Retrospective Evaluation of Pseudoaneurysms in Autogenous AV Fistulas in Chronic Kidney Disease Patients - Insights from a Single Institution Study

Dr. Renuka Paladugula[1], Dr. Archana Rajan[2], Dr. Santhosh VR[3], Dr. S R Subramanniyan[4]

[1] Final year MCH Post Graduate, Department of Vascular Surgery, Saveetha Medical College, Thandalam, Chennai, Tamil Nadu - 602105, India. Email: drrenukapaladugula@gmail.com

[2] Assistant Professor, MCH Vascular Surgery, Department of Vascular Surgery, Saveetha Medical College, Thandalam, Chennai, Tamil Nadu - 602105, India. Email: dr.archanasibi0511@gmail.com

[3] Final year MCH Post Graduate, Department of Vascular Surgery, Saveetha Medical College, Thandalam, Chennai, Tamil Nadu - 602105, India. Email: arztvr@yahoo.in

[4] Professor and Head of Department, MCH Vascular Surgery, Department of Vascular Surgery, Saveetha Medical College, Thandalam, Chennai, Tamil Nadu - 602105, India. Email: presidentvsi@gmail.com

Received: 20th Feb, 2026; **Revised:** 4th Mar, 2026; **Accepted:** 25th Mar, 2026; **Available Online:** 10th Apr, 2026

ABSTRACT

Background

Pseudoaneurysms in autogenous arteriovenous fistulas (AVFs) are a significant complication in chronic kidney disease (CKD) patients undergoing hemodialysis. This can lead to thrombosis, infection, rupture, and access failure, affecting patient morbidity and dialysis efficiency. This study aims to evaluate the clinical presentation, risk factors, microbiological profile, and management outcomes of pseudoaneurysms in AVFs.

Methods

A retrospective observational study was conducted on 250 CKD patients on maintenance hemodialysis at Saveetha Medical College and Hospital, India between January 2018 and December 2023. Patients diagnosed with pseudoaneurysms (n=47, 18.8%) were identified through clinical examination and Doppler ultrasound. Data on demographics, risk factors, clinical symptoms, microbiology, complications, and treatment outcomes were analyzed. Statistical comparisons between patients with and without pseudoaneurysms were performed using chi-square and t-tests, with significance set at $p < 0.05$.

Results

The study cohort demonstrated a mean age of 62.4 ± 10.3 years among patients developing pseudoaneurysms, with a notable male predominance (70.2%). Comorbidities were highly prevalent, particularly hypertension (85.1%) and diabetes mellitus (68.1%). Clinically, the majority presented with a pulsatile mass (83.0%), while significant proportions exhibited skin thinning (36.2%) or local pain (31.9%). The most prevalent risk factor was Catheter-related bloodstream infections (CRBSIs) observed in 80.9% of cases, suboptimal needling techniques (44.7%). Microbiological analysis of infected cases revealed Staphylococcus aureus (50%) as the most frequent pathogen. Rupture/bleeding complications occurred in 29.8% of cases. Regarding management, surgical interventions were done in 75% of cases, conservative management was done in 25% cases with 85% patency rates.

Conclusion

This study confirms pseudoaneurysms as a frequent and clinically significant complication of AVFs in the hemodialysis population, with CRBSI, mechanical factors (repeated needling, aneurysmal degeneration) and comorbidities (diabetes) playing pivotal roles in their pathogenesis. The findings underscore the importance of vigilant surveillance for early detection, with particular attention to patients exhibiting pulsatile masses or skin changes. Optimal management requires a tailored approach incorporating surveillance on catheter directed infections prior to AVF creation, proper cannulation techniques, and consideration of prompt intervention for complicated cases. Future research efforts should focus on multicenter prospective studies to validate these observations and refine evidence-based management protocols, with particular emphasis on strategies to mitigate preoperative CRBSI identification, needling-related trauma and improve long-term vascular access outcomes.

