Evaluation of Percutaneous Transluminal Angioplasty on the Success of Venoplasty in the Management of Hemodialysis Fistula Stenosis

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Introduction: Patients with chronic kidney failure whose life depends on routine hemodialysis, need good hemodialysis access. Arteriovenous fistula (AVF) is the best access, but this access is prone to stenosis. The best treatment for the problem of AVF stenosis is by percutaneous transluminal angioplasty (venography /venoplasty). This action has developed in Cipto Mangunkusmo National Hospital since 2013, but there is no data and evaluation of its success. This study was conducted to evaluate the success of venoplasty in the treatment of AVF stenosis.

Method: This study used a retrospective cohort study to assess the outcome of percutaneous transluminal angioplasty (venography and venoplasty) actions in AVF stenosis in patients with chronic kidney failure. The study was conducted in the Ward Division of Vascular and Endovascular Surgery, Integrated Heart Center, Cipto Mangunkusmo National Hospital's medical records installation, and Hermina Depok Hospital from December 2016 to May 2017 by evaluating the demographic characteristics, underlying diseases, venoplasty, and venography assessment results, and ultrasound results.

Results: Characteristics of people with chronic kidney disease with AVF stenosis were found mostly in the age group 50-60 years (40.9%). As many as 59% of patients were male, and underlying disease was mainly caused by hypertension (93.9%) and diabetes mellitus (42.4%). We found a significant relationship between age and sex with the size of AVF stenosis from demographic analysis. There was no significant relationship between the underlying disease, the location of AVF stenosis, and the venography's outcome with the size of AVF stenosis from venography. There was a significant relationship between the location of AVF stenosis and the success of venoplasty. There was a significant increase in the results of the ultrasound examination, which were the draining vein diameter, volume flow, and peak systolic velocity to the results of venoplasty after the procedure or three months after the procedure.

Conclusion: There was a significant relationship between age and sex with the size of AVF stenosis that occurred. There was no significant relationship between the underlying disease, the location of AVF stenosis with the size of AVF stenosis from venography. A significant relationship was found between the location of AVF stenosis and the success of venoplasty. There was a significant relationship between the results of the ultrasound examination (diameter draining vein, volume flow, and peak systolic velocity) to the results of venoplasty after the procedure or three months after the procedure.

Keywords: arteriovenous fistula stenosis, percutaneous transluminal angioplasty, venoplasty, ultrasound

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INTRODUCTION

People with chronic kidney disease maintain their lives by routinely doing hemodialysis. Good vascular access is needed to get optimal hemodialysis results. Of the various types of access, permanent vascular access to the arteriovenous fistula (AVF) is the primary choice. Based on data released by the Indonesian Renal Registry (IRR) in 2012, the incidence of patients with chronic kidney failure reaches 20,000 cases per year, with diabetic nephropathy and hypertensive kidney disease are the leading causes. As many as 83% of all patients undergoing hemodialysis are end-stage renal disease (ESRD) patients, which are terminal conditions of chronic kidney disease (CKD) based on data from the Indonesian Nephrological Society.¹

Installation of adequate vascular access is a requirement for the success of hemodialysis therapy in these patients. For that purpose, reasonable access is access that has excellent patency. The main problem of vascular access is how to maintain adequate conditions for many influential factors. The annual vascular access patency rate varies from 55% to 75% with failure because of stenosis being the primary cause.²

Stenosis most often occurs in the arteriovenous anastomosis, along with draining veins, or in the central vein. However, the handling of this stenosis is often late because patients generally come to control after hemodialysis problems arise.³

Percutaneous transluminal angioplasty (PTA) is an endovascular action to treat both central and peripheral venous stenosis problems. Percutaneous intervention for the management of AVF stenosis is an outpatient procedure, where immediate access can be used after successfully corrected. Lesions in all parts of arteriovenous access and their draining vein, both peripheral and central, can be effectively and safely managed.² This procedure has the advantage of minimal blood loss, no need for hospitalization, and post-minimal pain relief. In the world, this action has been used since 1980. While in Cipto Mangunkusumo National Hospital itself, PTA's operations by the Vascular and Endovascular Division have been carried out since 2013, but complete data and evaluation until recently is not available.

The therapeutic modality for AVF stenosis is with PTA, but there are limited retrospective and prospective reports. From the results of existing studies, PTA measures can improve and extend the survival rate of venous fistula artery access. This

study was conducted to evaluate the success of venoplasty in the treatment of AVF stenosis.

