Original Article

Predictors of recurrent arteriovenous fistula stenosis in Saudi patients undergoing hemodialysis

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ABSTRACT

الأهداف : تهدف هذه الدراسة إلى التعرف على العوامل التي تنبئ بالتضيق المتكرر للناسور الشرياني الوريدي. كماتسعى إلى حساب متوسط المدة الأولية لبراءة الناسور من التضيقات للمرضى السعوديين الذين يخضعون لغسيل الكلى .

المنهجية : أجريت دراسة الحالات والشواهد بأثر رجعي في مستشفى رعاية ثالثية بالرياض. تم تحليل بيانات 180 مريضًا خضعوا لعملية رأب الأوعية بين مايو 2009م ومايو 2020م. بعد معايير الاشتمال / الاستبعاد ، تم تضمين 99 مريضا . بناءً على وجود أو عدم وجود تضيق متكرر، تم تقسيم المرضى إلى حالات وضوابط . تم تعريف التكرار على أنه حدوث تضيق خلال أقل من 12 شهرًا من حدث تضيق سابق ، أو المرضى الذين لديهم أكثر من 3 أحداث تضيق كلية. تم جمع المتغيرات السريرية والإشعاعية والمخبرية وإخضاعها لتحليل الانحدار الثنائي متعدد المتغيرات لتقييم احتمالات تكرار تضيق الناسور .

النتائج : تم تصنيف ما مجموعه 29 مريضا على أنها حالات، بينما تم تصنيف 70 مريضا على أنهم مجموعة ضابطة . وُجد أن متوسط المدة الأولية لبراءة الناسور هي سبعة أشهر. أظهر تحليل الانحدار الثنائي متعدد المتغيرات مستويات أعلى من الكالسيوم في الدم ومؤشر كتلة الجسم في المرضى الذين يعانون من تضيق متكرر . كما لوحظ وجود علاقة إيجابية بين استخدام مضادات الصفيحات والتضيق المتكرر .

الخلاصة : تم العثور على مستويات أعلى من الكالسيوم المصحح ، مؤشر كتلة الجسم ، وتطبيق العلاج المضاد للصفيحات لتكون تنبئ بالتضيق المتكرر . لم يتم العثور على متغيرات تقليدية أخرى لتكون مهمة .

Objectives: To identify predictors of recurrent arteriovenous fistula (AVF) stenosis. It also seeks to calculate the average primary patency duration in Saudi patients undergoing hemodialysis.

Methods: A retrospective case-control study was conducted at a tertiary care hospital in Riyadh. Data from 180 patients who had undergone angioplasty between May 2009 and May 2020 were analyzed. Following the inclusion/exclusion criteria, 99 patients were included. Based on the presence or absence of recurrent AVF stenosis, the patients were divided into cases and controls, respectively. Recurrence was defined as an occurrence of stenosis within <12 months of a previous stenotic event, or patients who had >3 total stenotic events. Clinical, radiological, and laboratory variables were collected and subjected to multivariate binary regression analysis to assess the odds of a recurrence of fistula stenosis.

Results: A total of 29 patients were categorized as cases, while 70 patients were categorized as controls. The median primary patency duration was found to be seven months. Multivariate binary regression analysis revealed higher levels of serum calcium (*p*=0.012) and BMI (*p*=0.007) in patients with recurrent stenosis. A positive association was also observed between the use of antiplatelets (0.039) and recurrent stenosis.

Conclusion: Higher levels of corrected calcium, BMI, and the application of antiplatelet therapy were found to be predictors of recurrent AVF stenosis. No other traditional variables were found to be significant.