Retrospective Evaluation of Pseudoaneurysms in autogenous AV Fistulas in Chronic Kidney Disease Patients - Insights from a single institution study

Keyword: chronic kidney disease, arteriovenous fistula, infection, pseudoaneurysm, catheter related blood stream infections
How to cite this article: Paladugula R, Rajan A, Santhosh VR, Subramanniyan SR. Retrospective Evaluation of Pseudoaneurysms in Autogenous AV Fistulas in Chronic Kidney Disease Patients - Insights from a Single Institution Study. Int J Drug Deliv Technol. 2026;16(26s): 715. DOI: 10.25258/ijddt.16.26s.86
Source of support: Nil.
Conflict of interest: None

Introduction

Chronic Kidney Disease (CKD) is a significant global health concern, affecting millions worldwide. As CKD progresses to end-stage renal disease (ESRD), hemodialysis becomes a critical treatment modality. The establishment of a reliable vascular access is paramount for effective hemodialysis, with autogenous arteriovenous fistulas (AVFs) being the preferred choice due to their superior patency rates and lower complication profiles compared to synthetic grafts and central venous catheters (1). AVFs are created by surgically connecting an artery to a vein, typically in the forearm or upper arm, allowing for increased blood flow suitable for hemodialysis.

Despite their advantages, AVFs are not without complications. One notable complication is the development of pseudoaneurysms, which are false aneurysms arising from a disruption in the vessel wall, leading to a contained blood leak. Pseudoaneurysms can result from repeated needle punctures during dialysis sessions, surgical technique, or underlying vessel wall pathology (2). They pose significant risks, including rupture, infection, and thrombosis, potentially compromising the efficacy of the vascular access and increasing morbidity among CKD patients (3).

The incidence and management of pseudoaneurysms in AVFs have been subjects of clinical interest. A study by de Paula et al. (2024) assessed the performance of vascular accesses in hemodialysis patients and identified pseudoaneurysms as a prevalent cause of AVF inadequacy, with a prevalence ratio of 6.580 (95% CI: 3.723-11.629). This finding show the clinical significance of pseudoaneurysms in the context of hemodialysis vascular access (4).

Management strategies for AVF-related pseudoaneurysms vary, ranging from conservative monitoring to surgical intervention. Endovascular treatments, such as stent placement, have emerged as viable options, especially in elderly populations (5). A retrospective analysis by Azevedo and Turmel-Rodrigues (2015) evaluated endovascular interventions in nonagenarian patients with AVF complications, including pseudoaneurysms. The study reported a high immediate clinical success rate of 97.4%, with primary patency rates of 60% and 43% at 1 and 2 years, respectively, suggesting that endovascular approaches can be effective even in advanced age groups (6).

While existing literature provides insights into the occurrence and management of pseudoaneurysms in AVFs, there remains a need for comprehensive evaluations within specific patient populations and institutional settings. Retrospective analyses from single institutions can offer valuable data on the prevalence, risk factors, and outcomes associated with pseudoaneurysms, contributing to the optimization of management protocols (7).

This study aims to retrospectively evaluate the incidence, contributing factors, and clinical outcomes of pseudoaneurysms in autogenous AVFs among CKD patients at our institution. By analyzing patient records, surgical techniques, and management approaches, we seek to identify patterns that may inform best practices and improve patient care.

Understanding the specific circumstances under which pseudoaneurysms develop and the effectiveness of various treatment modalities will aid in developing targeted strategies to prevent and manage this complication. Furthermore, insights gained from this single-institution study may serve as a reference for other centers aiming to enhance the durability and safety of AVFs in hemodialysis patients.

This retrospective evaluation will contribute to the body of knowledge on AVF-related pseudoaneurysms, with the goal of improving clinical outcomes for CKD patients undergoing hemodialysis.

Aim:

To evaluate the clinical presentation, risk factors and management of pseudoaneurysms in autogenous arterio-venous fistulas (AVFs) among patients with chronic kidney disease undergoing hemodialysis.

Objectives:

1. To analyze the clinical presentations and symptoms associated with pseudoaneurysms in autogenous AVFs.

2. To identify potential risk factors contributing to the development of pseudoaneurysms in autogenous AVFs
3. To identify the most common microorganism associated with pseudoaneurysms in autogenous AVFs.
4. To measure the time interval from AVF creation to the detection of pseudoaneurysm.
5. Incidence of complications such as infection, thrombosis, rupture, and bleeding related to pseudoaneurysms.

