

COMPLICATIONS RELATED COMORBIDITIES OF ARTERIOVENOUS FISTULA (AVF) CREATION AS HEMODIALYSIS ACCESS FOR END STAGE RENAL DISEASE (ESRD) IN BEN MBOI DISTRICT HOSPITAL, RUTENG FLORES INDONESIA

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ABSTRACT

Introduction: Since Brescia and Cimino (1966) posted AV Fistula technique, there has been increase of long term survival of patients with End Stage Renal Disease (ESRD). AV fistula has its own set of indications, benefits, and complications.

Purpose: To show AV Fistula creation outcomes, complications and its related comorbidities in Ben Mboi District Hospital, Ruteng Flores Indonesia

Method: An analytical study design using a cross sectional approach was employed in this study. Using medical record data from 2019 to 2022, all men and women who received hemodialysis through AV Fistula were included. Bivariate analysis was carried out from baseline data such as age, sex, comorbidities, location of an av fistula (AVF), previous dialysis insertion with complications that arise using Chi-square.

Results: Age, sex, hypertension and AV Fistula creation location has no significant correlation with complications such as failed to mature, thrombosis, infection, venous hypertension. Diabetes mellitus has a significant correlation with occurrence of failed to mature (p=0.012), thrombosis (p=0.014), venous hypertension (p=0.08). Obesity has a significant correlation with occurrence of failed to mature (p=0.000), thrombosis (p=0.000). Previous insertion of CDL in right subclavian vein has a significant correlation with occurrence of venous hypertension (p=0.000).

Conclusion: Diabetes mellitus has a significant correlation with occurrence of complications such as failed to mature, thrombosis and venous hypertension. Obesity has a significant correlation with occurrence of failed to mature and thrombosis. History of CDL insertion in right subclavian vein has a significant correlation with venous hypertension.

Keywords: End stage renal disease, Vascular access, Arteriovenous fistula, Complications, Comorbidities

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INTRODUCTION

The number of people with end-stage renal disease who require kidney transplants continues to rise worldwide. According to the Global Burden of Disease survey, end-stage renal disease (ESRD) was one of the world's largest cause of death in 2010. More than 2 million patients worldwide get dialysis or a kidney transplant, although only around 10% receive those treatments¹. Every year, 10% of the world's population suffers from end-stage renal failure due to a lack of therapy. End Stage Renal Disease (ESDR) affected around 113,136 individuals in the United States in 2011, with diabetes and hypertension being the leading causes. According to the Ministry of Health of the Republic of Indonesia, as many as 2 out of every 1000 people, or 499,800 Indonesians, suffer from renal failure. Men had a greater frequency of renal failure than women. The highest prevalence was in the age group over 75 years old, and it began to rise from the age of 35 and above¹⁻³.

The Gold Standard therapy for end-stage renal disease is kidney transplantation; however, not every hospital in the world, particularly in developing countries such as Indonesia, can conduct kidney transplants. Hence peritoneal dialysis or vascular dialysis is used instead. Short- and long-term central dialysis catheters, as well as arteriovenous fistulas, are two forms of vascular access that can be used for hemodialysis (AVF). An arteriovenous fistula is an autologous arteriovenous access created by connecting a vein to the patient's artery, making the vein easily accessible^{2,4,5}.

Each type of vascular access for dialysis has its own set of indications, benefits, drawbacks, and issues. In comparison to dialysis catheter installation (CDL), KDOQI

promotes Arteriovenous Fistula access (AVF) as a permanent dialysis treatment alternative. After surgery for an arteriovenous fistula (AVF), two things must be considered: complications and maturation. Many research in many locations in Indonesia have described vascular access profile data^{6,7}. However, there are few studies that thoroughly explain and detail difficulties, and there is no data on vascular access especially AVF in places with limited facilities, such as on the island of East Nusa Tenggara. Data on vascular access and associated difficulties will be provided in this study at Ben Mboi District Hospital in Ruteng, Flores, Indonesia.

METHODS

An analytical study design using a cross sectional approach was employed in this study. Using medical record data from 2019 to 2022, this study was undertaken at the Ben Mboi District Hospital's departments of surgery, internal medicine, and the hemodialysis facility. In this study, all men and women who received hemodialysis through arteriovenous fistula were included (AVF).

