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Comparison of primary patency of radiocephalic and brachiocephalic arteriovenous fistula in East Borneo, Indonesia

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ABSTRACT

Background: There is still very limited study available for patency of arteriovenous fistulas (AVF) from developing country, specifically in East Borneo, Indonesia. The aim of this study is to compare the primary patency rate between radiocephalic (RC) and brachiocephalic (BC) AVF and to analyze the risk factors involved in the primary patency results of AVF RC and BC for hemodialysis.

Methods: This study is a retrospective cohort study with a total of 154 patients underwent AVF from February 2017 until august 2018 and were monitored until august 2019. The patient's primary patency of AVF was evaluated by the Kaplan-Meier survival curve. Each of the risk factors that were predicted to influence patency was analyzed for each AVF.

Result: The mean age of 154 patients was 52.9 ± 9.5 years old. RC AVF was made in 130 patients (84.4%) and BC AVF was made in 24 patients (15.6%). There was no significant difference between the estimated primary patency for the RC group and BC AVF, the log-rank test (p=0.15). Risk factors for age, gender, hypertension, DM, and frequency of hemodialysis in both AVF showed statistically insignificant for primary patency.

Conclusion: Our study showed there was no significant difference in the primary patency rate between the RC AVF and BC AVF group and other risk factors not significantly affecting primary patency in either type of AVF.

Keywords: arteriovenous fistulae, patency, vascular access, end-stage renal disease, hemodialysis.
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BACKGROUND

Chronic kidney disease is one of the long-term health problems that have a high prevalence, estimated to involve 5-10% of populations worldwide.[1,2] According to recent guidelines by Kidney Disease Outcomes Quality Initiative (KDOQI), renal replacement therapy was recommended in all individuals with an estimated Glomerular Filtration Rate <30ml/min/1.73m.[2,3] In many countries, hemodialysis has been widely accepted as the most common renal replacement therapy strategy used for chronic kidney disease, and the provision of effective vascular access is fundamental for successful hemodialysis.[4]

Currently, AVF is recommended by many guidelines as the first line of permanent vascular access for hemodialysis. The benefit of AVF includes decreased mortality, a lower rate of infection and complication.[5] There are three fundamental types of AVF, which are radiocephalic (RC), brachiocephalic (BC), and brachial-basilic.[6] Distal RC AVF is the primary choice to preserve future access attempts.[7]

The patency of AVF is the primary determinant of dialysis effectivity, however, it was affected by numerous factors, and thus needing further research.[8] Meanwhile, most of the data comes from developed countries, and there is a limited amount of study from developing countries such as Indonesia, particularly East Borneo. In this study, we aim to compare the primary patency rate between RC and BC AVF, and to determine the effects of gender, hypertension (HT), diabetes mellitus (DM), elderly patients, and frequency of hemodialysis on primary patency outcomes of AVF RC and BC for hemodialysis in East Borneo.

METHODS

Data Collection

A retrospective cohort study was conducted at Abdul Wahab Sjahranie Hospital between February 2017 and August 2018, involving all patients who underwent AVF processing. Their fistulas were then monitored until August 2019. All patients are classified into two groups RC and BC AVF. Demographics, patient management, and clinical variables are included in the data obtained from medical records. Patients were followed up to first access dysfunction or any intervention by phone.

The inclusion criteria were: a) Patients aged 20 to 75 years old, with chronic kidney disease in stages 4 and 5; b) Patients who

underwent RC and BC AVF surgery for the first time. While the exclusion criteria were: a) Patients who have declined to become participants of the research; b) Patients with arteriovenous grafts. The ethical approval was obtained from the Clinical Research Ethics Committee of Abdul Wahab Sjahranie General Hospital, Samarinda, East Borneo, Indonesia.

Surgical technique

Patients underwent preoperative clinical examination, with doppler ultrasound as a complement. The first choice for AVF is RC at the wrist level, if the arterial or vein diameter is less than 2 mm from USG doppler, or if there has been stenosis and thrombosis in the artery (inflow) or vein (outflow), the access option switches to BC. All fistulas were created under local anesthetic. Saline was injected to dilate the cephalic vein before anastomosis, and end-to-side anastomosis was achieved by continuous suture using double-armed polypropylene 7-0 for all patients. Both preoperative clinical assessment and surgery were performed by a certified cardiothoracic-vascular surgeon in Abdul Wahab Sjahranie.

