



Cohort Study

The survival analysis of tunnel-cuffed central venous catheter versus arteriovenous hemodialysis access among elderly patients: A retrospective single center study

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ABSTRACT

Background: There is currently a controversy for the optimal vascular access option in the elderly, regarding their multiple comorbidities and life expectancies. Our study aimed to compare the survival of tunneled cuff venous catheter (CVC) and arteriovenous access (AV access) in elderly patients.

Methods: A retrospective cohort study was performed by electronic medical record review. All hemodialysis patients aged 65 years and over who firstly initiated dialysis from January 1, 2012 to December 31, 2016 at Siriraj hospital, Thailand, were included. The primary outcomes are to compare a 2-year period of survival between CVC and AV access in terms of abandonment, death, and combined outcome. Propensity score covariate and Charlson Comorbidity Score (CCI) were used for multivariable analysis adjustment.

Results: A total of 359 patients were included; 216 (60.2%) patients had initiated hemodialysis via CVC while the rest used AV access. The patients' average ages were 76.7 ± 7.0 and 74.0 ± 5.8 years (p -value < 0.001) in the CVC and AV access group, respectively. The 2-year mortality rates of CVC and AV access groups were 24.1% and 15.4%, respectively (p -value = 0.038). Multivariable analyses showed that the adjusted hazard ratio (aHR) of combined endpoints, i.e., vascular access abandonment and death, was statistically different only in the CCI-adjusted model (aHR = 0.68, 95% CI: 0.46–0.99). Mortality from infection cause was more common in the CVC group than the AV access group.

Conclusion: CVC access maybe considers an alternative option for frail elderly patients. However, the patient selection is a crucial issue, given higher infection-related mortality in patients using CVC.

1. Background

Recently, the prevalence and incidence of renal replacement therapy in the aging population have been increasing. The guidelines recommended arteriovenous (AV) access, especially arteriovenous fistula (AVF), as the preferred long-term vascular access for dialysis patients regarding longer patency, fewer access-related complications, and the lowest mortality [1–9]. However, there are many barriers to promoting AVF in the elderly, including multiple comorbidities and atherosclerotic diseases that may affect AVF maturation and patency. Previous studies demonstrated a high rate of primary failure of AVF in elderly patients

[10]. Moreover, approximately 70% of elderly patients aged over 80 years died before the AVF maturation [11]. Nevertheless, another finding depicted the advantages of the tunneled cuff venous catheter (CVC) in elderly patients, mostly in low cardiac reserve patients [11,12]. However, data on clinical outcomes and vascular access patency in elderly patients is still lacking.

Our study aimed to compare the survival of two vascular access types for elderly hemodialysis patients.

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2. Materials and methods

A retrospective cohort study was performed by electronic medical record review. All hemodialysis patients aged 65 years and over at Siriraj hospital, Thailand, who firstly initiated dialysis from January 1, 2012 to December 31, 2016 were included. The primary outcomes are to compare the two years of survival between CVC and AV access in terms of abandonment from both thrombosis and infection, death, and combined outcome of vascular access abandonment and death. The vascular access abandonment was defined by no longer using available, and catheter abandonment was determined by the date of placement until removal or intervening manipulation according to the standard definition guideline in the society for vascular surgery on an intention-to-treat basis [13].

Censored dates comprised the dates of kidney transplantation, transferring to peritoneal dialysis, or loss-to-follow up. All patients in this study were followed for two years. The study was approved by Ethics committees and institutional review boards Siriraj Hospital Ethic number 907/2561 (EC1). The study was registered at [researchregistry.com](https://www.researchregistry.com) via a unique identifying number (UIN)- researchregistry5763. The work has been reported in line with the STROCSS criteria [14].

The types of initial vascular access for HD were classified into tunnel-cuffed CVC and AV access, including AVF and arteriovenous graft (AVG). The baseline demographic and clinical data were collected and analyzed. The studied outcomes were the hazard ratios of three endpoints (abandonment, death, and combined). The starting point was the first dialysis date using each access type.