Gender, age, comorbid diseases history of hypertension, diabetes mellitus, and obesity, location of AV-fistula creation, location of previous dialysis catheter insertion, and complications caused by AV-fistula creation were the basic data collected in this study. Radio-cephalic (RC), brachio-cephalic (BC), and basilic vein transposition (BVT) were the three principal fistula sites employed. An end-to-side surgical method was used for all AVF procedures. Infection, thrombosis, venous hypertension, pseudoaneurysm, and steal syndrome are complications of AV-fistula found. Due to the absence of

diagnostic equipment at Ben Mboi District Hospital, the majority of AV-fistula complications are identified by history taking and physical examination without the use of Doppler ultrasonography studies.

Data analysis was performed using SPSS. Bivariate analysis was carried out from

baseline data such as age, age, comorbid diseases causing kidney failure, location of an av fistula (AVF), with complications that arise using Chi-square. Prior to bivariate analysis, data normality was tested using the Kolmogorov Smirnov or Shapiro–Wilk test.

RESULTS

Hemodialysis Patient Profile

Table 1 Hemodialysis Patient Profile

Gender	Total
Men	38
Women	27
Age	Total
0-30	3
31-60	38
>60	24
Risk Factor	Total
Diabetes Mellitus (DM)	50
Hypertension	28
Obesity	15
AVF Creation Location	Total
Radio-cephalic (RC)	41
Bracio-cephalic (BC)	19
Basillic vein transposition (BVT)	5
CDL Insertion Location	Total
Femoral (S)	15
Femoral (D)	26
Subclavia (D)	24
Subclavia (S)	-
Jugular (S)	-
Jugular (D)	-

In this study, 65 people underwent hemodialysis using an arteriovenous fistula (AVF). In the gender category, there were 38 males (58.4%) and 27 females (41.6%). From the age group category, there were 3 patients in the 0 until 30-year-old age group (4.6%), the 31-60 year age group had 38 patients

Table 2 Hemodialysis Complication Profile

Complication	Total
Failed-to-Mature	15
Thrombosis	15
Infection	7
Bleeding	2
Venous Hypertension	16
Pseudoaneurysm	4
Steal Syndrome	1

(58.4%), the >60 year age group had 24 patients (37%). Each patient in this study could have one or more risk factors. In this study, 50 patients had risk factors for diabetes mellitus (76.9%), as many as 28 patients had risk factors for hypertension (37.3%) and 15 patients had risk factors for obesity (23%).

Moreover, in this study, there is data on the location of the AVF creation with a history of installing a double lumen catheter. From the AVF location data, 41 AVFs were created in Radio-cephalic (63%), 19 Brachio-cephalic AVFs (29.2%), 5 AVFs were created in Brachio-bacilic or bacillic vein transposition (7.8%). Of the 65 patients with AVF, all patients had a history of previous CDL insertion. Of the 65 patients, 15 patients had CDL placed on the left femoral vein, 26

patients had CDL placed on the right femoral vein, 24 patients had CDL on the right subclavian vein.

Patients in this study may have one or more complications due to AVF creation. Complications failed-to-mature occurred in 23.07% (15/65), thrombosis 23.07% (15/65), infection 10.7% (7/65), bleeding 3.07% (2/65), venous hypertension 24.61% (16/65), pseudoaneurysm 6.15% (4/65), steal syndrome 1.53% (1/65).

Complications of Failed-to-Mature with Gender, Age, AVF Creation Location, Hypertension, Diabetes Mellitus and Obesity

Table 3. Failed To Mature Complication And Risk Factor Statistical Analysis

Risk Factors for Failed-to-Mature Complication	Total	P
Age	15	0.486
Gender	15	0.360
Diabetes Mellitus	15	0.012
Hypertension	9	0.131
Obesity	12	0.000
AVF Creation Location	15	0.393

The results of statistical analysis showed that age ($p=0.486$), gender ($p=0.360$), hypertension ($p=0.131$), location of AVF creation ($p=0.393$) had no effect when it was associated with the incidence of failed to

mature. Meanwhile, the risk factors for diabetes mellitus ($p=0.012$) and obesity ($p=0.000$) had an effect on the incidence of failed-to-matur

Thrombosis Complications with Gender, Age, AVF Creation Location, Hypertension, Diabetes Mellitus and Obesity

Table 3. Thrombosis Complication And Risk Factor Statistical Analysis

Risk Factors for Thrombosis Complication	Total	P
Age	15	0.322
Gender	15	0.360
Diabetes Mellitus	15	0.014
Hypertension	8	0.360
Obesity	11	0.000
AVF Creation Location	15	0.393

The results of the statistical analysis showed that age ($p=0.322$), gender ($p=0.360$), hypertension ($p=0.360$), location of AVF creation ($p=0.393$) had no effect when

associated with the incidence of thrombosis. Meanwhile, the risk factors for diabetes mellitus ($p=0.014$) and obesity ($p=0.000$) had an effect on the incidence of thrombosis