Materials and Methods

This study was designed as a retrospective, single-institution observational study to evaluate the clinical presentation, risk factors, and management of pseudoaneurysms in autogenous arteriovenous fistulas (AVFs) among chronic kidney disease (CKD) patients undergoing hemodialysis. The study involved a review of electronic medical records over a five-year period (January 2018 – December 2023) to assess the incidence, complications, and treatment strategies for pseudoaneurysms in AVFs.

Study Population: The study included adult patients (≥18 years) diagnosed with stage 4 or 5 CKD who were undergoing maintenance hemodialysis with an autogenous AVF as their primary vascular access. Patients were included if they had a confirmed diagnosis of pseudoaneurysm, identified through clinical examination, Doppler ultrasound. Those with arteriovenous grafts (AVGs), central venous catheters, pseudoaneurysms unrelated to hemodialysis, or incomplete medical records were excluded from the study.

Data Collection: Patient data were collected retrospectively from institutional medical records. The following parameters were recorded: demographics (age, sex, dialysis duration, and comorbidities such as diabetes and hypertension), clinical presentation (pain, swelling, pulsatile mass, ulceration, or bleeding), potential risk factors (repeated cannulation, poor needling techniques,catheter related blood stream infection), microbiological profile (bacterial pathogens in infected pseudoaneurysms), time interval from AVF creation to pseudoaneurysm detection, and complications (infection, thrombosis, rupture, and bleeding).

Diagnostic Approach: The diagnosis of pseudoaneurysms was confirmed through a combination of clinical assessment and imaging modalities. Patients presenting with pulsatile masses, skin changes, or bruit underwent Doppler ultrasound to assess flow abnormalities, aneurysmal dilation, and thrombus formation. In patients with suspected infection, blood cultures, catheter tip cultures and pseudoaneurysm aspirate cultures were obtained to identify microbial pathogens and guide antimicrobial therapy.

Management Strategies: The management of pseudoaneurysms was categorized into conservative, and surgical approaches, depending on the size, symptoms, and presence of infection. Conservative management involved ultrasound monitoring and compression techniques for small, asymptomatic pseudoaneurysms. Surgical intervention was performed in patients with large, symptomatic, or infected pseudoaneurysms, including pseudoaneurysm excision, primary AVF repair, or interposition grafting. For infected pseudoaneurysms, patients received empiric antibiotic therapy, followed by targeted antimicrobial treatment based on culture results.

Outcome Measures: The primary outcomes of the study included the incidence of pseudoaneurysms in autogenous AVFs, the prevalence of risk factors, and the identification of the most common microorganisms in infected cases. Secondary outcomes included the time interval from AVF creation to pseudoaneurysm detection, the complication rate (infection, thrombosis, rupture, bleeding), and the success rate of different management strategies.

Statistical Analysis: Descriptive statistics were used to summarize demographic data, risk factors, and clinical presentations. Chi-square and Fisher's exact tests were employed for categorical comparisons, while Kaplan-Meier survival analysis was performed to evaluate AVF patency post-treatment. A p-value of <0.05 was considered statistically significant, ensuring the robustness of the analysis. All statistical analysis was done using SPSS version 25.0.

Ethical Considerations: Ethical approval was obtained from the Institutional Ethics Review Board (IERB) before initiating data collection. All patient data were de-identified to ensure confidentiality, and the study adhered to the ethical principles outlined in the Declaration of Helsinki. No direct patient contact or intervention was involved, minimizing ethical risks.

Results

A total of 250 chronic kidney disease (CKD) patients undergoing hemodialysis with autogenous arteriovenous fistulas (AVFs) were reviewed in this retrospective study. Out of these, 47 patients (18.8%) were diagnosed with pseudoaneurysms, which were confirmed through clinical examination and Doppler

ultrasound. The mean age of the patients with pseudoaneurysms was 62.4 ± 10.3 years, with a male predominance (70.2%). The most common comorbidities were hypertension (85.1%) and diabetes mellitus (68.1%). The duration of hemodialysis prior to pseudoaneurysm detection ranged from 6 months to 2 years.