Keywords: arteriovenous fistula, vascular access, renal replacement therapy recurrent stenosis, angioplasty

The global prevalence of chronic kidney disease (CKD) in all its stages was 13.4% in 2016.[1] The treatment of the most severe form of CKD, also known as, end stage renal disease (ESRD), mandated the inclusion of a type of renal replacement therapy within their management plan. These include kidney transplantation, peritoneal dialysis, and hemodialysis.[2]

Of which, Hemodialysis is the most common. Vascular access in patients undergoing hemodialysis is achieved through a central venous catheter, arteriovenous grafts, or arteriovenous fistulas (AVF). Arteriovenous fistulas are usually the recommended type of vascular access by the National Kidney Foundation.[3] Arteriovenous fistulas are usually created when long-term hemodialysis access is required. The main types of AVF are radial-cephalic, brachial-cephalic, and brachial-basilic fistulas.[4]

One of the most common problems that hemodialysis patients face is vascular access dysfunction.[5] It was also found that stenosis, which comprises 78% of all cases of early AVF dysfunction, is the main cause of AVF dysfunction.[6] Arteriovenous fistula stenosis is characterized by a reduction of the normal vessel diameter by more than 50%, and is usually treated with angioplasty of the fistula.[5] The importance of a patent AVF has led to research on determining possible predictors associated with the incidence of recurrent AVF stenosis, which has variable definitions across studies.[7] For example, a study carried out by Nevez et al,[7] who defined recurrent stenosis as any stenosis occurring within 180 days of the initial angioplasty, found that diabetes and residual stenosis after the initial index angioplasty, even though fewer than 30%, were predictive of recurrent stenosis.[8] According to a study carried out in 2021, The number of Saudi patients undergoing hemodialysis is estimated to be 20,000. While the combined prevalence of patients undergoing renal replacement therapy in Saudi Arabia is estimated at 294.3 per million population.[9] Unfortunately, studies targeting recurrent stenosis are scarce on the Saudi Arabian hemodialysis population. So, this study may identify predictors and variables concerning the hemodialysis population in Saudi Arabia that might aid in the management of Saudi patients undergoing hemodialysis. The objective of this study was to identify predictors of recurrent AVF stenosis in hemodialysis patients.

Methods. The objectives of this study required the use of a retrospective case-control design, through which the required data was gathered using electronic medical records and radiological reporting systems available at the hospital. Data were collected from 180 patients admitted from May 2009 to May 2020 to the interventional radiology unit due to AVF stenosis.

The participants chosen for inclusion in this study were i) patients aged 18–70 years, ii) patients undergoing chronic hemodialysis, and iii) patients with a brachiocephalic, radiocephalic, or brachiobasilic fistula. The exclusion criteria were patients i) had a fistula fail before undergoing a dialysis session, and ii) patients who did not have regular follow-ups in the hospital. Due to the lack of an established definition of "recurrent stenosis," the definition used in this study is either 3 stenoses events or a stenosis event that occurred within 12 months of the initial index angioplasty. The cases had recurrent stenosis, while the controls did not develop it.

As a result of applying the inclusion and exclusion criteria, 81 patients were excluded, leaving 99 patients who underwent angioplasty. in the interventional radiology department. Indications of angioplasty included decreased blood flow during hemodialysis session, stenosis more than 60% of lumen at the site of arteriovenous anastomosis or at drainage vein site. A total of 200 angioplasties were included in our analysis. The sample patients' notes, lab values, and relevant clinical information were acquired from the statistical logbook after obtaining approval from the hospital's Institutional Review Board. The data collected on their fistulas were the date of the first angioplasty to be used as the index procedure, the type of fistula, the date of the subsequent angioplasty, the total stenoses the patient had experienced, and the history of fistula abandonment. Most of the angioplasties were plain Balloon angioplasties. However, the angioplasties performed on patients with recurrent stenosis or central venous stenosis employed high-pressure and drug coated balloons as well as the usage of stents. Some details regarding the first angioplasty assessing the lesion's severity, such as the degree of severity and the location of the stenosis, were included within the variables. To determine if there was a correlation between these outcomes and the evaluated predictors, the patients' age, gender, smoking status, body mass index (BMI), angiotensin converting enzyme (ACE) inhibitor therapy, antiplatelet therapy, the presence of diabetes, dyslipidemia, and coronary or peripheral arterial disease were examined. The laboratory predictors were hemoglobin levels, albumin, corrected calcium, phosphorus, C-reactive protein, vitamin D levels, and hemoglobin A1C levels in people who are diabetic. Due to the chronic process through which stenosis occurs, these factors were monitored and collected as the average of the last 3 readings within a year of the first stenotic event.