Definition of maturation

An ultrasound will be performed four to eight weeks after surgery and the AVF is said to be mature if the minimum length is 6 cm, the diameter of the draining vein is ≥ 5 mm, the distance from the skin to the vein is < 6mm, 6-week post-AVF creation or at least six times usage, and the blood flow is ≥ 600 ml/min.[3,9]

Definition of variables & Statistical analysis

Meaning of primary patency of AVF as per the European Society of Vascular Surgery (ESVS) is the interval from the first time an AVF has created to relinquishment or to the first re-intervention for maintaining AVF patency or thrombosis. Hypertension is defined as systolic blood pressure of ≥140 mmHg and/or diastolic blood pressure of 90 mmHg or greater.[10] The cut-off of elderly by WHO definition is anyone who is 60 years of age or more.[11] Diabetes mellitus is fasting plasma glucose values of ≥126 mg/dL (7.0 mmol/L), two-hour post-oral glucose challenge values of ≥200 mg/dL (11.1 mmol/L), and HbA1C values ≥6.5%.[12] Risk factors were introduced as categorical variables and a chi-squared test was utilized to measure differences between the two AVF groups.

Analytical Statistics

The primary patency of AVF was determined by the Kaplan-Meier survival curve. To evaluate the differences between curves and multivariate hazard ratio of risk factors, the log-rank test and cox proportional hazard regression were used respectively. The multivariate analysis was then used to evaluate risk factors. The patient was censored in the event of death, changed to a different treatment modality, final measurement of patency, or discontinued hemodialysis. The respective endpoints were the date of the first intervention or AVF failure. All statistical analyses were completed using SPSS software (version 25.0).

RESULTS

There were a total of 154 patients between February 2017 and August 2018. The average age of the patients is 52.9 ± 9.5 years old. Out of 152 patients, 87 (56.5%) were males, and 67 (43.5%) were females. RC and BC AVF was created in 130 patients (84.4%) and in 24 patients (15.6%), respectively. This study revealed that 57 patients (37.0%) had diabetes mellitus type 2 (DMT2), 96 patients (62.3%) had a history of hypertension and 33 patients (21.4%) were eligible for elderly criteria. Among them, 38 patients undergo frequent hemodialysis once a week and 116 patients more than once a week. Patient characteristics are listed in **Table 1**, and clinical characteristics are based on the type of AVF in **Table 2**.

The primary patency of both AVF was illustrated in **Figure 1** by using the

Table 1. Patients Demographic of the study population at the time of AVF placement

Variables	N=154
Age	20-75 years old
Elderly	33 (21.4%)
Gender	
Male	87 (56.5%)
Female	67 (43.5%)
Anastomosis Type	
Radiocephalic	130 (84.4%)
Brachiocephalic	24 (15.6%)
Underlying disease	
Diabetes Mellitus type II	
Yes	57 (37.0%)
No	97 (63.0%)
Hypertension	
Yes	96 (62.3%)
No	58 (37.7%)
Frequency of Hemodialysis	
Once a weeks	38 (24.7%)
More than once a week	116 (75.3%)

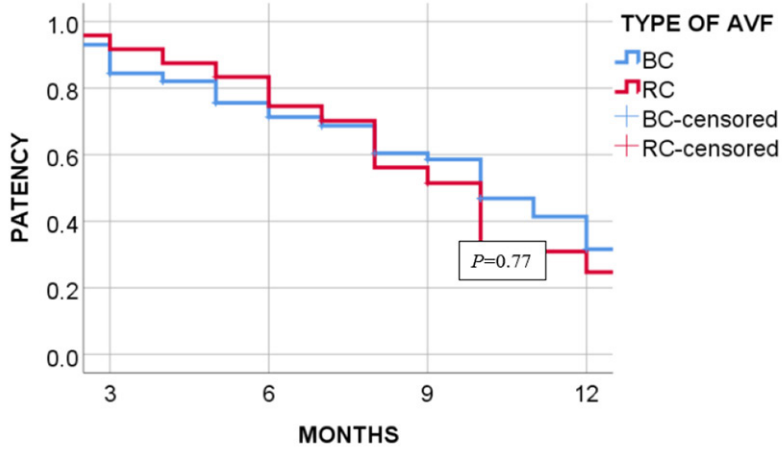
Table 2. Clinical Characteristics of the study population at the time of AVF placement according to type of AVF

	RC N=122	BC N=30	P-Value
Male sex	68 (55.7%)	19 (63.3%)	0.27
Underlying disease			
HT	81 (66.3%)	14 (46.7%)	0.18
DM	38 (31.1%)	13 (43.3%)	0.96
Elderly	28 (23.0%)	5 (16.7%)	0.54
Frequency of hemodialysis (more than once a week)	66 (54.1%)	19 (63.3%)	0.28

Kaplan-Meier survival curve. Our study showed that the primary patency of BC AVF group is 92%, 75%, 52%, and 25% at 3, 6, 9, and 12 months respectively. five BC AVF patients remained patent (20.1%), and six patients (25.0%) died at the end of the study with functioning AVF.

