patients were called for control at regular intervals after the procedure, and their dialysis processes were also followed. Complications, follow-up times, and final status were noted. In case of failure of the applied procedure, the patient was referred to the Interventional Radiology Department for evaluation. Images were acquired to assess the tip position of the new catheter, catheter folding, or the presence of the fibrin sheath. If a fibrin sheath was identified, the replacement procedure for the catheter was performed using the same method (SA-DW) after breaking the sheath with a balloon catheter. Patients who developed thrombus or deep vein thrombosis were treated with anticoagulation, while those who developed catheter-related infections were managed with antibiotics according to the previously described protocol (4). Antibiotic selection was adjusted to match blood culture types and susceptibility results (4). The patient's blood cultures, infection markers and body temperature were expected to return to normal levels before catheter re-exchange. Antibiotic treatment was continued for 3 weeks after re-exchange. These and subsequent catheter re-exchanges of patients undergoing catheter exchange due to infection and thrombus were not included in the study. Each catheter exchange was considered an independent event (or, for simplicity, an independent patient).

Definitions
Technical success was defined as completion of at least one hemodilysis session with a flow of 300 mL/min after exchange from a tunneled to a tunneled catheter (5).

Early complications was defined as those occurring within the first 3 days after catheter replacement. Midterm complications were defined as those that developed within 4-30 days after the catheter exchange. Late complications were defined as the complication developing 30 days after the catheter exchange.

Catheter insufficiency was defined as the inability to maintain adequate blood flow velocity for reasons other than thrombus, fibrin sheath formation or catheter malposition (such as catheter folding or cuff extrusion), because these were evaluated separately. Catheter tip thrombosis was defined as the inability of the catheter to maintain adequate blood flow velocity due to thrombi or fibrin (4).

The definition of catheter-related infection included three situations: catheter-related bacteremia (defined as positive blood culture taken from the catheter of a febrile patient without any other infection), exit-site infection (defined as the presence of a discharge from the tunnel exit or soreness without any tenderness over the tunnel) and tunnel infection (defined as as the presence of discharge from the tunnel exit and tenderness or induration over the tunnel) (13).

Detection of catheter tip shift from its original position to an inappropriate area was defined as malposition, and any corrections performed for these cases were defined as revisions.

Duration of follow-up was determined as the time between catheter replacement and the end date of the study. According to the final status, catheter revision, catheter exchange and catheter-related mortality were considered to be catheter failure.

Statistical Analysis

All analyses were performed on IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). For the normality check of numerical variables, the Shapiro-Wilk test was employed. Data are given as mean ± standard deviation or median (minimum - maximum) for continuous variables according to normality of distribution, while frequency (percentage) are used to summarize categorical variables.

RESULTS

A total of 69 catheter exchanges were performed in 50 patients. Each of these 69 exchanges was considered a separate case. Patients' ages ranged from 34 to 92 years, with a mean of 65.18 ± 13.68 years. Of the participants, 68.12% (n = 47) were female. The median duration of chronic renal failure was 5 years (range 1-12 years). Before the SA-DW method was used, more than 1 catheter change had been performed in 73.01% of the patients. The reason for catheter replacement was catheter insufficiency in 64 patients (92.75%) and cuff extrusion through the skin in 5 patients (7.25%). All catheter exchange procedures using the SA-DW method were technically successful, and no patients developed arrhythmia. A new catheter was inserted through the internal jugular vein in 42 patients (60.87%) and through the femoral vein in 27 patients (39.13%). The median follow-up time was 127.5 days (range 15-404 days).

Early complications included leakage in 11 patients (15.94%) and bleeding in 4 patients (5.80%). Catheter replacement was performed again in 3 patients with leakage due to later failures. Midterm complications included deep vein thrombosis in one patient (1.45%) after 20 days and thrombus in one patient (1.45%) after 15 days. Catheter-related problems after 30 days included infection in 17 patients (24.64%) [8 (11.6%) of whom underwent catheter replacement], insufficiency in 9 patients (13.04%) (catheter replacement was applied to all of them), malposition in 2 patients (2.90%) (revision was performed in one of them, and another underwent catheter exchange), and thrombosis in 3 patients (4.35%) (all underwent catheter exchange). Eighteen patients were hospitalized once, and 2 patients were hospitalized twice for catheter-related issues. In the final status, 29 patients (42.03%) continued to use the same catheter. The catheter was removed in 11 patients (15.94%) because the AVF matured. The catheter was revised in 1 patient (1.45%). Re-catheter exchange was performed in 23 patients (33.33%). Two patients (2.90%) died due to multi-organ failure caused by catheter-related infection. Three patients (4.35%) died of causes not directly related to the catheter. The percentage of failed catheters was 37.68% (n = 26) (Table 1).