Statistical analysis. Mean and standard deviation were used to describe continuous measured variables, while frequency and percentages were used to describe categorically measured variables. While the Mann-Whitney U non-parametric test was used to assess the statistical significance on metric variables with skewness between patients with and without recurrent stenosis. The histogram and the statistical Kolmogorov–Smirnov test were used to assess the normality assumption of continuous variables. Levene's test of homogeneity of variance was used to evaluate the equality of variance statistical assumption. The Chi-squared ($\chi2$) test of association was used to assess the associations among categorically measured variables. Continuity-adjusted Chi-squared tests and associated *p*-values were quoted when the statistical assumption of observed counts below expected was noted for contingency tables. An independent samples t-test was used to assess the statistical mean differences of metric variables across the levels of binary categorically measured variables. Multiple response dichotomy analysis was applied to describe the variables with more than one option (such as, medical history and the reasons for ESRD). Multivariate binary regression analysis was used to assess the statistical significance of the predictors of the patients' odds of having recurrent fistula stenosis. The association between the patients' sociodemographic and disease-related factors and recurrent fistula stenosis events was expressed as an odds ratio with an associated 95% confidence interval. The alpha significance level was considered at the 0.050 level, and the commercially available SPSS version 21 (IBMCorp, Armonk, NY, USA) statistical analysis program was used for the data analysis. Bivariate analysis methods were also used to better understand the cause of recurrence of AVF stenosis among the sample of patients A total of 99 patients with AVFs were reviewed retrospectively.

Results. The resulting analysis showed that 50.5% were female patients and 49.5% were male patients. The mean age (years) of the sample of patients was 53.04 years (standard deviation [SD]=11.86 years). The patients in the study had a mean BMI (body mass index) of 29.47 (SD=7.89), and the majority (43.4%) were obese. The results of the analysis of the patient's type of fistula, severity, location of stenosis of the index angioplasty, and data on the chronology of the stenotic event is displayed in (Table 1). The most common cause of ESRD was diabetic nephropathy (52.5%). Reviewing the medical and therapeutic history of the patients also showed that most of them (43.4%) were taking antiplatelet agents, while some (12.1%) were taking

Table 1 - Descriptive analysis of the patient's arteriovenous fistula characteristics.

Characteristics	n	%
Type of initially inserted fistula		
Brachio-cephalic	57	57.6
Radio-cephalic	34	34.3
Brachio-basilic	8	8
Developed first stenosis after fistula creation		
No	4	4.0
Yes	95	96.0
Degree of lesion stenosis		
Mild (40%-50% occlusion)	7	7.07
Moderate (50%-70% occlusion)	20	20.2
Severe (70%-90% occlusion)	31	31.31
Unreported	41	41.41
Developed a second stenosis		
No	62	62.6
Yes	37	37.4
Time between the first stenosis and second stenosis in months (Primary patency), median (Quartiles 1 & 3)		7 (1, 14)
Locations of stenosis lesions		
Anastomotic site	31	31.31
Venous side	17	17.17
Juxta anastomotic stenosis	13	13.13
Cephalic vein and arch	10	10.01
Para anastomosis site	4	4.04
Subclavian vein	3	3.03
Brachial vein	2	2.02
Junction of left subclavian-brachiocephalic vein	1	1.01
Unreported	18	18.18
***Number of lesions found during revision, median (quartiles 1 & 3)		1 (1,1)
Number of angioplasties required median (quartiles 1 & 3)		1 (1, 3)
Identified to have recurrent stenosis		
No	70	70.7
Yes	29	29.3
Had previous abandoned fistula		
No	85	85.9
Yes	14	14.1

Quartiles are percentiles.***Quartile -1 means that 25% of the patients had lasted one month between first and second stenosis, and quartile-3 denotes that 75% of the patients waited 14 months between their 1st and second stenosis events.