3. Statistical analysis

The comparison of baseline demographic and clinical characteristics between the tunnel-cuffed central venous catheter group and arteriovenous hemodialysis access group was analyzed using the independent *t*-test for continuous variables and Fisher's exact test for categorical variables. The patients' propensity scores of the patients were generated by multivariable logistic regression analysis of the factors related to the selection bias of the compared groups (age, diabetes, myocardial infarction, heart failure, and cancer). Continuous variables with normal distribution were presented as mean (standard deviation, SD), while categorical variables were revealed as frequencies (percentage, %). The study's endpoints were illustrated between vascular accessed types using Kaplan-Meier curves, and Cox's proportional hazard regression assessed the differences. Both univariable and multivariable regression was done. The multivariable regression models composed of CCI-adjusted and propensity score-adjusted models. Statistical analysis was performed using Stata Statistical Software: Release 15 (StataCorp, College Station, TX, USA).

4. Results

A total of 359 hemodialysis vascular accesses were created in elderly patients with end-stage renal disease (ESRD). Two hundred and sixteen patients have initiated hemodialysis via CVC (60.2%), while one hundred and forty-three patients used AV access (39.8%). The patients' average ages were 76.7 ± 7.0 years and 74.0 ± 5.8 years (*p*-value < 0.001) in the CVC and AV access group, respectively. There was a significantly higher male proportion in the AV access-group compared with the CVC group (53.9% vs. 39.6%, respectively; *p*-value = 0.009). The baseline patient characteristics were depicted in Table 1. About 69% in the CVCs group and 66% in the AV access group had diabetes. Patients using CVC had a higher percentage of myocardial infarction (74.9% vs. 35.0%) and significantly higher Charlson comorbidity index (10.6 ± 2.4 vs. 9.2 ± 2.0) than the AV access group. The number of peripheral arterial disease and cerebrovascular disease was similar among the two groups. The propensity scores were statistically different between CVC and the AV access group (0.37 ± 0.12 vs. 0.44 ± 0.12 , *p*-value < 0.001).

Table 1
Baseline characteristic.

Vascular access, n (%)	Overall n = 359	CVCs n = 216 (60.2)	AV access n = 143 (39.8)	<i>p</i> -value
Age (years)	75.6 ± 6.7	76.7 ± 7.0	74.0 ± 5.8	<0.001
BMI (kg/m ²)	22.9 ± 4.2	22.7 ± 4.4	23.1 ± 4.0	0.43
Male	162 (45.1%)	85 (39.6%)	77 (53.9%)	0.009
Diabetes	245 (68.3%)	150 (69.4%)	95 (66.4%)	0.564
Hyperlipidemia	285 (79.4%)	179 (82.9%)	106 (74.1%)	0.047
Myocardial infarction	147 (41%)	97 (74.9%)	50 (35%)	0.063
Heart failure	59 (16.4%)	43 (19.9%)	16 (11.2%)	0.03
Peripheral arterial disease	56 (15.6%)	34 (15.7%)	22 (15.4%)	0.9
Cerebrovascular disease	65 (18.11%)	45 (20.8%)	20 (14.0%)	0.123
Smoking	85 (23.7%)	52 (24.1%)	33 (23.1%)	0.9
Hemoglobin (g/dL)	10.1 ± 1.6	10 ± 1.6	10.3 ± 1.5	0.0692
Propensity score	0.40 ± 0.10	0.37 ± 0.12	0.44 ± 0.12	<0.001
Charlson comorbidity index	10.0 ± 2.4	10.6 ± 2.4	9.2 ± 2.0	<0.001
Aspirin	183 (51%)	107 (49.5%)	76 (53.2%)	0.519
Clopidogrel	44 (12.3%)	34 (15.7%)	10 (7%)	0.014
Vitamin K antagonists	30 (8.4%)	22 (10.2%)	8 (5.6%)	0.172

AbbreviationCVCs; Tunnel-cuffed central venous catheters, AV access; arteriovenous access, BMI; Body-mass index.

Clopidogrel was prescribed more common in the CVC group (15.7% vs. 7.0%).

