Long-term Prognosis of Vascular Access in Haemodialysis Patients with Systemic Lupus Erythematosus: A Retrospective Cohort Study

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Abstract

Patients with systemic lupus erythematosus (SLE) have a higher risk of vascular complications. The objective of the study is to analyse the differences in the risk of arteriovenous fistula or graft (AVF/AVG) dysfunction in haemodialysis patients with and without SLE over a 10-year period. A final sample of 1366 SLE and 4098 non-SLE patients remained after propensity score matching. The outcome measure primarily evaluated is the incidence rate of AVF/AVG dysfunction. SLE patients had higher incidence rates of AVF/AVG dysfunction than non-SLE patients in all time periods. Three specific time periods that reached significant difference were the following: (1) after 1 year (incidence rates = 15.21, 13.01, respectively; subdistribution hazard ratio (SHR) = 1.15; P = 0.007), (2) 1st-to-10th-year period (incidence rates = 15.36 and 13.25, respectively; SHR = 1.16; P = 0.007), and (3) overall period (incidence rates = 23.53 and 21.66, respectively; SHR = 1.09; P = 0.027). In conclusion, there were significantly higher incidence rates of AVF/AVG dysfunction in SLE patients during the long-term follow-up period in this study.

Introduction

Systemic lupus erythematosus (SLE) is a systemic autoimmune disease that has a worldwide prevalence ranging from 0.3 to 23 per 100,000 person-years, affecting many of different age, racial, and ethnic groups [1]. Asian SLE patients manifest higher rates of renal involvement (50–60%) compared to Caucasian patients (30–38%) and are often associated with greater risk of severe renal disease [2]. There were approximately 612.8 SLE cases per 100,000 patient-years that progressed to end-stage renal disease (ESRD) and received haemodialysis (HD) treatment based on the National Health Insurance Research Database (NHIRD) in Taiwan between 2000 to 2008 [3].

Vascular diseases are commonly observed in SLE patients. Vascular access dysfunction, involving either arteriovenous fistulas (AVF) or arteriovenous grafts (AVG), is an important factor that not only determines the quality of HD, but also has crucial impact on morbidity and mortality. Prolonging access patency and limiting the complications of a functioning access require interprofessional collaborative practice.

Previous research pointed out that SLE patients on HD are more probable to develop vascular access thrombosis [4]. Theoretically, SLE patients may have increased risk of vascular access patency loss even from the time of AVF/AVG creation. However, it is still uncertain whether or not the SLE disease itself has an impact on vascular access patency. There are studies conducted that were focused only on the short-term outcome (within 1 year) of vascular access patency in SLE-ESRD patients, and the conclusion is still very controversial [4, 5]. So far little is known whether or not there is a difference in the rate of AVF/AVG dysfunction between SLE patients and non-SLE patients during the long-term follow-up period (after 1 year and onwards). Therefore, the aim of the study is to investigate the long-term dysfunction rate of AVF/AVG in HD patients with and without SLE.

Methods

Study population and data source

In this retrospective cohort study, data were obtained from Taiwan's NHIRD. Since 1995, all citizens and residents in Taiwan are provided with compulsory universal health insurance. The program provides full coverage for renal replacement therapy for patients with ESRD. Healthcare institutions are then required to submit computerized claim documents for renal replacement therapy to the National Health Insurance Administration. Taiwan's NHIRD is a population-based data source for producing real-world data to help make diagnostic decisions and health care policies, which covers almost all of the inpatient and outpatient medical records for Taiwan's 23 million residents. Information such as patient identification number, birthday, gender, dates of hospital admission and discharge, healthcare institutions providing services, ICD-9-CM/ICD-10-CM diagnostic and procedure codes, and outcomes, among many other data, are stored in this database.

The study was carried out in accordance with the Helsinki Declaration (edition 6, revised 2000) and was approved by the Institutional Review Board of Taipei Veterans General Hospital (2020-09-018BC). The need of informed consent was waived by the Institutional Review Board of Taipei Veterans General Hospital since the dataset was encrypted and de-identified.