angiotensin converting enzyme/angiotensin-receptor blockers (ACE/ARB) agents. Furthermore, 58.6% of the patients had a positive medical diagnosis of diabetes mellitus. Regarding the type of AVF, the findings showed that most of the patients (57.6%) had a brachiocephalic fistula, (34.3%) had a radiocephalic fistula, and 8% had a brachiobasilic fistula. A total of 37.4% of the patients in the sample developed a second AVF stenosis event, with a median duration between the first and second fistula stenosis of 7 months. Accordingly, 75th percentile

analysis showed that most of the patients (75% of those who experienced a second stenosis) had been symptom free for at least 14 months before experiencing a second stenosis. It was also observed that even fewer patients (21.2%) experienced a third stenosis event requiring medical intervention after their first and second stenoses. Among the patients with tertiary stenosis, the median duration of time between secondary and tertiary stenoses was 6.54 months, but most patients (75% of those with tertiary stenosis) experienced their third stenosis event after 14–16 event-free months on average. According to the definition of recurrent fistula stenosis, 29.3% (n=29) of the patients were considered to have had recurrent AVF stenosis and were classified as cases. While 70.7% (n=70) of the patients were classified as controls. The time between recurrent fistula stenosis was equal to the median value of 4.5 months, but quartile analysis findings showed that most of the patients (75%) acquired a secondary stenosis within 11.5 months. The medical record review also showed that 14.1% of the patients included in this sample previously had abandoned fistulas.

The results of the bivariate analysis on data of the patients' demographics and past medical history are shown in (Table 2). The table shows that the patients' gender, age, BMI score, and obesity classification did not significantly correlate with their likelihood of recurrent fistula stenosis. While an independent t-test indicated that the BMI of patients with and without recurrent fistula stenosis differed slightly, the difference was not statistically significant. Those with recurrent stenosis had slightly higher BMI scores (mean=31.66, SD=8.72) on average than those without recurrent dialysis fistula stenosis (mean BMI=28.53, SD=7.32, p=0.070). The findings from the bivariate analysis indicated that patients' smoking habits and causes of initiation of hemodialysis did not significantly correlate with the patient's likelihood of recurrent dialysis fistula stenosis. In addition, the patients' use of ACE/ARB inhibitor agents was not significantly associated with their likelihood of having recurrent fistula stenosis. The patients' use of antiplatelet therapeutic agents, though, significantly increased the likelihood of recurrent AV fistula stenosis (p=0.050). Moreover, the results of the Bivariate analysis of the patients' data regarding the chronology and severity of their stenoses is shown on Table 3. Interestingly, the table shows that the patients' type of fistula, severity of the index stenosis, and average lab values also did not significantly correlate with their likelihood of recurrent fistula stenosis.

The statistical data analysis was further shown by a decrease in the patients' odds of recurrent AVF stenosis

Table 2 - Bivariate analysis on data of the patient's demographic and past medical history.

Demographic	Recurrent stenosis		test statistic	P-value
	No	Yes		
Grnder				
Female	36 (51.4)	14 (48.3)	$\chi^2(1)=0.082$	0.775
Male	34 (48.6)	15 (51.7)		
Age (years), mean (SD)	53.23 (11.87)	52.59 (12.03)	t(97)=0.24	0.808
Age group				
<=35 years	6 (8.6)	3 (10.3)	$\chi^2(3)=1.72$	0.633
36-45 years	14 (20)	5 (17.2)		
46-55 years	16 (22.9)	10 (34.5)		
>=56 years	34 (48.6)	11 (37.9)		
BMI, mean (SD)	28.53 (7.32)	31.66 (8.78)	t(97)=1.82	0.070
BMI group				
Underweight (<18.5)	7 (10)	1 (3.4)	$\chi^2(3)=4.99$	0.173
Normal (18.5-24.9)	15 (21.4)	3 (10.3)	LR	
Overweight (25-29.9)	22 (31.4)	8 (27.6)		
Obese (>30)	26 (37.1)	17 (58.6)		
Smoker				
No	65 (92.9)	28 (96.6)	$\chi^2(1)=0.50$	0.483
Yes	5 (7.1)	1 (3.4)		
Use of ACE/ARB inhibitors				
No	61 (87.1)	26 (89.7)	$\chi^2(1)=0.001$	0.992
Yes	9 (12.9)	3 (10.3)		
Use of antiplatelet therapy agents				
No	44 (62.9)	12 (41.4)	$\chi^2(1)=3.90$	0.050
Yes	26 (37.1)	17 (58.6)		
Past medical history of diabetes				
No	30 (42.9)	11 (37.9)	$\chi^2(1)=0.21$	0.651
Yes	40 (57.1)	18 (62.1)		
Past medical history of coronary artery disease (CAD)				
No	60 (85.7)	25 (86.2)	$\chi^2(1)=0.04$	0.949
Yes	10 (14.3)	4 (13.8)		
Past medical history of peripheral arterial disease (PAD)				
No	63 (90)	27 (93.1)	$\chi^2(1)=0.11$	0.917
Yes	7 (10)	2 (6.9)		
Past medical history of dyslipidemia				
No	54 (77.1)	22 (75.9)	$\chi^2(1)<0.001$	1.000
Yes	16 (22.9)	7 (24.1)		