Complications of Infection with Gender, Age, Hypertension, Diabetes Mellitus and Obesity

Table 4. Infection Complication And Risk Factor Statistical Analysis

Risk Factors for Infection Complication	Total	P
Age	7	0.559
Gender	7	0.426
Diabetes Mellitus	6	0.502
Hypertension	3	0.990
Obesity	7	0.559
AVF Creation Location	7	0.484

The results of statistical analysis showed that age ($p=0.559$), gender ($p=0.426$), diabetes mellitus ($p=0.502$), hypertension ($p=0.990$),

obesity ($p=0.559$), location of AVF creation ($p=0.484$) did not have an effect when associated with the incidence of infection.

Complications of Venous Hypertension with Hypertension, Diabetes Mellitus and Obesity and the location of the previous dialysis catheter insertion.

Table 5. Venous Hypertension Complication And Risk Factor Statistical Analysis

Risk Factors for Venous Hypertension Complication	Total	P
Age	16	0.720
Gender	16	0.271
Diabetes Mellitus	16	0.008
Hypertension	7	0.950
Obesity	5	0.371
AVF Creation Location	16	0.345
Right subclavian vein CDL insertion	16	0.000

The results of statistical analysis showed that age ($p=0.720$), gender ($p=0.271$), hypertension ($p=0.950$), obesity ($p=0.371$), location of AVF creation ($p=0.345$) had no effect when associated with the incidence of venous hypertension. Meanwhile, the risk factors for diabetes mellitus ($p=0.008$) and the location of the CDL insertion in the right subclavian vein ($p=0.000$) affected the incidence of venous hypertension.

Discussion

Hemodialysis is frequently used as a renal replacement treatment in patients with ESRD¹⁻³. The presence of vascular access cannot be isolated from the hemodialysis process running according to the objective of achieving its adequacy. For individuals undergoing normal hemodialysis, arteriovenous fistula (AVF) is the optimum vascular access option. According to KDOQI, every patient with stage 4 chronic renal disease should be prepared for an

arteriovenous fistula before starting hemodialysis^{8,9}. The essential necessity for effective hemodialysis therapy is access to adequately functioning hemodialysis.

From 2019 to 2021, 65 individuals with chronic renal disease were given access to hemodialysis via an arteriovenous fistula (AVF). End-to-side anastomosis surgery was used to create arteriovenous fistulas in radiocephalic, braciocephalic, and basilic vein transposition^{8,10,11}. An arteriovenous fistula was established in the upper extremity, utilizing the blood artery as far away from the hand as feasible and on the non-dominant side. Due to the limits of equipment such as Doppler USG, the surgeon uses a physical examination to identify the target blood arteries. Preoperative planning is essential for the effective development of an arteriovenous fistula. Diameter, flow velocity, artery wall thickness, and the presence or absence of calcifications are all examined during an arterial examination. The recommended arterial diameter is $>2\text{mm}$ ^{12,13}.

The examination of veins involves both superficial and deep veins. The diameter of the cephalic vein to the axillary vein, venous flow, the presence of thrombus or stenosis, the depth of the vein to the skin, and the length of the straight segment of the vein are all examined¹⁴. According to Ferring et al. (2017), the success rate of arteriovenous fistulas was 74% when the vein diameter was greater than 2mm, and 29% when the diameter was less than 2mm. Cannulation veins have a straight segment length of roughly 8-10 cm and are placed approximately 6mm from the skin¹⁵. The arterial vein examination cannot be completed thoroughly due to restricted facilities.

In this study, 38 male patients (58.4%) and 27 female patients (41.6%). A meta-

analysis study by the Mayo Clinic in 2020 showed through data from several previous retrospective studies that men have a tendency to fall into a state of chronic kidney failure more quickly than women. The most common age group in this study was 31-60 (58.4%) followed by the age group >60 (37%) 0-30 (4.6%)¹⁶. In this study, patients with ESRD with a history of diabetes mellitus were 50 of 65 patients (76.9%), while patients with a history of hypertension were 28 of 65 patients (37.3%) and obesity were 15 of 65 patients (23%). A study by Ghaderian and Mousavi in 2014 stated that in developing countries, the majority of patients with ESRD have comorbidities such as obesity, diabetes, and hypertension¹⁷.