METHOD

This study was a retrospective cohort study to assess the results of percutaneous transluminal angioplasty (PTA) for the management of hemodialysis fistula stenosis in patients with chronic kidney failure. This study was conducted in the Ward Division of Vascular and Endovascular Surgery, Integrated Heart Center, and medical records installation of Cipto Mangunkusumo National Hospital, and Hermina Bekasi Hospital during the period of 1st December 2016 to 31st May 2017. The samples of this study were all patients with draining vein stenosis, which PTA (venographic and venoplasty) procedure will be carried out by a vascular surgeon. The sample was taken consecutively. The data was collected through interviews according to questionnaires, physical examination, and doppler ultrasound. The results of PTA action were assessed in the evaluation of the clinical improvement and venoplasty results before, after, and three months after the PTA procedure. Data processing was performed using SPSS 20.0 for Macintosh.

Descriptive analysis was performed to assess the characteristics and distribution of data (age, sex, and underlying disease, location of stenosis, clinical symptoms, venography, and venoplasty results) of each variable presented as a percentage in tabular or graphical form. Numerical data (ultrasound examination results, which are diameter draining vein, peak systolic velocity, and volume flow) were tested for normality, and categorical data were performed statistical tests with chi-square or fisher (bivariate). The results of the AV Fistula ultrasound examination will be compared before the procedure with post-procedure three months after the procedure.

RESULTS

During the period of 1st December 2016 to 31st May 2017, 66 AVF stenosis subjects underwent venography and venoplasty in Cipto Mangunkusumo National Hospital and Hermina Bekasi Hospital. The demographical distribution and underlying diseases of AVF stenosis subjects with CKD, the average age of CKD patients with AVF stenosis were 58.78. The youngest was 31 years old, the oldest was 86 years old, and 40.9% in the age group of 50-60 years old. From the sex, the highest number of patients with AVF

Table 1. Relationship between venoplasty results (size of residual stenosis) with demographic factors and underlying disease.

Variable	Venoplasty			
	Complete	<30%	≥30%	p
Age (years)				
<50	8	7	1	0.542
50-60	16	10	0	
>60	10	13	1	
Gender				
Male	18	19	2	0.34
Female	16	11	0	
Underlying disease				
Hypertension	32	28	2	0.175
Diabetes mellitus	19	9	0	
Autoimmune disease	4	4	1	
Kidney stone	1	5	0	

Table 2. Relationships of venous AVF location with size of AVF stenosis.

Type	Venography			p
	<30%	30-50%	>50%	
Juxta anastomosis	1	9	30	0.438
Arterial	0	1	5	
Draining vein	4	13	23	

Table 3. Relationship between the location of AVF stenosis and the results of venoplasty.

Type	Venoplasty			p
	Complete	<30%	≥30%	
Juxta anastomosis	20	20	0	0.075
Arterial	1	4	1	
Draining vein	22	17	1	

Table 4. Relationship between venographic features and venoplasty results.

Venography (size of stenosis)	Venoplasty (size of residual stenosis)			p
	≥30%	<30%	complete	
>50%	1	23	20	0.475
30-50%	1	6	10	
<30 %	0	1	4	

stenosis was found in male with 39 people (59%). For underlying diseases that cause chronic kidney failure, hypertension was the most common cause of 62 people (93.9%) followed by diabetes mellitus 28 people (42.4%), autoimmune disease nine people (13.6%), and kidney disease six people (9.1%). Distribution of AVF types with CKD patients with AVF stenosis was found most in the brachiocephalic type with 32 people (48.5%), radiocephalic type 28 people (42.5%), brachiocephalic type 5 people (7.5%) while the AV graft type 1 people (1.5%). For the distribution of clinical symptoms of CKD patients with AVF stenosis, mostly were found to be a failure to mature as many as 29 people (43%), low dose hemodialysis (42.4%), tortuosity and widening draining vein of 6 people (9.1%), and difficulty in cannulation of 3 people (4.6%). For the stenosis location, there were as many as 40 people (46.5%) of juxta anastomosis and draining veins, while stenosis in the arterial area was six people (7%). In the bivariate analysis, There was a significant relationship between age and stenosis from venography ($p=0.007$). There was a significant relationship between gender and stenosis from venography ($p=0.002$). There was no relationship between underlying diseases and venous stenosis ($p=0.43$).