DISCUSSION

In this study, we aimed to present the results of tunneled catheter exchanges using the SA-DW method. With this method, the early complication rate of the catheter exchange procedure was 21.7%, the midterm complication rate was 2.9%, and the late complication rate was 44.9%. Although all procedures were technically successful, overall failure rate was 38.7% during the follow-up.

Tunneled catheters are an important vascular access alternative in patients receiving long-term hemodialysis when AVF is not used (2); however, over time, they may cause higher infection, thrombosis, central venous stenosis and catheter dysfunction rates (5, 6). Studies have shown that the incidence of stenosis after catheter placement varies between 20% and 50% for subclavian veins and up to 10% for internal jugular vein (22-24). All of these result in short-lived patency and necessitate repetitive catheter replacements. In a study by Sepas et al., it was suggested that the patency duration of permanent tunnelled catheters was 5.65 ± 4.57 months (25). Similarly in another study, mean 1-year primary patency rates of 65–75% were reported (range, 3%–74%) (21). It has been established that these rates are lower in femoral catheters (4). Philipneri et al. showed that routine exchange of tunneled, cuffed catheters over a guidewire in hemodialysis catheter patients presenting with bacteremia can significantly reduce serious infectious complications such as epidural abscess or vertebral osteomyelitis (26). Therefore, the tunneled catheter should be exchanged periodically. However, increased cannulation procedures from the same vessel and prolonged cannulation time are reported to be risk factors for vascular stenosis and loss (4). Given that cuffed tunneled catheters are used by more than one-third of the population afflicted with ESRD (2) and that patients with ESRD have to receive hemodialysis for the rest of their life, it is vital to minimize exchange-related complications. Fr this purpose, catheter exchanges should be performed using methods that will minimally traumatize the central vessels.

Many studies have demonstrated the efficacy and safety of the tunneled catheter exchange with the OGWE method (18, 27-30) using the same tunnel (2, 13, 18) or a new tunnel (19). OGWE has become a standard of care in tunneled dialysis catheter management as a way to preserve venous access (18). Also, it has been reported in previous studies that the OGWE does not increase the risk of infection and post-procedure bleeding after catheter insertion (28-30). Perhaps most importantly, it is possible to prevent stenosis of a punctured or central vessel by reducing the extent of the vessel injury with OGWE (13). However, in the OGWE technique, it is sometimes difficult to advance the catheter over a single wire (18). To overcome this challenge, stiffer wires can be used (21) or double-wire insertion can be utilized (18). The single wire technique is estimated to account for 95% of OGWEs (18). However, there is limited data on the success of double-wired approaches compared to single-wire or stiff-wire approaches.

In the present study, we found the early complication rate (0-3 days) to be 21.7% (n = 15) in the tunneled catheter exchange using the SA-DW method. Of these complications, all of which were non-severe, leakage occurred in 11 (15.94%) patients and bleeding occurred in 4 (5.80%) patients. The midterm complication (4-30 days) rate was 2.9% (n = 2). Deep vein thrombosis occurred in 1 (1.45%) patient after 20 days, and thrombus formation occurred in 1 (1.45%) patient after 15 days. The complication rate after 30 days was 44.9% (n = 31). Of these, 17 (24.64%) were catheter-related infections, 9 (13.04%) were catheter insufficiency, 2 (2.90%) were catheter malposition and 3 (4.35%) were catheter-type thrombosis. Catheter-related hospitalization rate was 28.99%. During the follow-up period, the rate of catheter exchange due to infection was 11.6%, and the mortality rate due to catheter infection was 2.9%. Two patients (2.90%) died due to catheter-related infection. In a similar study, two guidewires were used in some problematic catheter exchanges and in the removal of the existing tunneled catheters followed by insertion a new catheter after balloon dilation (21). The authors reported that the immediate technical success rate for these two techniques was 100% and there were no early complications (21). Additionally, the cumulative rates of persisting catheter function were reported: demonstrating 73% (for only catheter exchange) and 65% (catheter exchange after balloon dilatation) functionality after 1 month, 43% and 39% at 3 months, and 28% and 39% at 6 months (21). In yet another study, exchange of thrombosed tunneled femoral catheters was reported using the same tunnel, same access, and two wires (one of which was a super-rigid hydrophilic guidewire inserted to guide the balloon catheter) (4). However, the primary aim of this study (4) was not to investigate the success of the over two-wire guided exchange procedure, but to evaluate the outcomes of tunneled femoral vein catheter. As we mentioned before, published studies on catheter replacement with double wire are quite limited, and these studies have usually assessed the use of double wire for the replacement of dysfunctional catheters due to thrombus. In a study of pediatric patients, the results of catheter replacements with the classical (remove and replace) and the single-wire OGWE (same tunnel and same vessel) were reported respectively as follows: catheter-related bacteremia 46% and 43%, malfunction/cuff extrusion 22% and 20%, elective removal 32% and 37%, overall catheter survival (days) 198 ± 130 and 215 ± 158, and infection-free catheter survival 117 ± 81 and 141 ± 108 days (31).

