



Published By : IVAA
the Indonesian Vascular Access Association

Correlation between intraoperative blood vessel diameter and technical success rate of AV shunt surgery in Dr. Soetomo Hospital Surabaya



Diva Saphira^{1*}, Heroe Soebroto², Mochammad Thaha³, Arief Rakhman Hakim²,
Gabriel Rio Widipriyatama¹

ABSTRACT

Introduction: An arteriovenous (AV) shunt is an anastomosis between vein and artery made in a surgical procedure as vascular access for patients with end-stage renal disease that are projected to undergo hemodialysis. Unfortunately, AV shunt failure remains a significant clinical problem for hemodialysis patients. In general, the cause of most early AV shunt failure is still unknown, but the quality of the blood vessels is suspected as a factor. This study aimed to determine the correlation between blood vessel diameter and the success of AV shunt surgery.

Methods: This study is a cross sectional study that uses a descriptive-analytic design. The samples were obtained from the patient's medical records with the total sampling technique of all patients who have undergone AV shunt surgery from January 2019 – December 2020 at Dr. Soetomo General Hospital which matches the inclusion and exclusion criteria.

Results: Patients' blood vessel diameter measurement is divided into four categories which are <2 mm, 2 - <4 mm, 4 - <6 mm, and ≥6 mm. From a total of 62 patients, the highest successful surgery rate is carried out in patients with a vein diameter of 2 - <4 mm (77.59%) and artery diameter of 2 - <4 mm (63.79%). The results of the Chi-Square analysis found no significant correlation between vein diameter ($p=0.769$) or artery diameter ($p=0.922$) and the success of AV shunt surgery at Dr. Soetomo Hospital, Surabaya 2019-2020.

Conclusions: In conclusion, this study did not find a correlation between the intraoperative blood vessel diameter and the technical success of AV shunt surgery.

Keywords: arteriovenous shunt, postoperative evaluation, successful surgery, vessel diameter.

Cite This Article: Saphira, D., Soebroto, H., Thaha, M., Hakim, A.R., Widipriyatama, G.R. 2023. Correlation between intraoperative blood vessel diameter and technical success rate of AV shunt surgery in Dr. Soetomo Hospital Surabaya. *Journal of Indonesia Vascular Access* 3(2): 33-36. DOI : 10.51559/jinava.v3i2.45

¹Medical Program, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia;

²Department of Cardiothoracic and Vascular Surgery, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia / Dr. Soetomo General Academic Hospital, Surabaya, Indonesia;

³Department of Internal Medicine, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia / Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

*Corresponding to:

Diva Saphira;
Medical Program, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia;
diva.saphira-2019@fk.unair.ac.id

Received: 2022-09-30

Accepted: 2023-11-10

Published: 2023-12-09

INTRODUCTION

An arteriovenous (AV) shunt is a connection or anastomosis between vein and artery made in a surgical procedure as vascular access indicated for patients with end-stage renal disease (ESRD) that are projected to undergo routine hemodialysis or have undergone initiation of hemodialysis with a central venous catheter. Installation of an AV shunt allows the formation of a pathway with low resistance so that blood can be flowed from arteries to veins without going through capillaries. The presence of an AV shunt will increase the pressure and blood flow to the vein so that the vein can enlarge and undergo epithelialization, therefore the vein will become more adequate for repeated dialysis needle puncture access.¹

The criteria for AV fistula maturation

based on NKF KDOQI guidelines are blood flow of at least 600 mL/minute, vein diameter of at least 6 mm, and minimum distance of 6 mm from the skin surface. Fistulas may take four to six weeks to mature and thereafter can be utilized for hemodialysis and inability to meet this goal is defined as the failure to mature (primary failure).

Many preoperative and postoperative parameters influence the success of AV shunt surgery. Currently, few clinical pathways are used to predict the success of access maturation for AV shunt creation, and the impact of the vessel diameter was researched in numerous studies. The arteriovenous fistula success rate is 74% when the venous diameter is more than 2 mm compared to 29% if the diameter is less than 2 millimeters.²

Unfortunately, AV shunt maturation

failure and AV graft (AVG) thrombosis remain major clinical problems for hemodialysis patients as 20% to 60% of AV shunts created fail to mature successfully for dialysis use.¹ A prospective cohort study conducted by Hemodialysis Fistula Maturation study in the United States shows that of 602 patients, 28% failed 2 weeks after surgery and 30% failed 6 weeks after surgery.³ In line with that, AV shunt surgery failure rate is still above 30% in Indonesia.⁴

The cause of most early AV shunt failure in general is still unknown, but the quality of the blood vessels is suspected as a factor. Small or stenotic cephalic veins, partial thrombus, and a small or atherosclerotic radial artery are suspected as possible causes of this failure.⁵ Therefore, the aim of this research is to understand the correlation between postoperative

diameter of blood vessels and success of AV shunt surgery.