In the RC group, the primary patency was 84%, 71%, 59%, and 32.0% at 3, 6, 9, and 12 months, respectively. There were 40 patients (30.8%) who remained patent, and 45 patients (34.6%) died (**Figure 1**). We found that all deaths are unrelated to the AVF complication and primary patency was found to be similar in both groups ($p = 0.15$).

Multivariate analysis using the cox proportional hazards regression analysis was performed considering the factors that significantly influence primary patency. From the risk factor analysis, we identified that risk factors for age, gender, hypertension, DM, and frequency of hemodialysis in both AVF showed statistically insignificant for primary patency (**Table 3,4**) (Figure 2-6). At the end of the study, it was found that about 45 av shunts were still usable, 51 patients died, 20 patients lost to follow-up, 1 patient stopped dialysis, 1 patient changed access to continuous ambulatory peritoneal dialysis, and there were 36 patients who experienced failure including 10 patients experiencing stenosis and underwent balloon angioplasty, 2 patients had aneurysms and underwent revision aneurysms, and 24 patients had thrombosis and underwent revised AV shunt.



	3	6	9	12
RC	84%	71%	59%	32%
BC	92%	75%	52%	25%

Figure 1. Kaplan-Meier Survival Curve for Primary Patency

Table 3. Factors associate with primary patency of BC AVF

Brachiocephalic			
Variables	Univariate	Multivariate	
	P - Value	HR (95% CI)	P - Value
Gender (male)	0.72	2.20 (0.58-8.24)	0.24
Hypertension	0.13	0.29 (0.70-1.19)	0.09
DM	0.87	0.80 (0.20-3.21)	0.75
Elderly	0.85	1.26 (0.24-6.68)	0.78
Frequency of Hemodialysis (more than once a week)	0.48	0.83 (0.24 – 2.85)	0.77

Table 4. Factors associated with primary patency of RC AVF

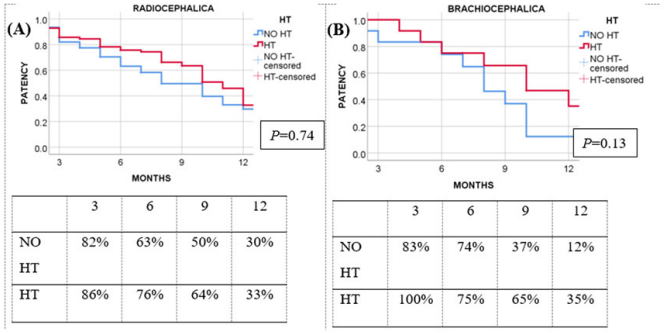
Radiocephalic			
Variables	Univariate	Multivariate	
	P - Value	HR (95% CI)	P - Value
Gender	0.95	1.05 (0.67-1.66)	0.82
Hypertension	0.74	0.81 (0.51-1.30)	0.39
DM	0.22	1.37 (0.87-2.15)	0.18
Elderly	0.39	0.85 (0.51-1.42)	0.53
Frequency of Hemodialysis (more than once a week)	0.99	1.07 (0.66 – 1.75)	0.78

DISCUSSION

Our retrospective study showed the primary patency of AVF outcome for hemodialysis patients within a single center over a one-year period. Additional information was thus provided on the differences in primary patency between RC and BC AVF in developing countries, particularly in East Borneo-Indonesia.

The latest KDOQI guideline recommends AVF as the first choice for hemodialysis access.[3] This recommendation is due to the superiority of RC and BC AVF in survival, complication, and intervention rates relative to another site or permanent vascular access.[5] This research consists mainly of RC access (84.4%), as it was commonly selected to maintain future access sites. In addition, it decreases the incidence of associated complication including high-flow access, vascular steal phenomenon, and arterial alteration of cardiac output.[13]