The primary outcome in this study is the cumulative incidence rate of AVF/AVG dysfunction, which measures the occurrence of an intervention (angioplasty, thrombectomy, or new AVF/AVG creation) from the time of vascular access creation to the first episode of dysfunction within 3 months, 6 months, 1 year, 5 years, and 10 years. Secondary outcomes include the occurrence of major adverse cardiovascular events (MACE) (defined as the first occurrence of death from cardiovascular causes, non-fatal myocardial infarction, or non-fatal stroke), myocardial infarction, and ischaemic stroke.

Patient Selection

Data were collected retrospectively from the NHIRD for HD patients in Taiwan between 2000 and 2011. The patients were divided into two groups (SLE and non-SLE group). The exclusion criteria of the study are as follows: (1) under 20 years old, (2) undergoing peritoneal dialysis, (3) pregnant, (4) kidney transplant recipients, (5) had never initiated HD via AVF/AVG or had a permanent double-lumen catheter placed after AVF/AVG creation, and (6) ineligible for the National Health Insurance catastrophic illness card (given to HD patients who require life-long renal replacement therapy).

Statistical analysis

SAS version 8.0 (SAS Institute, Cary, North Carolina, USA) was used to conduct statistical analysis. Continuous variables were expressed in mean ± SD and analysed using t-test. All data were normally distributed. Categorical variables were expressed in number and percentage and analysed using chi-square test. The propensity scores of the probability of SLE diagnosis were determined using multivariate logistic regression analysis, conditional on the baseline covariates (Supplementary Table 1). Three non-SLE patients were matched with each patient in the SLE cohort with a similar propensity score based on the nearest neighbor matching without replacement using calipers of width equal to 0.1 of the standard deviation of the logit of the propensity score. The survival curves for the cumulative incidence rate of AVF/AVG dysfunction were analysed using Cox regression model, Kaplan-Meier method, and log-rank test. All reported tests were two-sided and the statistically significant value was set at $P < 0.05$.

Results

A total of 146818 HD patients were enrolled. However, 65308 patients were excluded from the study for the following reasons: 276 were under 20 years old, 14111 underwent peritoneal dialysis, 0 was pregnant, 1523 were kidney transplant recipients, 37149 had never initiated HD via AVF/AVG, and 9153 had a permanent double-lumen catheter placed after AVF/AVG creation. A total of 81510 patients were selected, which comprised of 1366 SLE and 80144 non-SLE patients. After implementing the catastrophic illness card exclusion criteria, 1366 SLE and 4098 non-SLE patients remained in the study after propensity score matching with a ratio of 1 to 3.

The baseline characteristics of SLE and non-SLE patients shown in Table 1 were not found to be significantly different. The distribution of patients in the SLE and non-SLE group have similar values in terms of mean age (51 and 51.2 years old, respectively), gender percentage (23% males and 77% females; 25% males and 75% females, respectively), mean Charlson Comorbidity Index scores (6.0 for both groups), and number of patients with AVF (1189 and 3577, respectively). The use of concomitant medications and presence of comorbidities were also similar in both groups.