Table 1 shows that age and gender did not correlate statistically with the success of venoplasty in AVF stenosis subjects. The same result was found in underlying diseases, which were hypertension, diabetes mellitus, autoimmune diseases, and kidney disease.

From table 2, venography results according to the location of stenosis from AVF, obtained stenosis AVF >50%, mostly in juxta anastomosis as many as 30 people. For AVF stenosis 30-50% and stenosis <30%, mostly found in stenosis in draining vein area as many as 13 people. There was no significant relationship between AVF stenosis location and the size of stenosis from venography ($p=0.438$).

From table 3, there was no significant relationship between the location of the stenosis and venoplasty results ($p=0.075$).

From table 4, there was no significant relationship between the size of AVF stenosis with the results of venoplasty ($p=0.475$).

From table 5, ultrasound examination results obtained the mean diameter of the draining vein before venoplasty was 3.33 mm, after venoplasty was

4.07 mm, and three months post-procedure was 5.78 mm. In the volume flow obtained, the mean volume flow before venoplasty was 255.96 ml/m, after venoplasty was 374.56 ml/m, and three months post-procedure was 794.56 ml/m. For peak systolic velocity, obtained the mean before venoplasty was 71.96 cm/s, after venoplasty was 88.27 cm/s, and three months after the procedure was 116 cm/s. From the ultrasound, procedure of venoplasty increased the diameter of draining vein, volume flow, and peak systolic velocity.

From table 6, the results of the ultrasound examination (diameter of draining vein, volume flow, and peak systolic velocity), a significant increase was obtained after venoplasty when compared to before treatment ($p<0.001$).

From table 7, statistical tests showed that the results of ultrasound examination analysis (draining vein diameter, volume flow, and peak systolic velocity) showed a significant increase at three months post-venoplasty follow-up when compared to before venoplasty ($p<0.001$).

From table 8, the results of ultrasound examination (diameter draining vein, volume flow, and peak systolic velocity) obtained a significant increase at three months post-venoplasty follow-up when compared to post-treatment ($p<0.001$).

DISCUSSION

In this study, there were 66 subjects of AVF stenosis who underwent venoplasty in Cipto Mangunkusumo National Hospital and Hermina Bekasi Hospital during the period of 1st December 2016 to 31st May 2017. From the demographic distribution, the subjects were displayed in age, gender, and underlying disease. Most subjects were in the 50-60 years age group (40.9%) and male (59%). The most underlying disease caused by hypertension was 93.9%, and diabetes mellitus was 42.4%. This is consistent with Indonesian Renal Registry data. (3) showed that age and gender did not correlate statistically with the success of venoplasty in AVF stenosis subjects. The same result was found in underlying diseases, which were hypertension, diabetes mellitus, autoimmune diseases, and kidney disease.

Distribution of clinical symptoms of CKD patients with AVF stenosis mostly were found to be

Table 5. Results of ultrasound examination before, after, and 3 months after venoplasty.

Variable	Mean									
	Before venoplasty			After venoplasty			Three months after venoplasty			
	Mean	SD	Median	Min	Max	Mean	SD	Mean	Median	Max
Diameter draining vein	3.33	0.93	3.15	2.1	6.8	4.07	0.99	3.9	2.8	6.8
Volume flow	255.96	79.89	234	152	416	374.56	142.53	315	201	650
Peak systolic velocity	71.96	13.70	72.5	33	102	88.27	13.20	89	45	112
								116.28	12.37	149

maturing failure as many as 29 people (43%), low dose hemodialysis (42.4%), tortuosity and widening of draining vein were found in 6 people (9.1%), difficulty in cannulation was found three people (4.6%). One of the literature mentioned symptoms of skin necrosis or aneurysm, which was not found in this study (12). The distribution of stenosis in patients with chronic kidney disease with AVF stenosis was equal to 40 people (46.5%) of juxta anastomosis and draining vein. In comparison, stenosis in the arterial area was six people (7%). Juxta anastomosis stenosis is a stenosis that occurs at 3-4 cm from the arterial anastomosis. This is the most common location, especially in AVF, that fails to mature with clinical picture decreasing access blood flow.⁴