Failed-to-Mature

Maturation arteriovenous fistula (AVF) can develop 4-6 weeks after surgery. Primary maturation failure occurs when the fistula cannot be utilised in some situations. Failed fistula maturation occurred in 15 participants (23.07%) in this research. This is consistent with the findings of Al Jaishi et al. (2017), who found that the failure rate of AVF maturation was 20%-33%¹⁸. According to Allon and Robbin (2002), AVF maturation failure might range between 20% and 60%¹⁹. The risk factors for maturation failure in general are unknown. However, variables such as old age, obesity, diabetes mellitus, and cardiovascular disease may play a role. In this study, 15 patients (100%) were obese ($p=0.012$), and 12 patients (80%) were obese ($p=0.000$).

Yan et al. discovered that failure to mature was considerably higher in people with diabetes mellitus compared to non-diabetics in a meta-analysis study. Diabetes mellitus is hypothesized to increase the chance of platelet aggregation and boost von

Willebrand factor, causing damage to vascular endothelial cells, while the mechanism of causation remains uncertain. Diabetes also enhances the formation of thrombus^{7,20}.

Obesity is another issue that contributes to difficulties that do not mature. According to Kats et al. (2007), obese individuals experienced more failed to mature problems than non-obese patients. According to the study, the failure of maturation in obese people might be caused by the decreased size of blood vessels²¹. Obese individuals also require venous transposition to assist cannulation during the hemodialysis process. Obese people also have blood that is more hypercoagulable than non-obese patients, which increases the risk of thrombosis²⁰.

Thrombosis

Thrombosis, which develops 30 days after surgery, is a common early complication in all type arteriovenous fistulas. Technical issues, hypotension, blood hypercoagulability, or the presence of lesions in the proximal or central veins are all factors that might lead to thrombosis^{18,22,23}. Thrombosis occurred in 15 (23.07%) of the participants in this research. Early AVF thrombosis is mostly caused by inflow issues (juxta-anastomotic stenosis or accessory vein). Hypotension, elevated hemoglobin levels, and hypercoagulability are all risk factors for thrombosis. Female gender and diabetes are two patient variables. In this study, 15 individuals with thrombotic problems had diabetes mellitus risk factors in as many as 15 people (100%) ($p=0.014$) and obese risk factors in as many as 11 people (73.3%) ($p=0.000$). Diabetes contributes to angiopathy complications. Angiosclerosis and tunica intima injury occur concurrently, making thrombosis easy. Hyperglycemia and

elevated glycosylation end products cause harm to the inner walls of blood vessels and impair their flexibility. Atherosclerosis is more common in diabetic and obese people, generating lesions and blood vessel blockage, leading in thrombosis. Lipid buildup develops in the blood vessel walls at the anastomosis⁷.

Infection

Infection is a frequent complication that can develop after any type of surgery, including AVF formation. Infections in arteriovenous fistulas are known to occur at a rate of 0.5-5% each year. Patient hygiene, diabetes, obesity, skin excoriation, and buttonhole cannulation are all risk factors for infection in AVF¹⁰. Staphylococcus aureus and Staphylococcus epidermidis are the most common bacteria that cause infection. 7 participants (10.7%) in this research suffered infectious problems. A total of 6 patients (85.7%) ($p=0.502$) with infection had diabetes risk factors. In this research there is no significant correlation between AVF infection and diabetes mellitus, due to small size of samples and good precaution such as washing the AVF access site before entering the hemodialysis unit might help to prevent infection. It has been demonstrated that using sterile gloves and disinfecting with antiseptic fluids such as chlorhexidine and alcohol prior to needling reduces the risk of infectious complications in AVF. Extra measures should be taken in patients who use the buttonhole approach for dialysis cannulation, such as providing a topical antibiotic after needle removal²⁴.

Infection in arteriovenous fistulas is managed by administering broad-spectrum antibiotics while waiting for culture results and treating the source of infection. The length of antibiotics is determined by the

severity and spread of the infection. Surgical therapy is administered based on the surgeon's assessment of the amount and location of the infection, the existence of systemic symptoms, and the selection of the next access point²⁵.

Venous Hypertension

In this study, 16 individuals (24.61%) had venous hypertension consequences. As many as 16 individuals (100%) with venous hypertension, had a risk factor for central dialysis catheter insertion on the ipsilateral side of the right subclavian vein. Mittal et al (2016) conducted a research in 37 individuals with venous hypertension who had a history

of central dialysis catheter insertion^{26,27}. The presence of turbulent blood flow induces intimal hyperplasia and generates an inflammatory response. Venous hypertension is normally asymptomatic; however, symptoms may develop if AVF is established. When there is stenosis, increasing flow rates are decompensated, resulting in symptoms such as edema. The symptoms of edema will intensify if the collateral circulation is unable to tolerate hemodynamic compensation. Other symptoms include fingertip ischemia, neuralgia, and amputation in more severe instances^{28,29}.