Table 1
Baseline Characteristics of Patients

Characteristics	SLE Patients (N = 1366)	Non-SLE Patients (N = 4098)	P
Age, years, mean (SD)	51.0 (16.8)	51.2 (15.2)	0.616
Gender			
Male	312 (22.84)	1011 (24.67)	0.171
Female	1054 (77.16)	3087 (75.33)	
CCI score, mean (SD)	6.0 (2.7)	6.0 (3.5)	0.894
AVF	1189 (87.04)	3577 (87.29)	0.815
Concomitant medications			
Antiplatelet agents‡	445 (32.58)	1339 (32.67)	0.947
ACE inhibitor or ARB	514 (37.63)	1528 (37.29)	0.821
Beta blocker	570 (41.73)	1721 (42)	0.862
Calcium channel blocker	846 (61.93)	2526 (61.64)	0.847
Statin	179 (13.10)	484 (11.81)	0.205
Comorbidities			
Diabetes mellitus	447 (32.72)	1336 (32.6)	0.933
Hypertension	1175 (86.02)	3521 (85.92)	0.928
Myocardial infarction	64 (4.69)	186 (4.54)	0.823
Heart failure	423 (30.97)	1241 (30.28)	0.635
Peripheral vascular disease	93 (6.81)	283 (6.91)	0.902
Dementia	33 (2.42)	102 (2.49)	0.880
Chronic pulmonary disease	597 (43.7)	1839 (44.88)	0.451
Dyslipidemia	579 (42.39)	1704 (41.58)	0.601
Cerebrovascular disease	296 (21.67)	862 (21.03)	0.619
Valvular heart disease	196 (14.35)	591 (14.42)	0.947
Cancer	235 (17.2)	710 (17.33)	0.918
All data are presented as n (%), unless otherwise indicated.			
‡Including aspirin, clopidogrel, ticlopidine, and cilostazol.			
Abbreviations: SLE, systemic lupus erythematosus; CCI, Charlson Comorbidity Index; AVF, arteriovenous fistula; ACE, angiotensin-converting enzyme; ARB, angiotensin II receptor blocker; SD, standard deviation			

The incidence rates (per 100 person-years) and risks of AVF/AVG dysfunction in SLE and non-SLE patients are shown in Table 2. The findings demonstrated that SLE patients had higher incidence rates of AVF/AVG dysfunction than non-SLE patients in all of the specified time periods. There were 3 specific time periods that reached significant difference: (1) after 1 year (incidence rates = 15.21, 13.01, respectively; subdistribution hazard ratio (SHR) = 1.15; P = 0.007), (2) 1st-to-10th-year period (incidence rates = 15.36 and 13.25, respectively; SHR = 1.16; P = 0.007), and (3) overall period (incidence rates = 23.53 and 21.66, respectively; SHR = 1.09; P

= 0.027). The survival curves in Fig. 1 confirmed these results where there was a statistically significant difference in the cumulative incidence of AVF/AVG dysfunction between SLE and non-SLE patients (P = 0.048).

Table 2
Incidence Rates and Risks of AVF/AVG Dysfunction in SLE and Non-SLE Patients

Time Period	SLE Patients			Non-SLE Patients (Reference)			Crude		Competing Risk	
	No. of Events	Person-Years	Incidence Rate*	No. of Events	Person-Years	Incidence Rate*	HR (95% CI)	P	SHR (95% CI)	P
Overall Period	924	3927	23.53	2589	11950	21.66	1.07 (0.99–1.16)	0.068	1.09 (1.00, 1.17)	0.027*
Within 90 Days	206	313	65.87	580	937	61.90	1.06 (0.91–1.25)	0.446	1.06 (0.91, 1.25)	0.442
Within 180 Days	347	573	60.52	1009	1720	58.66	1.03 (0.91, 1.17)	0.616	1.04 (0.92, 1.17)	0.572
First Year	483	1027	47.05	1434	3071	46.69	1.01 (0.91, 1.12)	0.871	1.01 (0.92, 1.12)	0.782
After 1 Year	441	2900	15.21	1155	8879	13.01	1.15 (1.02, 1.29)	0.011	1.16 (1.04–1.29)	0.007*
Within 5 Years	815	3000	27.17	2344	8896	26.35	1.03 (0.96, 1.12)	0.4	1.05 (0.97, 1.14)	0.222
1–5 Years	332	1973	16.83	910	5824	15.62	1.08 (0.95, 1.22)	0.255	1.09 (0.96, 1.24)	0.174
1–10 Years	432	2813	15.36	1128	8516	13.25	1.15 (1.03, 1.28)	0.015	1.16 (1.04, 1.29)	0.007*

*per 100 person-years

Abbreviations: AVF, arteriovenous fistula; AVG, arteriovenous graft; SLE, systemic lupus erythematosus ; HR, hazard ratio; SHR, subdistribution hazard ratio; CI, confidence interval