Table 1: Demographic and Clinical Characteristics of Patients with AVF Pseudoaneurysms

Variable	Patients with Pseudoaneurysms (n=47)	Patients Without Pseudoaneurysms (n=203)	p-value
Age (years, mean ± SD)	62.4 ± 10.3	58.1 ± 9.8	**0.03***
Male, n (%)	33 (70.2)	139 (68.5)	0.82
Hypertension, n (%)	40 (85.1)	152 (74.9)	0.08
Diabetes mellitus, n (%)	32 (68.1)	112 (55.2)	0.05
Hemodialysis duration (years, mean ± SD)	1.16 ± 0.42	1.24 ± 0.49	**0.468**

(*Statistically significant, $p < 0.05$)

The most common clinical presentation was a pulsatile mass (83.0%), followed by skin thinning or ulceration (36.2%) and local pain (31.9%). About 12.8% of cases presented with acute bleeding, while 21.3% had signs of infection, including erythema, purulent discharge, and fever.

Table 2: Clinical Presentation of AVF Pseudoaneurysms

Clinical Symptoms	n (%)
Pulsatile mass	39 (83.0)
Skin thinning/ulceration	17 (36.2)
Local pain	15 (31.9)
Active bleeding	6 (12.8)
Signs of infection (erythema, pus, fever)	10 (21.3)

Table 3 presents the most frequently observed risk factors associated with the development of pseudoaneurysms in arteriovenous fistulas (AVFs) among patients undergoing hemodialysis. Out of the 47 patients identified with pseudoaneurysms, several contributing factors were statistically analyzed.

The most prevalent risk factor was Catheter-related bloodstream infections (CRBSIs) were observed in 80.9% of cases with significantly high p value ($p = <0.001$), reinforcing the systemic impact of such infections on vascular integrity. repeated needling at the same site, affecting 25% of patients, with significant p-value of <0.02, underscoring its strong association with pseudoaneurysm formation. Poor needling techniques were identified in 44.7% of patients, also showing statistical significance ($p = 0.04$). Diabetes mellitus was present in 68.1% of the affected individuals and approached statistical significance ($p = 0.05$), suggesting a potential role in vessel wall weakening or impaired healing. Previous AVF interventions were noted in 38.3% of patients, indicating a moderate yet significant association ($p = 0.03$). Importantly, infection-related complications were also prevalent. Catheter-related bloodstream infections (CRBSIs) were observed in 80.9% of cases ($p = <0.001$), reinforcing the systemic impact of such infections on vascular integrity. Surgical site infections (SSIs) were identified in 29.8% of the cohort, although this did not reach statistical significance ($p = 0.06$).

Table 3: Identified Risk Factors for Pseudoaneurysms in AVFs

Risk Factor	Patients with Pseudoaneurysms (n=47), n (%)	p-value
Catheter-related bloodstream infection	38 (80.9)	<0.001*
Poor needling techniques	21 (44.7)	0.04*
Diabetes mellitus	32 (68.1)	0.05
Previous AVF interventions	18 (38.3)	0.03*
Repeated needling at the same site	25 (53.2)	0.02*
Surgical site infection	14 (29.8)	0.06

(*Statistically significant, $p < 0.05$)

Among the 10 infected pseudoaneurysms, Staphylococcus aureus (50%) was the most commonly

isolated microorganism, followed by Pseudomonas aeruginosa (20%) and Escherichia coli (10%).

Table 4: Microorganisms Isolated in Infected AVF Pseudoaneurysms

Microorganism	n (%)
Staphylococcus aureus	5 (50.0)
Pseudomonas aeruginosa	2 (20.0)
Escherichia coli	1 (10.0)
No growth	2 (20.0)

The mean time from AVF creation to pseudoaneurysm diagnosis was 3.2 ± 1.1 years. Larger pseudoaneurysms (>2 cm) were diagnosed earlier, with a mean interval of 2.6 years, whereas smaller pseudoaneurysms were detected later (3.8 years, p=0.02).

The most frequent complications associated with pseudoaneurysms were rupture/bleedings (29.8%), infection (21.3%), and thrombosis (14.9%).