Figure 1. Clinical Picture of Central Vein Stenosis and Venous Hypertension in Patient with AVF (Source: Gerardo's Documentation)

Pseudoaneurysm

In this study, 4 patients (6.51%) had pseudoaneurysm problems. When the vessel wall is traumatized, pseudoaneurysms or fake aneurysms can form. Because to the presence of this wound, blood leaks into the surrounding tissue, forming a mass. Another

cause of pseudoaneurysm includes infection at the site of the AVF anastomosis, as well as iatrogenic causes during surgery. Pseudoaneurysm can also arise as a result of numerous punctures during blood vessel cannulation caused by rips in the two layers of the tunica media or tunica intima blood

vessels. Physical examination along with Doppler ultrasonography is used to diagnose pseudoaneurysm patients. The KDOQI recommends surgical repair for the treatment of pseudoaneurysms^{2,6,30}.

The treatment principle for pseudoaneurysm therapy is to eliminate the primary reasons, which include excessive

fistula flow discharge, stenosis of the distal venous outflow, and the source of the fistula leaking into the third cavity. AVF ligation followed by pseudoaneurysm excision is the standard therapy for a pseudoaneurysm. All patients in this research got pseudoaneurysm repair treatment while keeping their existing AVF access^{6,31}.



Figure 2. Clinical Picture of Pseudoaneurysm in Patient with AVF (Source: Gerardo's documentation)

Ischemic Steal Syndrome

Ischemic steal syndrome is a problem that might develop in 1-20% of AVF patients. During dialysis, clinical symptoms such as cold, paleness, paresthesia, or discomfort may develop. The systolic index ratio can be measured by measuring blood pressure at the distal fistula compared to the proximal side of the fistula or the contralateral extremity to identify ISS. ISS is a rare complication caused by compensatory vasodilation in the distal arteries and collateral development^{32,33}. Diabetes mellitus, peripheral arterial disease, age greater than 60 years, women, and recurrent surgery on the same leg are all risk factors for the development of ISS. Ischemia in the extremities caused by ISS

raises the chance of amputation. Reduced or reversed flow in the arterial segment distal to the AVF might produce ischemia in the ISS. Fistula banding or revascularization with Distal revascularization, interval ligation (DRIL), Revision utilizing distal inflow (RUDI), and Proximal arterial inflow graft (PAI) methods are used to treat ISS³⁴. There was one case in this research where the steal syndrome was suspected. The patient felt discomfort at rest and while on dialysis, as well as necrosis of the fingers. Physical examination indicated that the saturation of the fingers had decreased. Patients were directed to a facility with more comprehensive diagnostic capabilities and more skilled surgeons.

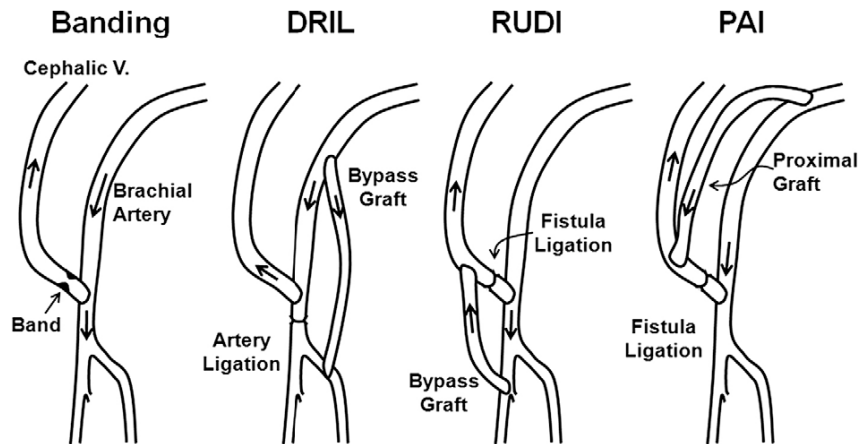


Figure 3. Schematic Surgery Picture in Ischemic Steal Syndrome Treatment³⁴

CONCLUSION

Diabetes mellitus has a significant correlation with occurrence of complications such as failed to mature, thrombosis and venous hypertension. Obesity has a significant correlation with occurrence of failed to mature and thrombosis. History of CDL insertion in right subclavian vein has a significant correlation with venous hypertension.

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