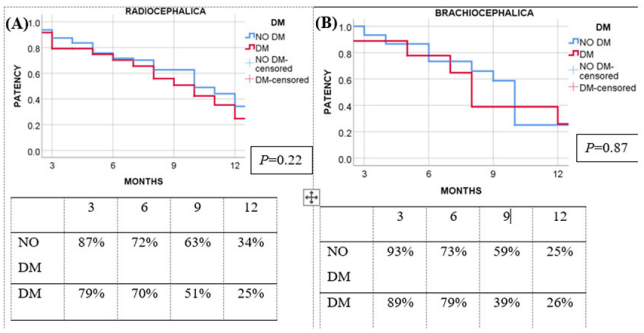
Our study shows statistically insignificant results between RC and BC groups on AVF patency (p=0.77) over a one-year period. This result is in line with Erkut B et al. who found there was a statistically insignificant difference between the two, and contrary to the study by Alecander C et al. which showed that primary patency of RC AVF was better than BC AVF in the first 12 months (81.5% vs. 62.1 %).[5,14] Other research found that routinely used BC AVF significantly increases patency and reduces the amount of time required to achieve maturation, this can be understood because turbulence



	3	6	9	12
NO HT	82%	63%	50%	30%
HT	86%	76%	64%	33%

	3	6	9	12
NO HT	83%	74%	37%	12%
HT	100%	75%	65%	35%

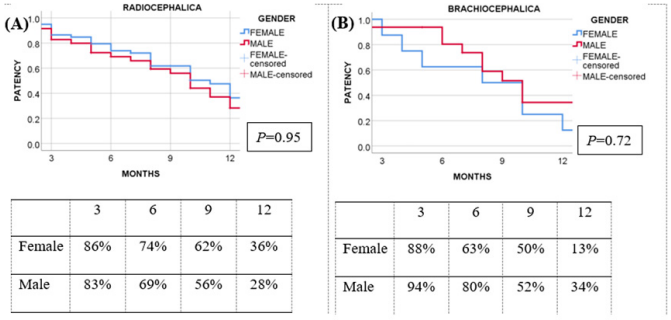
Figure 2. Kaplan-Meier Survival analysis of (a) RC AVF (b) BC AVF stratified by history of HT



	3	6	9	12
NO DM	87%	72%	63%	34%
DM	79%	70%	51%	25%

	3	6	9	12
NO DM	93%	73%	59%	25%
DM	89%	79%	39%	26%

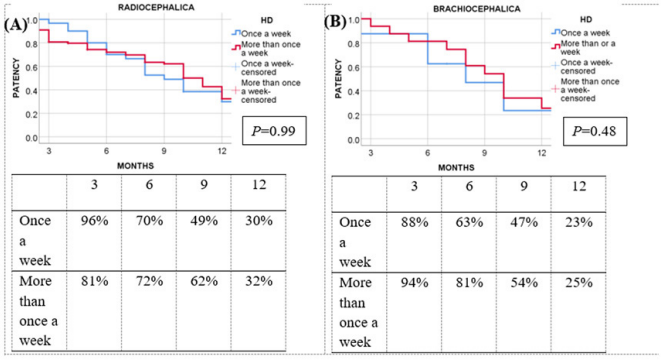
Figure 3. Kaplan-Meier Survival analysis of (a) RC AVF (b) BC AVF stratified by history of DM



	3	6	9	12
Female	86%	74%	62%	36%
Male	83%	69%	56%	28%

	3	6	9	12
Female	88%	63%	50%	13%
Male	94%	80%	52%	34%

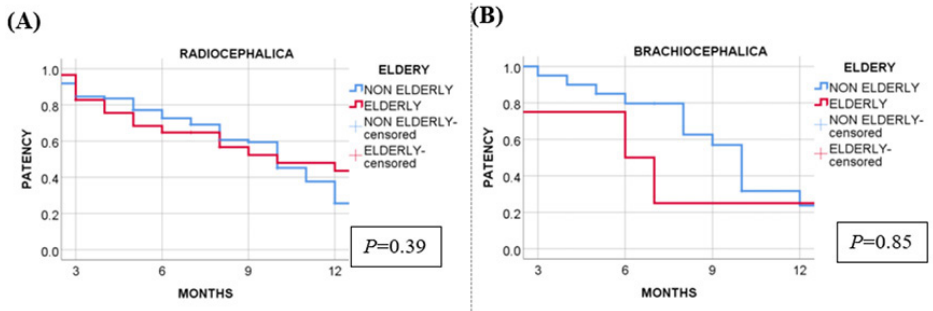
Figure 4. Kaplan-Meier Survival analysis of (a) RC AVF (b) BC AVF stratified by gender (male and female)