Various rates have been reported for hemodialysis catheter infections in the literature. In one study, the rate of infection after a tunneled cuff catheter was 6.25% (2), while in another it was 81.1% (after 6 months) (32). These rates may be even higher in femoral catheters (4). For example, in one study, 22 (25.6%) of 86 tunneled femoral catheter procedures, including catheter changes, were later replaced due to infection (4). The National Kidney Foundation-Dialysis Outcomes Quality Initiative (NFK/KDOQ) Guidelines previously described a catheter-related infection rate of less than 10% at 3 months and less than 50% at 1 year (5). The rates of catheter infection and infection-related catheter exchange in our study were lower than the literature and at an acceptable level. The reason for this success may be the empirical administration of rifampicin to the tunnel exit site.

With respect to the literature, our findings appear to show that hemodialysis catheter exchange with the SA-DW method reduces the risks for infection, infection-related catheter replacement, infection-related death, need for catheter revision, and catheter failure. In addition, the early bleeding rates obtained in our study are consistent with the rates reported previously (2, 33). We have shown that the use of SA-DW method in tunneled hemodialysis catheter exchanges performed for non-thrombus or non-infectious reasons provide both ease of application, and acceptable infection, complication and failure rates. For instance, we performed 8 tunneled catheter exchanges in the right femoral vein (throughout 3 years) in a patient whose jugular veins, subclavian veins and left iliac vein were completely thrombosed as a result of multiple catheter intervention. If this patient had had catheter changes with the SA-DW method in the past, it may have been possible to prevent thrombosis in some of these veins. We believe that with this method, which is less traumatic and easier to apply than single-wire and de novo catheters, vascular access reserves of patients who need long-term hemodialysis treatment can be preserved more effectively. We suggest further studies be conducted to demonstrate the feasibility of this method in tunneled catheter exchanges due to thrombosis and infection.

To the best of our knowledge, this is the first study to present the outcomes of tunneled catheter replacement required for non-infectious and non-thrombotic reasons using the SA-DW method. However, it is important to consider some limitations when interpreting the results of the study. Firstly, it is a single-center study, which may limit the generalizability of the findings. Additionally, the sample size is relatively small, although we believe it is appropriate given the specific patient group included in the study. Each procedure was evaluated as a separate case, taking into account factors such as patient age, number of previous catheter changes, and duration of chronic renal failure. While this approach may have biased the distribution of factors such as morbidity and sex, it was necessary to ensure accurate evaluation of each procedure. Long-term follow-up data, including duration of catheter patency, was not studied in detail. Furthermore, there was no control group used to compare the results to another method. Although no exclusions were made regarding follow-up periods, some patients had short follow-up periods. It is also worth noting that only patients with catheter insufficiency and cuff dislocation were included, and further studies are needed to determine the success of the SA-DW method on catheter exchanges performed for other reasons, such as thrombus or infection.

In conclusion, tunneled hemodialysis catheter exchange with SA-DW method provided acceptable rates for complication, catheter infection, catheter replacement, and mortality due to infection, and failure. This method may provide an easier application and better vascular protection in recurrent catheter exchanges. But the results need to be confirmed with more comprehensive studies.