ACE: angiotensin converting enzyme, ARB: angiotensin-receptor blockers, BMI: body mass index

in accordance with the patients' sociodemographic characteristics and other relevant predictors that were measured for the study. Table 4 shows that despite

Table 3 - Bivariate analysis of the patients' data on the chronology and severity of their stenoses.

	Recurrent stenosis			
Variables	**No**	**Yes**	**Test statistic**	***P*-value**
Type of Initially inserted fistula				
Brachio-cephalic	39 (55.7)	18 (62.1)	$\chi^2(3)=0.35$	0.951
Radio-cephalic	25 (35.7)	9 (31)		
Brachio-basilic	6 (8.6)	2 (6.7)		
Developed at least one fistula stenotic event				
No	50 (71.4)	11 (37.9)	$\chi^2(1)=9.73$	0.002
Yes	20 (28.6)	18 (62.1)		
*Average of serum hemoglobin mg/DL, mean (SD)	10.65 (1.45)	10.92 (1.36)	$t(97)=0.90$	0.391
*Average serum C-RP mg/L, mean (SD)	5.5 (27.25)	15 (27)	$Z=1.208$	0.237
*Average serum corrected calcium mmol/L, mean (SD)	2.03 (0.17)	2.14 (0.35)	$t(92)=1.98$	0.050
*Average serum phosphorus mmol/L, mean (SD)	1.26 (0.51)	1.31 (0.604)	$t(95)=0.40$	0.703
*Average serum Hemoglobin A1C, mean (SD)	7.19 (1.71)	7.50 (1.51)	$t(41)=0.61$	0.546
*Average serum albumin gm/L, mean (SD)	32.12 (5.37)	30.93 (7.26)	$t(92)=0.89$	0.376
*Average serum vitamin D nmol/L, mean (SD)	47.85 (34.70)	59.13 (28.00)	$t(53)=1.15$	0.254
Degrees of index stenosis				
Mild (40%-50% occlusion)	6 (14.6)	1 (5.9)	$\chi^2(2)=3.03$	0.220
Moderate (50%-70% occlusion)	16 (39)	4 (23.5)	LR	
Severe (70%-90% occlusion)	19 (46.3)	12 (70)		

*Average 3 readings taken before the initial index stenosis event within 12 months. SD: standard deviation

Table 4 - Multivariate binary logistic regression analysis of the sample patients' odds of recurrent fistula stenosis (N=99).

Demographic	Multivariate AOR	95% CI for (OR)		*P*-value
		Lower	Upper	
Age (years)	0.992	0.945	1.042	0.746
Gender=Male	1.630	0.589	4.509	0.347
Body Mass Index mean score.	1.110	1.029	1.198	0.007
Smoker	0.725	0.065	8.070	0.794
Uses ACE inhibitor agents	0.300	0.053	1.705	0.174
Uses antiplatelet agents	3.064	1.061	8.851	0.039
Positive History of diabetes	0.920	0.273	3.104	0.893
Positive history of dyslipidemia	0.345	0.091	1.315	0.119
Type of fistula	0.703	0.342	1.445	0.338
Average corrected serum calcium level	15.005	1.807	124.590	0.012
Constant	<0.001			0.004