Diabetes mellitus is a crucial underlying cause of ESRD. SLE and non-SLE patients were both further subdivided into groups with or without diabetes mellitus. The incidence rates (per 100 person-years) and risks of AVF/AVG dysfunction between different patient groups are shown in Table 3. Non-SLE patients without diabetes mellitus served as the reference group. The incidence rates of non-SLE and SLE patients without diabetes mellitus were 17.81 and 20.51, respectively, and the difference between groups were found to be statistically significant (SHR = 1.12; P = 0.011). Even if diabetes was removed as a confounding variable, SLE may still directly have an impact on AVF/AVG dysfunction.

Table 3
Incidence Rates and Risks of AVF/AVG Dysfunction in SLE and Non-SLE Patients With and Without Diabetes Mellitus

Patient Group	No. of Events	Person-Years	Incidence Rate*	Crude		Competing Risk	
				HR (95% CI)	P	SHR (95% CI)	P
Non-SLE Patients Without Diabetes Mellitus	1694	9510	17.81	Reference		Reference	
Non-SLE Patients With Diabetes Mellitus	895	2440	36.68	1.59 (1.47, 1.73)	< 0.001	1.34 (1.23, 1.46)	< 0.001*
SLE Patients Without Diabetes Mellitus	614	2994	20.51	1.12 (1.02, 1.23)	0.014	1.12 (1.03, 1.23)	0.011*
SLE Patients With Diabetes Mellitus	310	933	33.22	1.52 (1.35, 1.72)	< 0.001	1.35 (1.20, 1.53)	< 0.001*

*per 100 person-years

Abbreviations: AVF, arteriovenous fistula; AVG, arteriovenous graft; SLE, systemic lupus erythematosus; HR, hazard ratio; SHR, subdistribution hazard ratio; CI, confidence interval

The incidence rates (per 100 person-years) and risks of MACE, myocardial infarction, and ischaemic stroke in SLE and non-SLE patients are shown in Table 4 and the differences between groups were not found to be statistically significant. However, SLE patients have a lower incidence rate of ischaemic stroke than non-SLE patients (0.84 vs. 1.09, respectively; SHR = 0.77; P = 0.074) where it may seem that SLE patients may seem to have a lower risk of developing ischaemic stroke.

Table 4
Incidence Rates and Risks of MACE in SLE and Non-SLE Patients

Time Period	SLE Patients			Non-SLE Patients (Reference)			Crude		Competing Risk	
	No. of Events	Person-Years	Incidence Rate*	No. of Events	Person-Years	Incidence Rate*	HR (95% CI)	P	SHR (95% CI)	P
MACE	117	7287	1.61	387	21196	1.83	0.88 (0.72, 1.08)	0.225	0.89 (0.72, 1.09)	0.26
Myocardial Infarction	59	7409	0.8	178	21674	0.82	0.97 (0.72, 1.30)	0.839	0.98 (0.73, 1.31)	0.89
Ischaemic Stroke	62	7392	0.84	235	21534	1.09	0.77 (0.58, 1.02)	0.065	0.77 (0.59, 1.02)	0.074

*per 100 person-years

Abbreviations: MACE, major cardiovascular events; AVF, arteriovenous fistula; AVG, arteriovenous graft; SLE, systemic lupus erythematosus; HR, hazard ratio; SHR, subdistribution hazard ratio; CI, confidence interval

Discussion

The main hypothesis of the study is that there may be a difference in the risk of AVF/AVG dysfunction between SLE and non-SLE patients due to endothelial activation, apoptosis, and atherogenesis [6–8]. To the best of our knowledge, previous research addressing the risk of vascular access dysfunction in SLE patients receiving HD had not analysed the rate of dysfunction in SLE patients after 1 year [4, 5]. The observation period in this study was over a 10-year duration. The results have shown that SLE patients on HD had a significantly higher risk of developing AVF/AVG dysfunction during the long-term period follow up, especially after the first year, 1st-year-to-10th-year, and overall periods.