Table 2 illustrated 2-year mortality rate were observed more in CVC group than AV access group (24.1% vs. 15.4%, *p*-value = 0.038). Moreover, the combined endpoint (i.e., mortality and abandonment) were revealed significantly higher in CVC groups. However, the 2-year abandonment rate alone did not differ, as shown in Kaplan-Meier curves (Figs. 1–3). Cox proportional hazard regression analysis demonstrated that hazard ratio (HR) of 2-year mortality rates and combined endpoint were significantly lower in AV access group, compared with CVC group in univariable analysis (mortality HR: 0.59, 95%CI: 0.36–0.97 and combined endpoint HR: 0.65, 95%CI: 0.45–0.94). Unfortunately, in the multivariable analyses, the aHR of combined endpoints was statistically different only in the CCI-adjusted model (aHR: 0.68, 95%CI: 0.46–0.99) (Table 3).

Compared with the AV access group, infection-related abandonment was higher in the CVC group (32.4% vs. 15.8%). However, abandonment from thrombosis was higher in the AV access group than the CVC group (84.2% vs. 67.6%).

Mortality from any infection cause was more common in the CVC group than the AV access group (46.2% vs. 32.8%). The non-infectious related mortality cause in both groups included cardiovascular disease (20.3%), cancer (8.1%), and others (29.7%).

5. Discussion

According to the recommended guidelines for hemodialysis vascular

Table 2
2-year mortality and 2 year abandonment.

Vascular access, n (%)	CVCs n = 216	AV access n = 143	<i>p</i> -value
2-year mortality rate	52 (24.1%)	22 (15.4%)	0.038
2-year abandonment	37 (17.1%)	19 (13.3%)	0.25
Combined	89 (41.2%)	41 (28.7%)	0.02

AbbreviationCVCs; Tunnel-cuffed central venous catheters, AV access; arteriovenous access.

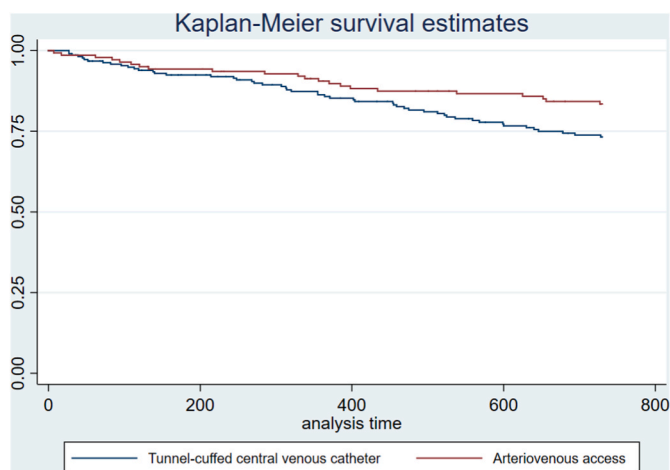


Fig. 1. Kaplan- Meier curve for 2 year mortality between CVC and AV access group.

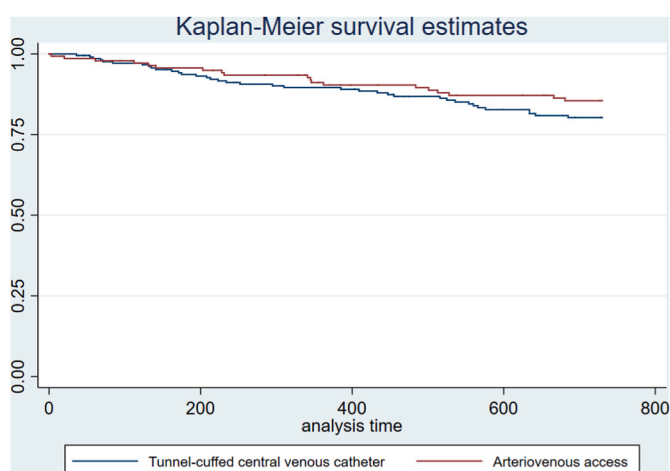


Fig. 2. Kaplan- Meier curve for 2 year abandonment between CVC and AV access group.