From the results of venography in this study, AVF stenosis locations <30% and 30-50% were mostly found in the draining vein. As for the location of AVF stenosis >50%, mostly found in juxta anastomosis. However, the analysis test found no correlation of venographic results with the location of AVF stenosis. After venoplasty, the residual location of complete AVF was found in the two most locations, which were draining vein (22 patients) and juxta anastomosis (20 patients). As for the location of residual AVF stenosis <30%, it was found in the majority of anastomoses. The analysis test found a significant relationship between the results of venoplasty and the location of AVF stenosis. From the ultrasound examination, the mean diameter of the draining vein obtained before venoplasty was 3.33 mm, after venoplasty was 4.07 mm, and three months after the procedure was 5.78 mm. In the examination of volume flow, the average volume flow obtained before venoplasty was 255.96 ml/m, after venoplasty was 374.56 ml/m, and three months after the procedure was 794.56 ml/m. For the examination of peak systolic velocity, the mean obtained before venoplasty was 71.96 cm/s, after venoplasty was 88.27 cm/s, and three months after the procedure was 116 cm/s.

From the results of the ultrasound examination analysis, there was a significant increase in the diameter of the draining vein, volume flow, and peak systolic velocity after venoplasty when compared with before the procedure. At three months post-venoplasty follow-up, there was a significant increase in vein diameter, volume flow, and peak systolic velocity compared with before venoplasty. The results of the ultrasound examination before venoplasty, after venoplasty, and three months after the venoplasty, found that the venoplasty can increase draining vein diameter, volume flow, and peak systolic velocity. Data regarding the use of duplex ultrasonography in AVF monitoring is minimal, but in a four randomized trial study, evaluated access flow-based monitoring in native AVFs was proven to prevent thrombosis in AVF access (RR 0.45, 95%CI 0.28-0.77). However, this does not reduce the risk of losing access or extending usage time.⁵ PTA is the treatment of choice because it can maintain AVF function and relieve symptoms of vein hypertension. However, there is a tendency for high initial restenosis to cause a primary patency rate of about 40% in 1 year. The clinical use of stents against elastic recoil should be considered after PTA and early or recurrent restenosis. But it is still debated whether primary stenting can improve this.⁶

The limitations of this study were mainly because the data were taken retrospectively based on medical records. Some recorded medical data such as

Table 6. Relationship of ultrasound examination before and after venoplasty.

Variable	Before venoplasty	After venoplasty	P
Diameter draining vein	3.33	4.07	<0,001
Volume flow	255.96	374.59	<0,001
Peak systolic velocity	71.96	88.27	<0,001

Table 7. Relationship of ultrasound examination before and after 3 months venoplasty.

Variable	Before venoplasty	After venoplasty	P
Diameter draining vein	3.33	5.78	<0,001
Volume flow	255.96	794.56	<0,001
Peak systolic velocity	71.96	116.28	<0,001

Table 8. Relationship of the results of ultrasound examination after the procedure and 3 months after the venoplasty.

Variable	Before venoplasty	After venoplasty	p
Diameter draining vein	4.07	5.78	<0,001
Volume flow	374.59	794.56	<0,001
Peak systolic velocity	88.27	116.28	<0,001

the percentage of initial stenosis and residual stenosis were not available until a repeat measurement was performed by researchers, not by operators, to create a bias. Then this study only took two hospitals as a sample. The results of the ultrasound examination in the form of draining vein diameter, volume flow, and peak systolic velocity can be different because they are dependent operators and were carried out by many operators to provide bias to the results.

Further research should be carried out on a multicenter location as well as more time to obtain a larger and more varied sample size. An ultrasound examination should be carried out by one operator with the same ultrasound device to reduce bias. When using an additional operator, an ultrasound inspection protocol must be made to eliminate bias.

CONCLUSION

Characteristics of people with chronic kidney disease with AVF stenosis were found mostly in the age groups of 50-60 years (40.9%), male sex (59%), and the most common underlying disease was caused by hypertension of 93.9% and diabetes mellitus by 42.4%. There was a significant relationship between age and sex with the size of AVF stenosis that occurs. Analysis between the underlying disease and the

location of AVF stenosis with the size of stenosis found no significant relationship. A significant relationship was found between the location of AVF stenosis and the success of venoplasty. There was a significant relationship between the results of the ultrasound examination (diameter draining vein, volume flow, and peak systolic velocity) on the results of venoplasty after the procedure or three months after the procedure.

CONFLICT OF INTEREST

The author states the original work, and there is no conflict of interest in doing this research.

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