Shafi et al. conducted a study where 66.6% of 36 SLE patients developed VAT at 1 year as compared to 38.9% of 36 non-SLE patients ($P < 0.05$) and the odds ratio of VAT in SLE patients was 3.1 (95% confidence interval = 1.2, 8.2) [4]. Plantinga et al. carried out a study on 117,836 incident adult and pediatric ESRD patients with a one-year follow-up period and revealed that SLE patients who started treatment with a permanent vascular access on first dialysis were less likely to experience patency loss than non-SLE patients within the first year (43.8% vs. 55.0%, respectively). This outcome may be due to the nature of the population in this study where SLE-ESRD patients were found to less likely have comorbid conditions (such as diabetes, congestive heart failure, peripheral vascular disease) and to smoke than the other ESRD patients [5]. Cuen-Ojeda et al. conducted a retrospective review of AVFs created between 2008 and 2017 where 134 patients were identified. When compared to patients with chronic diseases such as diabetes, hypertension, and idiopathic ESRD, SLE patients have an increased risk of developing AVF patency loss within the first 6 months of follow-up [9].

The possible pathogenetic mechanisms associated with a higher risk of vascular access thrombosis (VAT) include the Virchow triad, which consists of stasis, hypercoagulability, and endothelial injury [10]. Stasis is the condition of reduced blood flow within the vascular access. Hypoalbuminemia is a predisposing factor for stasis and is usually attributed to nephrotic syndrome or disease exacerbation in SLE, both of which may lead to vascular access dysfunction [11, 12]. Hypercoagulability in SLE may be attributed to lupus-specific antibodies (aPLs), which can lead to VAT through possible mechanisms such as atherogenesis, and endothelial activation [4]. Inflammation in SLE may also increase certain procoagulant factors that may increase the risk of developing VAT [13]. Endothelial activation and damage is commonly observed in SLE patients. Different mechanisms have been proposed to explain the prevalence of endothelial dysfunction in SLE [14]. Atehortúa et al. pointed out that different components of the immune system seem to participate in endothelial injury, such as autoantibody production and immune complex formation, which is characterized by an increase in the expression of adhesion molecules, production of pro-inflammatory cytokines and prothrombotic factors, oxidative stress upregulation, and abnormal vascular tone modulation [15]. The structural damage and attenuation of endothelial function in vascular access may lead to their loss of viability and integrity, which may eventually result in possible long-term vascular access failure.

VAT is a common complication that develops in majority of HD patients with an arteriovenous access, accounting for 65%-85% cases of permanent vascular access loss [16]. Antiphospholipid (aPL) antibodies, which include anticardiolipin (aCL) antibodies and lupus anticoagulants (LAC), are the most common acquired blood protein defects causing thrombosis [17, 18]. In SLE patients, there were 30%-40% who tested positive for aPL [19] and the prevalence of positive LAC activity ranged between 11–30% and positive aCL activity between 17–40% [20–22].

Grönhangen-Riska et al. reported for the first time the presence of aCL in the HD population [23]. Phillips et al. showed that the aCL presence had no significant relationship with thrombotic events [24], but Prakash et al. showed that HD patients with elevated IgG-aCL titers have higher odds of recurrent AVG thrombosis [25]. Haviv found that vascular access occluders had higher mean IgG and IgM aCL levels than non-occluders (24.47 and 8.39 IU/mL in occluders [$p < 0.0226$] vs. 8.45 and 3.59 IU/mL in non-occluders [$p < 0.05$]). These results indicated that HD patients, especially those with recurrent access occlusion episodes, may be associated with elevated IgG aCL levels, which could be applied to predicting the occlusive status of HD patients [26]. Shafi et al. observed SLE patients on HD during a 1-year period where patients with positive aCL antibodies had a statistically significantly higher rate of VAT (83.3%) as opposed to patients with negative aCL antibodies (33.3%) [4].