REFERENCES

1. Yang CW, Harris DCH, Luyckx VA, Nangaku M, Hou FF, Garcia Garcia G, et al. Global case studies for chronic kidney disease/end-stage kidney disease care. Kidney international supplements. 2020;10(1):e24-e48.
2. Vaidya S, Karmacharya RM, Bhatt S, Bhandari N, Duwal S, Karki YD, et al. Placement of cuffed tunnelled permanent hemodialysis catheter in patients with end stage renal disease: A cross sectional study. Annals of medicine and surgery (2012). 2022;76:103452.
3. End-stage renal (kidney) disease (from Cleaveland Clinic). Available at: https://my.cleveland clinic.org/health/diseases /16243-end-stage-renal-kidney-disease. (Accessed 15 March 2023).
4. Falk A. Use of the femoral vein as insertion site for tunneled hemodialysis catheters. Journal of vascular and interventional radiology : JVIR. 2007;18(2):217-25.
5. Clinical practice guidelines for vascular access. American journal of kidney diseases : the official journal of the National Kidney Foundation. 2006;48 Suppl 1:S248-73.
6. Vassalotti JA, Jennings WC, Beathard GA, Neumann M, Caponi S, Fox CH, et al. Fistula first breakthrough initiative: targeting catheter last in fistula first. Seminars in dialysis. 2012;25(3):303-10.
7. Jindal K, Chan CT, Deziel C, Hirsch D, Soroka SD, Tonelli M, et al. Hemodialysis clinical practice guidelines for the Canadian Society of Nephrology. Journal of the American Society of Nephrology : JASN. 2006;17(3 Suppl 1):S1-27.
8. Navuluri R, Regalado S. The KDOQI 2006 Vascular Access Update and Fistula First Program Synopsis. Seminars in interventional radiology. 2009;26(2):122-4.
9. Santoro D, Benedetto F, Mondello P, Pipitò N, Barillà D, Spinelli F, et al. Vascular access for hemodialysis: current perspectives. International journal of nephrology and renovascular disease. 2014;7:281-94.
10. Vessel health and preservation: the right approach for vascular access. Moureau NL, editor: Springer Nature; 2019.
11. Park HS, Lee YH, Kim HW, Baik JH, Won YS, Park CW, et al. Usefulness of assisted procedures for arteriovenous fistula maturation without compromising access patency. Hemodialysis international International Symposium on Home Hemodialysis. 2017;21(3):335-42.
12. Lomonte C, Basile C, Mitra S, Combe C, Covic A, Davenport A, et al. Should a fistula first policy be revisited in elderly haemodialysis patients? Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - European Renal Association. 2019;34(10):1636-43.
13. Park HS, Choi J, Kim HW, Baik JH, Park CW, Kim YO, et al. Exchange over the guidewire from non-tunneled to tunneled hemodialysis catheters can be performed without patency loss. The journal of vascular access. 2018;19(3):252-7.
14. Weijmer MC, Vervloet MG, ter Wee PM. Compared to tunnelled cuffed haemodialysis catheters, temporary untunnelled catheters are associated with more complications already within 2 weeks of use. Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - European Renal Association. 2004;19(3):670-7.