Dependent variables: Development of recurrent dialysis fistula stenosis (No/Yes). AOR: adjusted odds ratio, CI: confidence interval, ACE: angiotensin converting enzyme

accounting for the other predictor variables in the analysis model, age, and gender did not significantly correlate with recurrences of AVF stenoses. While the patients' BMI scores positively and significantly correlated with the odds of their having recurrent AVF stenosis events, as the patients' BMI scores rose by one

point on average, their odds of having recurrent stenoses rose by 1.11 times, or 11% times more than patients who had lower BMI scores. It should be noted that **Figure 1** shows the patients' BMI classification on the X-axis, and the model predicting the mean propensity of recurrent AVF stenosis on the Y-axis, as the patients' BMIs were underweight, normal, overweight, and obese. The predicted likelihood of recurrent AVF stenosis rose on average. Obese patients were most likely to experience a recurrent stenosis of the AVF, while underweight patients were least likely to experience it. Interestingly, it was also found that the patients using antiplatelet agents had correlated with a higher chance of developing recurrent AVF stenosis (*p*=0.039). After controlling for the other predictors, the patients taking antiplatelet drugs were therefore significantly (3.064 times) more likely to develop recurrent AVF stenosis than those who did not take these agents (*p*=0.039). A positive history of diabetes and dyslipidemia, as well as the type of fistula, did not significantly impact the chances of recurrent fistula stenosis events. Moreover, the multivariate analysis results showed that the patients' overall mean serum corrected calcium levels correlated significantly and positively with their chances of experiencing recurrent AVF stenosis. As the mean serum calcium level of patients who were in the cases group was higher than the average calculated for the control group by 0.11 mmol/L, the corresponding odds of developing recurrent stenosis increased by 15.01
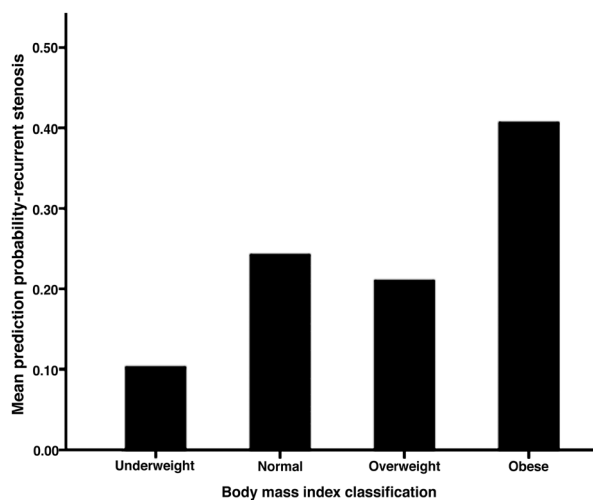
Figure 1 - The association between patients body mass index (BMI) classification with their model predicted probability of predicted stenosis.

times on average (*p*=0.012) once the other predictors in the analysis model were considered. The explanation of the corrected calcium's rebel odds ratio is the variability in patients average serum calcium readings. Where some controls were found to have low calcium compared to other controls whose average calcium reading was high in the period prior to the index stenosis. As a result, this imposed uncertainty as such the odds ratio is inflated and the confidence interval is widened

Discussion. This study's objectives were to identify predictors of recurrent AVF stenosis in hemodialysis patients and to calculate the average primary patency rate between the first and second stenosis. The data analysis suggested that the median primary patency duration was 7 months, which is lower than the average primary patency duration found elsewhere in previous studies. For example, a systematic review found that the average primary patency rates in different regions worldwide varied between 10.5 and 41 months.[10] It was also indicated that the strongest predictor of recurrent AVF stenosis was higher levels of corrected serum calcium and that patients with a higher mean of corrected calcium were 15.01 more times likely to experience recurrent stenosis. The exact mechanism through which this occurs is still largely unknown. There is a possibility that it can be a direct influencer of the rate at which vascular calcification occurs. This association has not been linked to AVF stenosis specifically in the literature, but it has been implicated in incidences of cerebral, coronary, and transplanted renal artery stenosis.[11-13] The

variability of patients corrected calcium levels caused the average calcium reading to have a large odds ratio and a wide confidence interval. This variability is likely attributed to hemodialysis itself which resulted in the average readings among the sample patients to largely differ. Although the patients in our sample with lower corrected calcium measurements had a lower risk of recurrent stenosis, the generalizability of this finding is limited. More research is necessary to reach a more solid conclusion.