Quereda et al. found that 30% of HD patients exhibited LAC activity compared to 11% patients on conservative treatment ($P < 0.02$). Patients with LAC also exhibited a higher incidence of thrombosis than patients without it (23% vs. 13%, respectively) [27]. Brunet et al. found that VAT was significantly more frequent in patients with LAC than in patients without LAC (62% vs. 26%, respectively;

P = 0.01) [28]. The Lupus in Minorities: Nature vs. Nurture (LUMINA) study found a significant correlation between thrombosis events and shorter disease duration, implying such events occur early in the course of SLE. In addition, the presence of LAC, smoking, older age, disease activity over time, and higher mean daily glucocorticoid dose were identified as risk factors in the development of venous thrombosis [29]. Bataille et al. determined the aPL prevalence and risk factors in 192 HD patients where at least one type of aPL was found in 19.8% of patients, of which 74% had only LAC. There was a significant association between VAT history and aPL presence (hazard ratio = 3.03; 95% confidence interval = 1.69, 4.42; P < 0.001) where aPL presence, especially LAC, is associated with VAT in HD patients [30].

García-Martín et al. tested both aCL and LAC activity in 51 HD patients where 31% had aCL activity, 22% had LAC activity, and 37% had LAC and/or aCL activity. [31]. Wahl et al. conducted a study where patients with SLE and LAC have approximately six times greater risk for venous thrombosis (odds ratio = 5.61; confidence interval = 3.80, 8.27; P < 0.0015) than patients without LAC, whereas patients with SLE and aCL have approximately two times greater risk for venous thrombosis (odds ratio = 2.17; confidence interval = 1.51, 3.11; P < 0.05) than patients without aCL [32].

Numerous studies have shown that SLE patients have increased risks of developing MACE, acute myocardial infarction, and stroke [33–35]. However, this study did not demonstrate SLE patients having a higher risk of developing MACE, AMI, and stroke than non-SLE patients. Differences in demographic characteristics in the SLE population of this study may account for the different outcomes and further studies may be needed to reevaluate the relationship between SLE, HD, and the aforementioned adverse events.

There are several limitations of this study that should be noted. This is a retrospective study and utilized a database where laboratory markers as potential prognostic variables cannot be analysed. It was also conducted in a single country (Taiwan) where all of the participants were of Chinese ethnicity. The prognosis and outcomes between SLE and non-SLE patients with different ethnicities is unknown, and may limit the generalization of results. The number of patients with AVG listed in the database were also too few and was combined with the number of patients with AVF for the final analysis. In spite of the aforementioned limitations, this study enrolled the largest number of SLE patients in analysing vascular access and has the longest observation period of 10 years.

AVF/AVG dysfunction in SLE patients is of crucial clinical relevance since it worsens the quality of life and is a clinical challenge for the healthcare professionals in HD units. Additional randomized large-scale prospective studies are needed in the future to confirm the results in this study and to also address the following important issues: (1) the roles of autoantibodies and other additional factors contributing to pathogenesis of AVF/AVG dysfunction, (2) the role of antiplatelet or anticoagulation in preventive strategy against VAT, and (3) the interaction between SLE, hemostasis, and immunological system in the pathogenesis of thromboembolism in SLE patients under maintenance HD.

In conclusion, there were significantly higher incidence rates of AVF/AVG dysfunction in SLE patients than non-SLE patients during long-term follow-up period (especially after 1 year and during the 1st-to-10th year period) in this study. A multi-disciplinary approach may be considered to improve vascular access patency in SLE patients. In order to extend the durability of a permanent vascular access and prevent further complications, such as VAT, early diagnostic evaluation of aCL and LAC activity in ESRD patients is recommended.

Declarations

Competing interests

The authors declare no competing interests.