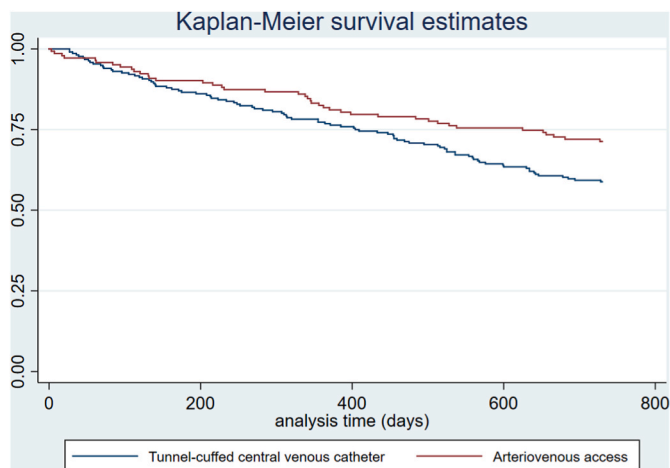


Fig. 3. Kaplan- Meier curve for combined end point.

access, AV fistula is still the best vascular access for the patients, and the fistula first initiative policy was adopted in practice worldwide [2]. The vascular access is the lifeline and Achilles heel in clinical practice,

especially in maturation and patency aspect. There are several factors affected by AVF maturation, including vascular anatomy and uremic vasculopathy [15]. We were considering a meaningful increase in the prevalence of end-stage renal disease in elderly people. Therefore, the optimal option of hemodialysis vascular access for these patients requires appropriate strategies concerning comorbidities such as frailty, geriatric syndrome, and life expectancy [16]. The previous studies demonstrated high mortality rates in elderly hemodialysis patients using CVC compared with AVF and AVG [11–13,17–21]. Our study's mortality rate was 12.9 per 100 person-year, which was similar to Rivara et al. [22]; this reflected the standard of care in our center.

Although United States Renal Data System (USRDS) data revealed the advantages in pre-emptive AV fistula in elderly who had a life expectancy over four months [23], there is limited data for catheter survival and complications in the elderly patient who could not be provided AV access. Thus, our study aimed to define the CVCs survival compared with permanent AV access in elderly patients. Our study, results from univariable analyses showed that patients in AV groups had significantly better survival and combined endpoints than patients in the CVC group. However, after the CCI and propensity score adjustment, all outcomes were indifferent, except the combined outcomes in the CCI-adjusted model still reached a significant level. Since high CCI (10.0 ± 2.4) was observed in our patients, CVC can be an alternative modality for frail elderly patients. A recent study by Jee Ko et al. demonstrated comparable mortality outcomes between CVC and AVF using patients over 80 years old [24]. Accordingly, our patient's mean age was around 75 years old, and we hypothesized that CVC might not be inferior to AV access in extreme-age hemodialysis patients. Nonetheless, infection is still an issue in patients using CVC, as shown in higher infection-related mortality and abandonment. We observed that the CVC group patients had lower serum albumin than the patients in the AV access group (mean serum albumin 3.1 ± 0.55 g/dL and 4.4 ± 0.85 g/dL for the CVC group and the AV access group, respectively) (data not shown). Therefore, malnutrition may be explained for a higher infection rate in the CVC groups. Similarly, a previous study reported that low serum albumin increased risk of septicemia in hemodialysis patients [25].

Consequently, appropriate patient selection is a crucial point for dialysis access consideration in elderly patients.

The present study's strengths were adequate sample size and follow-up duration, which provides enough power to detect the difference between the two groups. Furthermore, none of the patients lost to follow up during the study period. Additionally, the comparison groups cared under the same standard practice in a single hemodialysis unit.

Unfortunately, there were a few limitations to our study. Firstly, the retrospective nature of the study led to selection bias. We, therefore, adjusted the outcomes by CCI and propensity score to minimize this disadvantage. Secondly, we did not examine our patients' dialysis adequacy and quality of life, which were the general vital issues that should be considered in dialysis patient care. Further prospective studies, which include holistic aspects, should be performed to evaluate the optimal vascular access in elderly hemodialysis patients.