METHODS

This study is a cross sectional study that uses a descriptive-analytic design. The research subjects include patients who have undergone AV shunt surgery within the period of January 2019 – December 2020 which matches the inclusion and exclusion criteria at Dr. Soetomo General Hospital. The inclusion criteria of this research are patients who have undergone AV shunt surgery with data of postoperative artery and vein diameters and have data of the presence of thrill, bruit, and pulsation. The exclusion criteria of this research are patients who have undergone AV shunt surgery with no data of postoperative artery and vein diameters, no data of presence of thrill, bruit, and pulsation, and patients who have undergone revision of AV shunt surgery.

The sample size is 62 patients who have undergone AV shunt surgery within the period of January 2019 – December 2020 at Dr. Soetomo General Hospital. The sampling technique used in this research is a non-random total sampling technique in patients that meets the criteria of inclusion and exclusion. The instrument used in this research is medical record data from the Surgery Intensive Care Unit of Dr. Soetomo General Hospital within the period of January 2019 – December 2020. The final model included confounding variables significant at a two-tailed p-value of <0.05.

RESULT

Research regarding the correlation between blood vessel diameter and the success of AV Shunt surgery has been conducted from June 2021 – December 2022. This research uses the descriptive-analytic approach in order to determine the correlation between the diameter of the vein and artery in regard to the success of AV shunt surgery by evaluating the patient's demographic, intraoperative, and postoperative data.

There are 62 patients in the Intensive Care Unit RSUD Dr. Soetomo Surabaya from January 2019 – December 2020 who underwent AV Shunt Surgery. The data

Table 1. Characteristics of research subjects

Characteristics	n	%
Age (years)		
≤10 years old	0	0.00
10 - <20 years old	6	9.68
20 - < 30 years old	2	3.23
30 - <40 years old	12	19.35
40 - <50 years old	15	24.19
50 - <60 years old	20	32.26
60 - <70 years old	6	9.68
≥ 70 years old	1	1.61
Gender		
Male	28	45.16
Female	34	54.84
Risk Factor		
Diabetes Mellitus	7	11.29
Hypertension	11	17.74
Peripheral artery disease	0	0.00
Coagulation Disorder	0	0.00
No risk factors	32	51.61
DM and Hypertension	12	19.35
Type of AV shunt		
Fistula	62	100.00
Graft	0	0.00
Location of the AV shunt		
Radiocephalic	27	43.55
Brachiocephalic	32	51.61
Brachio basilic	3	4.84
Total	62	100.00

Table 2. Frequency distribution based on diameter measurement

Diameter	n	%
Vein		
< 2 mm	5	8.06
2 - <4 mm	49	79.03
4 - <6 mm	7	11.29
≥ 6 mm	1	1.61
Artery		
< 2 mm	3	4.84
2 - <4 mm	40	64.52
4 - <6 mm	16	25.81
≥ 6 mm	3	4.84
Total	62	100.00

was taken from the patient medical report in RSUD Dr. Soetomo Surabaya. Table 1 shows the characteristics of the research subjects.

Table 2 describes the subject's frequency based on the vein diameter. The number of patients with vein diameter categorized as under 2 mm is 5 (8.06%), between 2 and 4 mm is 49 (79.03%), between 4 and 6 mm is 7 (11.29%), and greater than equal to 6 mm is 1 (1.61%). It also describes the number of samples based on the artery

diameter. The number of patients with artery diameter categorized as under 2 mm is 3 (4.84%), between 2 and 4 mm is 40 (64.52%), between 4 and 6 mm is 16 (25.81%), and greater than equal to 6 mm is 3 (4.84%).