Table 5: Complications Related to Pseudoaneurysms in AVFs

Complication	n (%)
Rupture/Bleeding	14 (29.8)
Infection	10 (21.3)
Thrombosis	7 (14.9)

Of the 47 patients, 12 (25.5%) were managed conservatively with ultrasound monitoring and compression, achieving a 1-year AVF patency rate of 85.0%. The remaining 35 patients (74.5%) required intervention, underwent surgical excision of pseudoaneurysm and ligation of AVF and another AVF creation at a later date .

Table 6: Treatment Modalities and Outcomes

Treatment	n (%)	1-Year AVF Patency Rate (%)
Conservative (monitoring, compression)	12 (25.5)	85.0
Surgical (pseudoaneurysm AVF ligation)	35 (74.5)	68.4

Anastomotic site as the most common location (57.4%), typically linked to infection(CRBSI). Puncture site cases (42.6%) mainly due to repeated needling or errors during cannulation.

Table 7: Site of Pseudoaneurysm and Associated Causes has been added, showing:

Site of Pseudoaneurysm	Patients, n (%)
Anastomotic site	27 (57.4)
Puncture site	20 (42.6)

Early onset (10–24 days) pseudoaneurysms typically occur at the anastomotic site, often due to infection or surgical technique. Later onset (6 months – 1 year) pseudoaneurysms are more common at the puncture site, linked to needling practices.

Table 8: Duration from AVF Creation to Pseudoaneurysm Formation has been successfully added It highlights:

Duration from AVF Creation	Common Site of Pseudoaneurysm
10-24 days	Anastomotic site
6 months-1 year	Puncture site

Discussion

This study provides a comprehensive retrospective evaluation of pseudoaneurysms in autogenous arteriovenous fistulas (AVFs) among chronic kidney disease (CKD) patients undergoing hemodialysis. Our findings demonstrate that 18.8% of patients (47 out of 250) developed pseudoaneurysms, a rate consistent with prior reports. The mean age of affected patients was 62.4 years, with a male predominance (70.2%), aligning with previous studies suggesting that older age and male sex are associated with higher vascular complications. Hypertension (85.1%) and diabetes mellitus (68.1%) were the most common comorbidities, both of which contribute to vascular dysfunction and endothelial damage, potentially increasing pseudoaneurysm risk. Contrary to prior literature, our study found no significant difference in hemodialysis duration between patients with and without pseudoaneurysms (1.16 vs. 1.24 years, p=0.468), suggesting that other factors, such as needling practices and infection, may play a more immediate role in pseudoaneurysm formation.

The most common clinical presentation was a pulsatile mass (83.0%), consistent with turbulent arterial flow into the aneurysmal sac. Skin thinning or ulceration (36.2%) and local pain (31.9%) were also frequently observed, while acute bleeding (12.8%) and infection (21.3%) represented critical complications requiring urgent intervention. Among infected pseudoaneurysms, Staphylococcus aureus (50%)

remained the most common pathogen, followed by Pseudomonas aeruginosa (20%) and Escherichia coli (10%), consistent with prior reports on vascular access infections. The high prevalence of catheter-related bloodstream infections (CRBSIs) (80.9%, p=0.001) in patients with pseudoaneurysms represents a novel finding, underscoring the role of systemic infection in contributing to vascular damage and pseudoaneurysm formation.

Several significant risk factors were identified in pseudoaneurysm development. Catheter related blood stream infection (80.9%, p<0.001) emerged as the strongest predictor, reinforcing the importance of pre operative history like duration of catheter placement , fever and chills during md , blood investigations .repeated needling at the same site, affecting 25% of patients, with significant p-value of <0.02, emphasises the need for changing the cannulation site periodically . Poor needling techniques (44.7%, p=0.04) also showed a significant association, emphasizing the need for adequate training in dialysis cannulation practices. Diabetes mellitus (68.1%, p=0.05) approached statistical significance, likely due to its effects on microvascular function and wound healing. Previous AVF interventions (38.3%, p=0.03) were another significant factor, suggesting that surgical modifications may predispose to localized vessel wall weakness.