6. Conclusion

CVC may be an alternative modality for frail elderly patients in resource-limited settings. However, the appropriate patient selection is a crucial issue, given higher infection-related mortality in patients using CVC.

Funding

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Ethics approval and consent to participate

This study is a retrospective chart review, and as such, there is no

Table 3

2-year mortality and abandonment of other vascular access compared with central venous catheter in multivariable regression analysis.

Variables	Univariable		Multivariable			
			CCI-adjusted model		Propensity score-adjusted model	
	HR (95% CI)	p-value	aHR (95% CI)	p-value	aHR (95% CI)	p-value
Mortality	0.59 (0.36–0.97)	0.040	0.64 (0.38–1.08)	0.096	0.71 (0.42–1.18)	0.181
Abandonment	0.72 (0.42–1.26)	0.253	0.72 (0.41–1.28)	0.266	0.74 (0.41–1.30)	0.295
Combined	0.65 (0.45–0.94)	0.021	0.68 (0.46–0.99)	0.047	0.72 (0.49–1.06)	0.092

Abbreviation HR; Hazard ratio, CI; Confidence interval, CVCs; Tunnel-cuffed central venous catheters, AV access; arteriovenous access, CCI; Charlson comorbidity index.

need for informed consent. The Ethics committees and institutional review boards Siriraj Hospital approved the study design and methodology.

Authors' contributions

Dr. Raksasuk conceptualized, data collection, drafted and critically reviewed the manuscript. Dr. Chaisathaphol formal analysis and reviewed the manuscript. Kositamongkol data curation and formal analysis. Chokvanich data curation. Dr. Pumthavirat reviewed the manuscript. Dr. Srithongkul contributed to the concept, data collection, drafted, reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Availability of data and materials

Further clinical data are available from the corresponding author upon reasonable request.

Research registration unique identifying number (UIN)

Name of the registry: Research Registry.
 Unique Identifying number or registration ID: researchregistry5763.
 Hyperlink to your specific registration: <https://www.researchregistry.com/browse-the-registry#home/>

Guarantor

Thatsaphan Srithongkul: the corresponding author.

Provenance and peer review

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Declaration of competing interest

All authors have no financial or non-financial conflicts of interest related to this study.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.amsu.2020.10.032>.