Table 3 describes the number of samples based on the postoperative evaluation. The number of patients showing bruit, thrill, and pulsation is 6 (9.68%), bruit and thrill is 8 (12.90%), bruit and pulsation is none (0%), thrill and pulsation is 34 (54.84%),

Table 3. Frequency distribution based on postoperative evaluation

Postoperative Evaluation	n	%
Bruit, Thrill, Pulsation	6	9.68
Bruit, Thrill	8	12.90
Bruit, Pulsation	0	0.00
Thrill, Pulsation	34	54.84
Bruit	0	0.00
Thrill	10	16.13
Pulsation	2	3.23
No bruit, thrill, nor pulsation	2	3.23
Total	62	100.00

Table 4. Correlation between vein diameter and success of AV shunt surgery

Vein Diameter	Success		Failed		p
	n	%	n	%	
< 2 mm	5	8.62	0	0.00	0.769
2 - <4 mm	45	77.59	4	100.00	
4 - <6 mm	7	12.07	0	0.00	
≥ 6 mm	1	1.72	0	0.00	
Total	58	100.00	4	100.00	

Table 5. Correlation between artery diameter and success of AV shunt surgery

Artery Diameter	Success		Failed		p
	n	%	n	%	
< 2 mm	3	5.17	0	0.00	0.922
2 - <4 mm	37	63.79	3	75.00	
4 - <6 mm	15	25.86	1	25.00	
≥ 6 mm	3	5.17	0	0.00	
Total	58	100.00	4	100.00	

bruit only is none (0%), thrill only is 10 (16.13%), pulsation only is 2 (3.23%), and showing neither bruit, thrill, nor pulsation is 2 (3.23%).

Table 4 presents the AV shunt surgery success rate in accordance with the vein diameter. For vein diameter categorized as less than 2 mm, the number of successful surgeries is 5 (8.62%) with no failed surgery. For vein diameter categorized as 2 - <4 mm, the number of successful surgeries is 45 (77.59%) with 4 failed surgeries (100%). For vein diameter categorized as 4 - <6 mm, the number of successful surgeries is 7 (12.07%) with no failed surgery. For vein diameter categorized as >6 mm, the number of successful surgeries is 1 (1.72%) with no failed surgery. Table 4 shows that there is no significant difference between vein diameter and the success of AV shunt surgery ($p=0.769$).

Table 5 presents the AV shunt surgery success rate in accordance with the artery diameter. For artery diameter categorized as less than 2 mm, the number of successful surgeries is 3 (5.17%) with no failed

surgery. For artery diameter categorized as 2 - <4 mm, the number of successful surgeries is 37 (63.79%), with three failed surgeries (75.00%). For vein diameter categorized as 4 - <6 mm, the number of successful surgeries is 15 (25.86%) with one failed surgery (25.00%). For vein diameter categorized as >6 mm, the number of successful surgeries is 3 (5.17%) with no failed surgery. Table 5 shows that there is no significant correlation between artery diameter and the success of AV shunt surgery ($p=0.922$).

DISCUSSION

An AV shunt is considered successful when it can serve its function as an access for hemodialysis that can be used safely without any abnormalities and has a long patency.² There is various ways to determine the success of an AV shunt surgery such as from postoperative clinical findings as well as USG Doppler evaluation. In this research, the indicator that is used to determine the success of the

surgery is postoperative clinical findings which include palpation to determine the thrill and pulsation as well as auscultation to determine the absence of bruit.

It is found that palpable thrill and bruit are indicative of higher patency rates which means the success of the surgery. The absence of bruit following skin closure is a useful predictive test of AV shunt thrombosis, better than the absence of thrill.⁶ The absence of bruit is highly indicative of AV shunt thrombosis (70.6% and 80.9% sensitivity and specificity) while the absence of thrill alone has a low sensitivity to indicate AV shunt thrombosis (35.3% sensitivity and 87.2% specificity). In line with that, the presence of pulsation alone as well as the absence of all bruit, thrill, and pulsation does not indicate the success of AV shunt surgery. Inflow stenosis may be due to signs such as abnormalities in the thrill, pulse, and bruit and excessive collapse of the venous segment.⁷

The sample obtained was analyzed for the correlation of AV shunt surgery success rate in accordance with the vein diameter. For vein diameter categorized as less than 2 mm, the number of successful surgeries is 5 (8.62%) with no failed surgery. For vein diameter categorized as 2 - <4 mm, the number of successful surgeries is 45 (77.59%) with 4 failed surgeries (100%). For vein diameter categorized as 4 - <6 mm, the number of successful surgeries is 7 (12.07%) with no failed surgery. For vein diameter categorized as >6 mm, the number of successful surgeries is 1 (1.72%) with no failed surgery.