It was also found that BMI correlates significantly and positively with recurrent AVF stenosis. A possible explanation is that obese patients undergo more aggressive intimal hyperplasia, which leads to earlier occurrences of stenosis.[14] The average BMI of the sample was classified as overweight to obese (29.47), meaning that a large number of the patients in the sample had this risk factor. Consequently, more aggressive measures of weight loss interventions, such as liberal referrals to dietitians and weight loss clinics, may limit the occurrence of recurrent stenosis in this patient population. The incidence of earlier stenoses can also be counteracted by increasing the initial luminal diameter with hand grip exercises, as some studies have suggested.[15] Another significant intervention that may reduce the incidence of recurring stenotic events is employing the use of drug coated balloons (DCB) instead of plain balloon angioplasties (PBA). A study by Troisi et al,[16] found a significant increase in the time to restenosis when the angioplasty was carried out using DCB's compared to PBA's.

Interestingly, the use of antiplatelet therapy correlated with an increased incidence of recurrent AVF stenosis. This finding contradicts many studies on this topic, since antiplatelets have been found to prevent stenosis.[17] Although a study by Murley et al[18] on 670 patients demonstrated no change in the risk of fistula dysfunction with antiplatelet usage, another study was discontinued due to an increased risk of bleeding observed in the patient sample.[19] The association found in this study might be explained by patients on antiplatelet therapy having an inherently increased risk of coagulation. Antiplatelets are usually prescribed to patients with an increased stratified risk of adverse vascular events. The findings of our study may mean that hemodialysis patients should have a lower threshold for vascular screening procedures since they may be more susceptible to adverse vascular events. Further studies on the risk of adverse vascular events in the hemodialysis population are necessary to verify these findings. The use of ACE inhibitors/ARB's was not associated with a change in the risk of recurrent

stenosis. This finding is consistent with Heine et al's[20] study, in which the effect of ACE inhibitor usage did not consistently correlate with a decreased risk of fistula dysfunction.

Study limitations. This study has a low sample size due to the nature of the study and the target population, which may have affected its statistical power. Another limitation was the lack of patient information when collecting levels of C-reactive protein, and vitamin D because it was not ordered as liberally for patients undergoing angioplasty. Data regarding location and severity of stenosis, and the types of balloons used for each procedure was also unreported in most patients' post-procedural notes. However, most of the patients' data were complete.

A similar study carried out by Aktas et al,[21] which included 330 patients, found that the patient's age and the presence of diabetes mellitus were significant predictors of early fistula stenosis. Although these variables were considered in this study's analysis, they were not found to be significantly associated with recurrent stenosis. This finding may be due to the limitations mentioned earlier.

In conclusion, AVF stenosis is one of many complications that adds to the burden of CKD. This study found that the median primary patency duration between the first and second AVF stenosis was seven months, and that several predictors contributed to the occurrence of stenosis in Saudi patients, including high BMI, elevated serum corrected calcium levels, and the use of antiplatelet therapy. The lack of significant predictors in previous studies, such as age, diabetes, and residual stenosis, can likely be attributed to low sample sizes and subsequent study power. Further studies are necessary to reach a more definitive conclusion.