References

- [1] NKF-DOQI clinical practice guidelines for vascular access. National Kidney Foundation-Dialysis Outcomes Quality Initiative, *Am. J. Kidney Dis.* : the official journal of the National Kidney Foundation 30 (4 Suppl 3) (1997) S150–S191.
- [2] Widmer Schmidli, de Donato Basile, Gibbons Gallieni, 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*, the official journal of the European Society for Vascular Surgery vol. 55 (6) (2018) 757–818.
- [3] Shayakul, Hemodialysis Clinical Practice Recommendation 2014, Nephrology society of Thailand, Bangkok, 2014.
- [4] Ohira Kukita, Naito Amano, Ikeda Azuma, et al., Update Japanese society for dialysis therapy guidelines of vascular access construction and repair for chronic hemodialysis, *Ther. Apher. Dial.* : official peer-reviewed journal of the International Society for Apheresis, the Japanese Society for Apheresis, the Japanese Society for Dialysis Therapy 19 (Suppl 1) (2011) 1–39, 2015.
- [5] Foley Lok, Vascular access morbidity and mortality, *Trends of the Last Decade* 8 (7) (2013) 1213–1219.
- [6] Mueller Perera, Wilson Kubaska, Fujitani Lawrence, Superiority of autogenous arteriovenous hemodialysis access: maintenance of function with fewer secondary interventions, *Ann. Vasc. Surg.* 18 (1) (2004) 66–73.
- [7] Sontrop Lok, Rajan Tomlinson, Oreopoulos Catral, et al., Cumulative patency of contemporary fistulas versus grafts 8 (5) (2013) 810–818, 2000–2010.
- [8] Eustace Astor, Klag Powe, Coresh Fink, Type of vascular access and survival among incident hemodialysis patients: the Choices for Healthy Outcomes in Caring for ESRD (CHOICE) Study, *J. Am. Soc. Nephrol.* : JASN (J. Am. Soc. Nephrol.) 16 (5) (2005) 1449–1455.
- [9] Speckman Wasse, McClellan, Arteriovenous fistula use is associated with lower cardiovascular mortality compared with catheter use among ESRD patients, *Semin. Dial.* 21 (5) (2008) 483–489.
- [10] Steele Cui, Kawai Wenger, Elias Liu, et al., Hemodialysis arteriovenous fistula as first option not necessary in elderly patients, *J. Vasc. Surg.* 63 (5) (2016) 1326–1332.
- [11] James Murea, Byrum Russell, Tuttle Yates, et al., Risk of catheter-related bloodstream infection in elderly patients on hemodialysis, *Clin. J. Am. Soc. Nephrol.* 9 (4) (2014) 764–770.
- [12] Chang Chuang, Chan, The effect of haemodialysis access types on cardiac performance and morbidities in patients with symptomatic heart disease, *PloS One* 11 (2) (2016), e0148278 e0148278.
- [13] Mokrzycki Lee, Maya Moist, Lok Vazquez, et al., Standardized definitions for hemodialysis vascular access, *Semin. Dial.* 24 (5) (2011) 515–524.
- [14] Abdall-Razak Agha, Dowlut Crossley, Mathew Iosifidis, STROCSS 2019 Guideline: strengthening the reporting of cohort studies in surgery, *Int. J. Surg.* 72 (2019) 156–165.
- [15] Patel Hu, Santana Hanisch, Bai Hashimoto, et al., Future research directions to improve fistula maturation and reduce access failure, *Semin. Vasc. Surg.* 29 (4) (2016) 153–171.
- [16] Lok Viecelli, Hemodialysis vascular access in the elderly—getting it right, *Kidney Int.* 95 (1) (2019) 38–49.
- [17] Lammouchi Zouaghi, Rais Hassen, Smaoui Krid, et al., Determinants of patency of arteriovenous fistula in hemodialysis patients, *Saudi Journal of Kidney Diseases and Transplantation* 29 (3) (2018) 615–622.
- [18] Bevis Weale, Boyes Neary, Lear Morgan, et al., Radiocephalic and brachiocephalic arteriovenous fistula outcomes in the elderly, *J. Vasc. Surg.* 47 (1) (2008) 144–150.
- [19] Oliver Lok, Bhola Su, Jassal Hannigan, Arteriovenous fistula outcomes in the era of the elderly dialysis population, *Kidney Int.* 67 (6) (2005) 2462–2469.
- [20] A. Dębska-Ślizień, A. Kawecka, J. Prajs, E. Król, Z. Zdrojewski, M. Przekwas, et al., Remarks on surgical strategy in creating vascular access for hemodialysis: 18 Years of one center's experience, *Ann. Vasc. Surg.* 19 (4) (2005) 590–598.
- [21] Rhee Ko, Chang Obi, Kim Soohoo, et al., Vascular access placement and mortality in elderly incident hemodialysis patients. *Nephrology, Dialysis, Transplantation*, official publication of the European Dialysis and Transplant Association - European Renal Association, 2018.
- [22] Soohoo Rivara, Molnar Streja, Cheung Rhee, et al., Association of vascular access type with mortality, hospitalization, and transfer to in-center hemodialysis in patients undergoing home hemodialysis, *Clin. J. Am. Soc. Nephrol.* 11 (2) (2016) 298–307.

- [23] Sanchez Chan, Yevzlin Young, Vascular access outcomes in the elderly hemodialysis population: a USRDS study, *Semin. Dial.* 20 (6) (2007) 606–610.
- [24] Rhee Ko, Chang Obi, Kim Soohoo, et al., Vascular access placement and mortality in elderly incident hemodialysis patients, *Nephrol. Dial. Transplant.* 35 (3) (2020) 503–511, official publication of the European Dialysis and Transplant Association - European Renal Association.
- [25] Powe, Furth Jaar, Hermann, Briggs, Septicemia in dialysis patients: incidence, risk factors, and prognosis, *Kidney Int.* 55 (3) (1999) 1081–1090.