	3	6	9	12
Once a week	96%	70%	49%	30%
More than once a week	81%	72%	62%	32%

	3	6	9	12
Once a week	88%	63%	47%	23%
More than once a week	94%	81%	54%	25%

Figure 5. Kaplan-Meier Survival analysis of (a) RC AVF (b) BC AVF stratified by frequency of HD



	3	6	9	12
Non Elderly	85%	73%	59%	26%
Elderly	83%	65%	52%	44%

	3	6	9	12
Non Elderly	95%	80%	57%	24%
Elderly	75%	50%	25%	25%

Figure 6. Kaplan-Meier Survival analysis of (a) RC AVF (b) BC AVF stratified by age (elderly and non-elderly)

can be minimized as BC AVF has larger venous footplate and arteriotomy.[15] Additionally, a study for hemodialysis patients in Indonesia without making a difference between the type of access conducted by Yanto et al. showed that overall 6, 12, and 18-month primary patency rates of AVF were 88%, 85%, and 79%, respectively.[16] Other comparable kinds of literature are shown in **Table 5**. It has also been estimated that age and gender impact the primary patency. Male gender is an independent indicator of patency presumably due to the disparity in vascular caliber, where radial artery diameter is larger in males.[17] Over half of the population in our study is male (56.5%) and there was no significant difference in primary patency between gender. Primary patency may decrease in the elderly group due to the higher prevalence of atherosclerosis and comorbidities. Similar to the Beaulieu et al study, in this study, we found that elderly not significantly reduce primary patency in both types of AVF.[18]

Table 5. Comparison Between Previous Studies

Study	Subject	Study Design	Result
Alecander C, Wolf B, Joss N. (2017)[5]	128 patients	Retrospective, study	Primary survival rates at 6, 12, and 24 months were 73.4%, 61.6%, and 45.9%, respectively
Tjang Y, Sumadi G (2018)[16]	253 patients	Retrospective study	Primary patency rate at 6,12, and 18 months were 88%, 85%, and 79%
Kim J, Gifford E, Nguyen V (2015)[15]	213 patients	Retrospective study	Primary patency rate at 1 year, period 1:47%, period 2: 63%
Kazemzadeh GH, Modaghegh MHS, Ravari H, et al (2012)[22]	245 patients	Prospective study	Primary patency at 6 months, 1, 2, 3 and 4 years were 79.5%, 70%, 65%, 60.5% and 48% respectively.

In addition, our study also compared the patency between diabetic and non-diabetic along with hypertension and non-hypertension in RC and BC patients. We found diabetes not significantly affect patency in either AVF, this finding is comparable to a study by Kocaaslan et al. conducted on 87 people (43 diabetic and 44 non-diabetic patients) and it is said that the factor of arterial diameter and reduction of artery flow reduces primary patency.[19] According to Diehm et al. on the access outcome of diabetic female patients, they noticed that being female and diabetic are risk factors affecting the patency outcome.[20] In comparison, non-diabetic patients showed prolonged primary patency due to reduced arterial calcifications, greater vessel diameter as well as increased arterial peak systolic volume.[17] In our study we did not find a significant difference in patency between hypertensive and non-hypertensive patients. In hypertension, patency may be affected by an increase in vascular stiffness thus promoting arteriosclerosis and decreasing blood flow through the anastomosis.[21]

Frequency of hemodialysis in our patients consists of 38 patients (24.7%) who underwent hemodialysis once a week, and 116 patients (75.3%) more than once a week. Similar patency was observed in both frequency groups in our study. The mechanism of hemodialysis frequency affecting AVF patency is not yet understood, most likely hemostasis and altered blood flow in hemodialytic ESRD patients play a major role.[22]

In this study the risk factors which generally reduce primary patency were found to be insignificant, this is probably due to all patients who developed fistula undergoing pre-assessment by ultrasound, patients with small vessel diameter changed to another site or other hemodialysis access. This may explain why we did not find any risk factor that significantly reduces primary patency.

The limitation of this study is the information biases due to its retrospective design. The limited number of samples can also influence our outcome.

CONCLUSION

We conclude that the primary patency rate did not show significant differences between the RC AVF and BC AVF groups, and this study also did not find any risk factors that significantly affect primary patency in either type of AVF. However, in order to assess the long-term patency rate in each type of AV fistula, further analysis in large numbers and multi-centers would be required

CONFLICT OF INTEREST

None

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ETHICAL STATEMENT

This study was approved by the health research ethics committee at Wahab Sjahranie Samarinda Hospital (registration 251/KEPK-AWS/IX/2020)

AUTHOR CONTRIBUTION

All authors contributed equally in this study

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