References

1. Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, et al. Global prevalence of chronic kidney disease–a systematic review and meta-analysis. *PloS One* 12016; 11: e0158765.
2. Levey AS, Coresh J, Balk E, Kausz AT, Levin A, Steffes MW, et al. National Kidney Foundation practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *Ann Intern Med* 2003; 139: 137-147.
3. Bylsma LC, Gage SM, Reichert H, Dahl SLM, Lawson JH. Arteriovenous fistulae for haemodialysis: a systematic review and meta-analysis of efficacy and safety outcomes. *Eur J Vasc Endovasc Surg* 2017; 54: 513-522.
4. Michael S, Qaja E. Types of Arteriovenous Fistulas. Treasure Island (FL): StatPearls Publishing; 2022.
5. Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin AS, Abreo K, et al. KDOQI clinical practice guideline for vascular access: 2019 update. *Am J Kidney Dis* 2020; 75: S1-S164.
6. Campos RP, Do Nascimento MM, Chula DC, Do Nascimento DE, Riellal MC. Stenosis in hemodialysis arteriovenous fistula: evaluation and treatment. *Hemodial Int* 2006; 10: 152-161.
7. Neves M, Outerelo C, Pereira M, Neves F, Carvalho T, Maia P, et al. Predictive factors of recurrent endovascular intervention for cephalic arch stenosis after percutaneous transluminal angioplasty. *J Vasc Surg* 2018; 68: 836-842.
8. Al-Sayyari AA, Shaheen FA. End stage chronic kidney disease in Saudi Arabia. A rapidly changing scene. *Saudi Med J* 2011; 32: 339-346.
9. Mousa D, Alharbi A, Helal I, Al-Homrany M, Alhujaili F, Alhweish A, Marie MA, Al Sayyari A. Prevalence and associated factors of chronic kidney disease among relatives of hemodialysis patients in Saudi Arabia. *Kidney Int Rep* 2021; 6: 817-820.
10. Neuen BL, Gunnarsson R, Webster AC, Baer RA, Golledge J, Mantha ML. Predictors of patency after balloon angioplasty in hemodialysis fistulas: a systematic review. *J Vasc Interv Radiol* 2014; 25: 917-924.
11. Wu J, Xie J, Zhao Y, Gong LI, Liu X, Liu W. Serum calcium is related to the degree of artery stenosis in acute ischemic stroke." *Cell Physiol Biochem* 2018; 46: 1189-1197.
12. Rasouli M, Kiasari AM. Serum calcium and phosphorus associate with the occurrence and severity of angiographically documented coronary heart disease, possibly through correlation with atherogenic (apo) lipoproteins. *Clin Chem Lab Med* 2006; 44: 43-50.
13. Etemadi J, Rahbar K,Haghighi AN, Bagheri N, Falaknazi K, Ardalan MR, et al. Renal artery stenosis in kidney transplants: assessment of the risk factors. V*ascular health and risk management* 2011; 7: 503-507.
14. Kats M, Hawxby AM, Barker J, Allon M. Impact of obesity on arteriovenous fistula outcomes in dialysis patients. *Kidney Int* 2007; 71: 39-43.
15. Distefano G, Zanoli L, Basile A, Fatuzzo P, Granata A. Arteriovenous fistula and pre-surgery mapping: Potential role of physical exercise on endothelial function. *J Vasc Access* 2019; 20: 652-658.
16. Troisi N, Frosini P, Somma C, Romano E, Guidotti A, Dattolo PC, Et al. Drug-coated balloons reduce the risk of recurrent restenosis in arteriovenous fistulas and prosthetic grafts for hemodialysis. *Int Angiol* 2017; 37: 59-63.
17. Hsu YH, Yen YC, Lin YC, Sung LC. Antiplatelet agents maintain arteriovenous fistula and graft function in patients receiving hemodialysis: A nationwide case-control study. *PloS One* 2018; 13: e0206011.
18. Murley A, Wijewardane A, Wilmink T, Baharan J. Should patients be on antithrombotic medication for their first arteriovenous fistulae?. *J Vasc Access* 2016; 17: 118-123.
19. Kaufman JS, O'Connor TZ, Zhang JH, Cronin RE, Fiore LD, Ganz MB, et al. Randomized controlled trial of clopidogrel plus aspirin to prevent hemodialysis access graft thrombosis. *J Am Soc Nephrol* 2003; 14: 2313-2321.
20. Heine GH, Ulrich C, Köhler H, Girndt M. Is AV fistula patency associated with angiotensin-converting enzyme (ACE) polymorphism and ACE inhibitor intake? *Am J Nephrol* 2004; 24: 461-468.
21. Aktas A, Bozkurt A, Aktas B, Kirbas I. Percutaneous transluminal balloon angioplasty in stenosis of native hemodialysis arteriovenous fistulas: technical success and analysis of factors affecting postprocedural fistula patency. *Diagn Interv Radiol* 2015; 21: 160-166.