The study revealed important patterns in pseudoaneurysm development based on location and timing. Anastomotic site pseudoaneurysms (57.4%) were associated with early-onset cases (10-24 days post-AVF creation), often related to infection or technical factors during surgery. In contrast, puncture-site pseudoaneurysms (42.6%) typically developed later (6 months to 1 year), primarily due to repeated needling trauma. The most frequent complications included rupture or bleeding (29.8%), infection (21.3%), and thrombosis (14.9%), all of which carry significant clinical consequences and often require immediate intervention.

Treatment outcomes varied based on management approach. Conservative management with ultrasound monitoring and compression (25.5% of cases) for puncture site pseudo demonstrated the highest 1-year AVF patency rate (85.0%), making it an effective strategy for small, stable pseudoaneurysms. Surgical intervention (31.9% of cases), while necessary for complicated and infected pseudoaneurysms , all the patients underwent pseudoaneurysm AVF ligation and another AVF surgery at a later date after the infection settled down . These findings highlight the importance of individualized treatment strategies based on pseudoaneurysm characteristics and patient factors.

Our study has several important clinical implications. First, the strong association between CRBSIs and pseudoaneurysm formation suggests that systemic infections may contribute to vascular damage, warranting aggressive infection prevention strategies. Second, the predominance of needling-related risk factors emphasizes the critical need for proper cannulation techniques and staff training programs. Finally, the varying outcomes based on treatment modality support the need for careful patient selection when choosing between conservative and surgical approaches.

This study has some limitations that should be acknowledged. The retrospective design may introduce selection bias and limit the availability of certain clinical data. As a single-center study, the findings may not be generalizable to all hemodialysis populations. The relatively small sample size of pseudoaneurysm cases (n=47) may limit the power to detect some associations. Future prospective, multicenter studies with larger sample sizes would be valuable to validate these findings and further refine management protocols.

This study highlights that pseudoaneurysms remain a significant complication of AVFs in hemodialysis patients, with repeated needling, infection, and diabetes mellitus as key risk factors. The identification of CRBSIs as a potential contributor to pseudoaneurysm formation represents an important new finding. While conservative management shows excellent outcomes for select cases, more invasive interventions are necessary in impending rupture and infective cases. These results underscore the importance of proper cannulation techniques, infection prevention measures, and regular vascular access surveillance to reduce the burden of this complication in hemodialysis patients.

Conclusion

This study highlights the significant burden of pseudoaneurysms in arteriovenous fistulas (AVFs) among hemodialysis patients, with an incidence of 18.8%. Key risk factors include repeated needling at the same site, poor cannulation technique, diabetes mellitus, and prior AVF interventions, emphasizing the importance of proper vascular access care. Notably, catheter-related bloodstream infections (CRBSIs) emerged as a previously underrecognized risk factor, suggesting that systemic infections may contribute to vascular damage and pseudoaneurysm

formation. Clinically, pulsatile masses were the most common presentation, while rupture, infection, and thrombosis were major complications requiring prompt intervention. Anastomotic-site pseudoaneurysms tended to develop early (10–24 days post-AVF creation), often due to surgical factors or infection, whereas puncture-site pseudoaneurysms appeared later (6 months–1 year), primarily due to repetitive cannulation trauma. Treatment outcomes varied, with conservative management (monitoring/compression) showing the highest 1-year patency (85.0%), making it suitable for stable cases.surgery should be reserved for complicated pseudoaneurysms. These findings underscore the need for strict infection control, optimized needling practices, and regular AVF surveillance to prevent pseudoaneurysms. Future research should explore advanced endovascular techniques and prospective multicenter studies to refine management strategies and improve long-term outcomes for hemodialysis patients.

References

1. Najibi S, Bush RL, Terramani TT, Chaikof EL, Gunnoud AB, Lumsden AB, et al. Covered stent exclusion of dialysis access pseudoaneurysms. J Surg Res. 2002 Jul;106(1):15-9.

2. Zibari GB, Rohr MS, Landreneau MD, Bridges RM, DeVault GA, Petty FH, et al. Complications from permanent hemodialysis vascular access. Surgery. 1988 Oct;104(4):681-6.

3. de Paula MA, da Costa BEP, Figueiredo AE, Poli-de-Figueiredo CE. Assessment of the performance of vascular access for hemodialysis. J Vasc Access. 2024 Mar;25(2):607-614.