The success rate of AV shunt surgery is directly proportional to the diameter of the artery. For artery diameter categorized as less than 2 mm, the number of successful surgeries is 3 (5.17%) with no failed surgery. For artery diameter categorized as 2 - <4 mm, the number of successful surgeries is 37 (63.79%), with three failed surgeries (75.00%). For vein diameter categorized as 4 - <6 mm, the number of successful surgeries is 15 (25.86%) with one failed surgery (25.00%). For vein diameter categorized as >6 mm, the number of successful surgeries is 3 (5.17%) with no failed surgery.

From this research's results, AV shunt failure occurred in patients with smaller

vein diameters. However, this still does not indicate a correlation between vessel diameter and the success of the surgery as it only occurred in a small number of patients, and it also might be influenced by other factors such as gender and location of the arteriovenous shunt.

This is in accordance with research conducted by Wilmink et al. which states that vessel diameter measurements are poor predictors of functional dialysis use of arteriovenous fistulas. They found that arterial diameter did not add diagnostic value for brachiocephalic AV shunt but still has a limited value to predict functional dialysis use in radiocephalic. Meanwhile, vein size is deemed useful for predictions in the brachiocephalic AV shunt. As a conclusion from their research, even though vessel diameter has a poor diagnostic value, it can be used for several indications but should not be the reason to preclude the creation of the shunt.⁸

Based on the chi-square test results, it was found that the value for artery diameter is $p=0.922$, and the value for vein diameter is $p=0.769$. Thus, it can be concluded that this study did not find a correlation between intraoperative vein or artery diameter and the success of AV shunt surgery based on the postoperative evaluation of bruit, thrill, and pulsation.

This research certainly still has limitations. We included all patients who performed AV surgery at Dr. Soetomo General Hospital. This also causes the probability that confounding variables influence our results. We also did not perform multivariate analysis, which serves to rule out confounding variables

that could potentially affect the analysis results. Further research is needed to cover the weaknesses of this study.

CONCLUSION

From the obtained results and calculated statistical test, this research found no correlation between intraoperative blood vessel diameter and technical success of AV shunt surgery. It is recommended to limit the result of surgery to only one surgeon and one observer to exclude the probability of bias as different surgeons may have different skills and hence produce a different outcome while different observers may result in different measurements. Conducting the research with a different indicator that can be more precise such as from Doppler USG is also advisable for further research.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare there was no conflict of interest.

ETHICAL CLEARANCE

This research has received ethical approval from the Ethical Committee of Universitas Airlangga.

AUTHORS CONTRIBUTION

All authors contributed equally in the writing of this article.

REFERENCES

1. Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin AS, Abreo K, et al. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. *American Journal of Kidney Diseases*. 2020;75(4):S1–164.
2. Limanto DH, Christian DH, Joalsen I, Caesario M, Usman U. *Dasar-dasar teknik pembedahan fistula arteriovenosa*. Surabaya: Airlangga University Press; 2021.
3. Cheung AK, Imrey PB, Alpers CE, Robbin ML, Radeva M, Larive B, et al. Intimal Hyperplasia, Stenosis, and Arteriovenous Fistula Maturation Failure in the Hemodialysis Fistula Maturation Study. *Journal of the American Society of Nephrology*. 2017;28(10):3005–13.
4. Hapsari P, Djajakusumah TM, Fauzie Z, Ulurrosyad MF. Correlation Between Preoperative Vein Distensibility With Radiocephalic Arteriovenous Fistula Maturation in Patients With End Stage Renal Disease. *Journal of Indonesian Society for Vascular and Endovascular Surgery*. 2021;2(1):1–3.
5. Nagarik AP, S SS, Gopalkishan A, S RA. Incidence and Risk factors for primary AV fistula failure. *International Journal of Surgery Science*. 2020;4(2):21–4.
6. Schmidli J, Widmer MK, Basile C, de Donato G, Gallieni M, Gibbons CP, et al. Editor's Choice – Vascular Access: 2018 Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS). *European Journal of Vascular and Endovascular Surgery*. 2018;55(6):757–818.
7. Jackson VE, Hurst H, Mitra S. Structured physical assessment of arteriovenous fistulae in haemodialysis access surveillance: A missed opportunity? *J Vasc Access*. 2018;19(3):221–9.
8. Wilmink T, Corte-Real Houlihan M. Diameter Criteria Have Limited Value for Prediction of Functional Dialysis Use of Arteriovenous Fistulas. *European Journal of Vascular and Endovascular Surgery*. 2018;56(4):572–81.



This work is licensed under a Creative Commons Attribution