15. Rayner HC, Pisoni RL, Gillespie BW, Goodkin DA, Akiba T, Akizawa T, et al. Creation, cannulation and survival of arteriovenous fistulae: data from the Dialysis Outcomes and Practice Patterns Study. Kidney international. 2003;63(1):323-30.
16. Rayner HC, Pisoni RL. The increasing use of hemodialysis catheters: evidence from the DOPPS on its significance and ways to reverse it. Seminars in dialysis. 2010;23(1):6-10.
17. Wellons ED, Matsuura J, Lai KM, Levitt A, Rosenthal D. Transthoracic cuffed hemodialysis catheters: a method for difficult hemodialysis access. Journal of vascular surgery. 2005;42(2):286-9.
18. Hsu M, Trerotola SO. Air embolism during insertion and replacement of tunneled dialysis catheters: a retrospective investigation of the effect of aerostatic sheaths and over-the-wire exchange. Journal of vascular and interventional radiology : JVIR. 2015;26(3):366-71.
19. Leclaire C, Lobbedez T, Henri P, Lanot A, Gautier N, Béchade C, et al. A New Procedure for Guidewire Exchange of Tunneled Hemodialysis Catheters in Chronic Hemodialysis Patients: A Pilot Study. Blood purification. 2023;52(1):91-100.
20. Zhang J, Nie Q, Xu X, He B, Wang X, Wang F, et al. A novel extra-catheter guide wire technique for in situ exchange of dysfunctional tunnelled central venous hemodialysis catheter. The journal of vascular access. 2022:11297298221096520.
21. Janne d'Othée B, Tham JC, Sheiman RG. Restoration of patency in failing tunneled hemodialysis catheters: a comparison of catheter exchange, exchange and balloon disruption of the fibrin sheath, and femoral stripping. Journal of vascular and interventional radiology : JVIR. 2006;17(6):1011-5.
22. Clark DD, Albina JE, Chazan JA. Subclavian vein stenosis and thrombosis: a potential serious complication in chronic hemodialysis patients. American journal of kidney diseases : the official journal of the National Kidney Foundation. 1990;15(3):265-8.
23. Barrett N, Spencer S, McIvor J, Brown EA. Subclavian stenosis: a major complication of subclavian dialysis catheters. Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - European Renal Association. 1988;3(4):423-5.
24. Schillinger F, Schillinger D, Montagnac R, Milcent T. Post catheterisation vein stenosis in haemodialysis: comparative angiographic study of 50 subclavian and 50 internal jugular accesses. Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - European Renal Association. 1991;6(10):722-4.
25. Sepas HN, Negahi A, Mousavie SH, Vosough F, Farazmand B. Patency and outcomes of tunneled hemodialysis catheter via femoral versus jugular vein access. Journal of advanced pharmaceutical technology & research. 2019;10(2):81-4.
26. Philipneri M, Al-Aly Z, Amin K, Gellens ME, Bastani B. Routine replacement of tunneled, cuffed, hemodialysis catheters eliminates paraspinal/vertebral infections in patients with catheter-associated bacteremia. American journal of nephrology. 2003;23(4):202-7.
27. Wang J, Nguyen TA, Chin AI, Ross JL. Treatment of tunneled dialysis catheter malfunction: revision versus exchange. The journal of vascular access. 2016;17(4):328-32.
28. Duszak R, Jr., Haskal ZJ, Thomas-Hawkins C, Soulen MC, Baum RA, Shlansky-Goldberg RD, et al. Replacement of failing tunneled hemodialysis catheters through pre-existing subcutaneous tunnels: a comparison of catheter function and infection rates for de novo placements and over-the-wire exchanges. Journal of vascular and interventional radiology : JVIR. 1998;9(2):321-7.
29. Valliant AM, Chaudhry MK, Yevzlin A, Astor B, Chan MR. Tunneled dialysis catheter exchange with fibrin sheath disruption is not associated with increased rate of bacteremia. The journal of vascular access. 2015;16(1):52-6.
30. Langer JM, Cohen RM, Berns JS, Chittams J, Cooper ET, Trerotola SO. Staphylococcus-infected tunneled dialysis catheters: is over-the-wire exchange an appropriate management option? Cardiovascular and interventional radiology. 2011;34(6):1230-5.

31. Onder AM, Chandar J, Saint-Vil M, Lopez-Mitnik G, Abitbol CL, Zilleruelo G. Catheter survival and comparison of catheter exchange methods in children on hemodialysis. Pediatric nephrology (Berlin, Germany). 2007;22(9):1355-61.
32. Almenara-Tejederas M, Rodríguez-Pérez MA, Moyano-Franco MJ, de Cueto-López M, Rodríguez-Baño J, Salgueira-Lazo M. Tunneled catheter-related bacteremia in hemodialysis patients: incidence, risk factors and outcomes. A 14-year observational study. Journal of nephrology. 2023;36(1):203-12.
33. Abu-Sharkh I, Martinez S, Moas L, Arhda N, Diaz M. Tunneled femoral catheters and tunneled jugular catheters, our experience, efficacy and complications. Arch Clin Nephrol. 2020;6(1):001-4.