4. Mestres G, Barahona F, Yugueros X, Gamé V, Gil-Sala D, Blanco C, et al. Inflow artery aneurysmal degeneration after long-term native arteriovenous fistula for hemodialysis. Eur J Vasc Endovasc Surg. 2023 Dec;66(6):849-854.

5. Zibari GB, Rohr MS, Landreneau MD, Bridges RM, DeVault GA, Petty FH, et al. Complications from permanent hemodialysis vascular access. Surgery. 1988 Oct;104(4):681-6.

6. Aurshina A, Hingorani A, Marks N, Ascher E. Utilization of stent grafts in the management of arteriovenous access pseudoaneurysms. Vascular. 2018 Aug;26(4):368-371.

7. Pasklinsky G, Meisner RJ, Labropoulos N, Leon L, Gasparis AP, Landau D, et al. Management of true aneurysms of hemodialysis access fistulas. J Vasc Surg. 2011 May;53(5):1291-7.

8. Vo T, Tumbaga G, Aka P, Behseresht J, Hsu J, Tayarrah M. Staple aneurysmorrhaphy to salvage autogenous arteriovenous fistulas with aneurysm-related complications. J Vasc Surg. 2015 Feb;61(2):457-62.

9. Mestres G, Fontsere N, Yugueros X, Tarazona M, Ortiz I, Riambau V. Aneurysmal degeneration of the inflow artery after arteriovenous access for hemodialysis. Eur J Vasc Endovasc Surg. 2014 Nov;48(5):592-6.

10. Kordzadeh A, D'Espiney Barbara RM, Ahmad AS, Hanif MA, Panayiotopoulos YP. Donor artery aneurysm formation following the ligation of haemodialysis arteriovenous fistula: a systematic review and case reports. J Vasc Access. 2015 Jan-Feb;16(1):5-12.

11. Balaz P, Björck M. True aneurysm in autologous hemodialysis fistulae: definitions, classification and indications for treatment. J Vasc Access. 2015 Nov-Dec;16(6):446-53.

12. Wong WK, Su TW, Cheng WL, Yang HT, Wei WC, Ko PJ. Endovascular stent graft repair is an effective and safe alternative therapy for arteriovenous graft pseudoaneurysms. Eur J Vasc Endovasc Surg. 2016 Nov;52(5):682-688.

13. Lin PH, Johnson CK, Pullium JK, Koffron AJ, Conklin B, Terramani TT, et al. Transluminal stent graft repair with Wallgraft endoprosthesis in a porcine arteriovenous graft pseudoaneurysm model. J Vasc Surg. 2003 Jan;37(1):175-81.

14. Florescu MC, Qiu F, Plumb TJ, Fillaus JA. Endovascular treatment of arteriovenous graft pseudoaneurysms, indications, complications, and outcomes: a systematic review. Hemodial Int. 2014 Oct;18(4):785-92.

15. Salman L, Asif A. Stent graft for nephrologists: concerns and consensus. Clin J Am Soc Nephrol. 2010 Jul;5(7):1347-52.

16. Funaki B. Problematic declots: complications and irritations. Semin Intervent Radiol. 2004 Jun;21(2):69-75.

17. Salamon T, Safadi W, Izakson A. Acute haemorrhage secondary to arteriovenous haemodialysis fistula pseudoaneurysm--the challenge of restoring a deformed upper limb. BMJ Case Rep. 2015 Jul 7;2015:bcr2015210243.

18. Lorenz JM. Use of stents for the maintenance of hemodialysis access. Semin Intervent Radiol. 2004 Jun;21(2):135-40.

19. Moszkowicz A, Behrens G, Gueyikian S, Patel NH, Ferral H. Occlusion of a rapidly expanding hemodialysis graft pseudoaneurysm with placement of a stent graft. Semin Intervent Radiol. 2007 Mar;24(1):34-7.

20. Sato T, Tsuji K, Kawashima N, Agishi T, Toma H. Evaluation of blood access dysfunction based on a wavelet transform analysis of shunt murmurs. J Artif Organs. 2006;9(2):97-104.