TABLES

Table 1. Summary of variables

Age, years	65.18 ± 13.68
Sex	
Male	22 (31.88%)
Female	47 (68.12%)
Comorbidities	
Diabetes mellitus	51 (73.91%)
Hypertension	32 (46.38%)
Coronary artery disease	10 (14.49%)
Congestive heart failure	9 (13.04%)
Chronic obstructive pulmonary disease	4 (5.80%)
Obesity	16 (23.19%)
Peripheral arterial disease	3 (4.35%)
Other	3 (4.35%)
Duration of chronic renal failure, years	5 (1 - 12)
Number of previous interventions	
1	18 (26.09%)
2	32 (46.38%)
3	12 (17.39%)
≥4	7 (10.14%)
Indication of intervention	
Cuff extrusion through the skin	5 (7.25%)
Catheter insufficiency	64 (92.75%)
Side	
Right	57 (82.61%)
Left	12 (17.39%)
Vessel	
Jugular	42 (60.87%)
Femoral	27 (39.13%)
Catheter length	
19 cm	10 (14.71%)
23 cm	26 (38.24%)
28 cm	8 (11.76%)
33 cm	22 (32.35%)
55 cm	2 (2.94%)
Duration of follow-up, days	127.5 (15 - 404)
Early complications (0-3 days)	
Leakage	11 (15.94%)

Bleeding	4 (5.80%)
Midterm complications (4-30 days)	
Deep vein thrombosis	1 (1.45%)
Thrombus	1 (1.45%)
Late complications (>30 days)	
Infection	17 (24.64%)
Insufficiency	9 (13.04%)
Malposition	2 (2.90%)
Catheter tip thrombosis	3 (4.35%)
Catheter related hospitalization	20 (28.99%)
One time	18 (26.09%)
Two times	2 (2.90%)
Final status	
Using same catheter	29 (42.03%)
Catheter removed due to AVF maturation	11 (15.94%)
Catheter revised	1 (1.45%)
Replaced with new catheter	23 (33.33%)
Catheter related mortality	2 (2.90%)
Other mortality	3 (4.35%)
Catheter failure	
No	43 (62.32%)
Yes	26 (37.68%)

Data are given as mean ± standard deviation or median (minimum - maximum) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables.

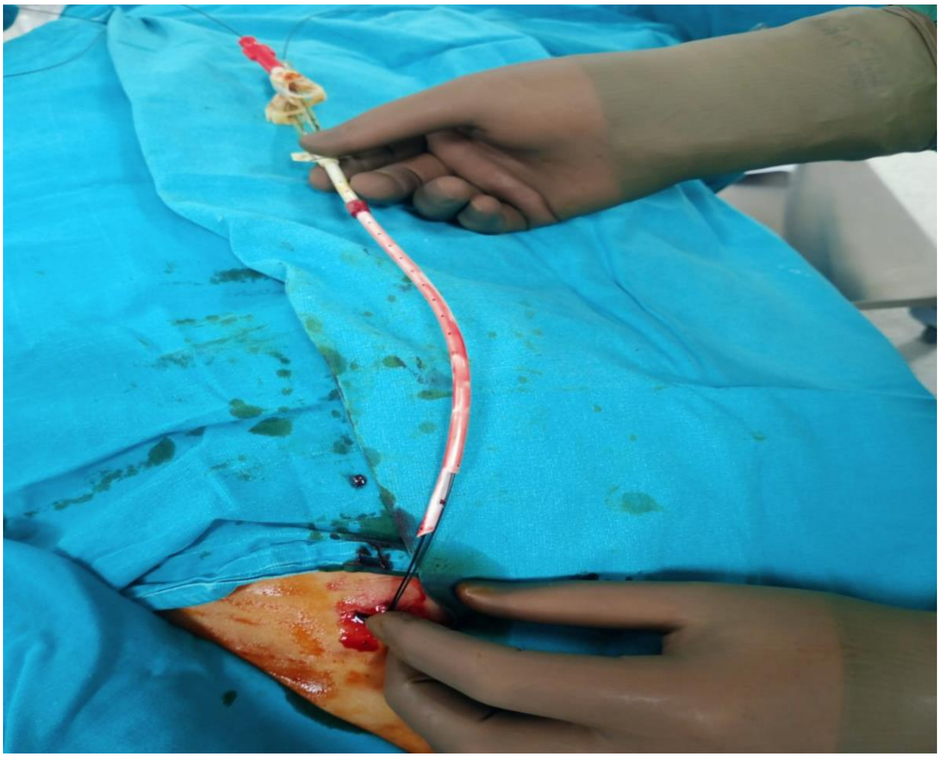
FİGURS 1-

After local anesthesia, the catheter cuff is released

2-

wire is passed through each cannula of the old catheter

3-


the old catheter is withdrawn over the inserted wires

4-

new catheter is made ready for insertion by threading a separate wire into each lumen

5-

the new catheter is advanced under the skin, through the superior vena cava and into the right atrium