Author contributions

Study conception and design: F.Y.C., Y.T.C., and C.C.L.; Data acquisition: Y.T.C.; Data analysis: F.Y.C. and C.F.C.; Data interpretation: F.Y.C., C.F.C., A.C.T., C.H.C., F.A.C., W.S.L., T.H.C., S.M.O., S.Y.L., M.T.T., Y.T.C., and C.C.L.; Funding acquisition: C.C.L.; Manuscript

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References

1. Rees, F., Doherty, M., Grainge, M. J., Lanyon, P. & Zhang, W. The worldwide incidence and prevalence of systemic lupus erythematosus: a systematic review of epidemiological studies. *Rheumatology (Oxford)* **56**, 1945–1961, doi:10.1093/rheumatology/kex260 (2017).
2. Yap, D. Y. H. & Chan, T. M. Lupus nephritis in Asia: clinical features and management. *Kidney Dis* **1**, 100–109, doi:10.1159/000430458 (2015).
3. Yu, K. H., Kuo, C. F., Chou, I. J., Chiou, M. J. & See, L. C. Risk of end-stage renal disease in systemic lupus erythematosus patients: a nationwide population-based study. *Int J Rheum Dis* **19**, 1175–1182, doi:10.1111/1756-185x.12828 (2016).
4. Shafi, S. T. & Gupta, M. Risk of vascular access thrombosis in patients with systemic lupus erythematosus on hemodialysis. *J Vasc Access* **8**, 103–108, doi:10.1177/112972980700800207 (2007).
5. Plantinga, L. C., Lim, S. S., Patzer, R. E., Pastan, S. O. & Drenkard, C. Comparison of vascular access outcomes in patients with end-stage renal disease attributed to systemic lupus erythematosus vs. other causes: a retrospective cohort study. *BMC Nephrol* **17**, 64–64, doi:10.1186/s12882-016-0274-y (2016).
6. Cockwell, P., Tse, W. Y. & Savage, C. O. Activation of endothelial cells in thrombosis and vasculitis. *Scand J Rheumatol* **26**, 145–150, doi:10.3109/03009749709065673 (1997).
7. Takeya, H., Tanaka, Y. & Suzuki, K. Thrombosis and apoptosis. *Rinsho Byori* **45**, 614–620 (1997).
8. Vaarala, O. *et al.* Crossreaction between antibodies to oxidised low-density lipoprotein and to cardiolipin in systemic lupus erythematosus. *Lancet* **341**, 923–925, doi:10.1016/0140-6736(93)91213-6 (1993).
9. Cuen-Ojeda, C. *et al.* Systemic lupus erythematosus diagnosis impacts clinical outcomes of arteriovenous fistulas in comparison to other end-stage renal disease etiologies. *Vascular*, 1708538120936407, doi:10.1177/1708538120936407 (2020).
10. Montagnana, M., Meschi, T., Borghi, L. & Lippi, G. Thrombosis and occlusion of vascular access in hemodialyzed patients. *Semin Thromb Hemost* **37**, 946–954, doi:10.1055/s-0031-1297373 (2011).
11. Al-Mogairen, S. M. Lupus protein-losing enteropathy (LUPLE): a systematic review. *Rheumatol Int* **31**, 995–1001, doi:10.1007/s00296-011-1827-9 (2011).
12. Gatta, A., Verardo, A. & Bolognesi, M. Hypoalbuminemia. *Intern Emerg Med* **7 Suppl 3**, S193–199, doi:10.1007/s11739-012-0802-0 (2012).
13. O'Shea S, I., Lawson, J. H., Reddan, D., Murphy, M. & Ortel, T. L. Hypercoagulable states and antithrombotic strategies in recurrent vascular access site thrombosis. *J Vasc Surg* **38**, 541–548, doi:10.1016/s0741-5214(03)00321-5 (2003).
14. Sciatti, E. *et al.* Systemic lupus erythematosus and endothelial dysfunction: a close relationship. *Curr Rheumatol Rev* **15**, 177–188, doi:10.2174/1573397115666181126105318 (2019).
15. Atehortúa, L. *et al.* Endothelial activation and injury by microparticles in patients with systemic lupus erythematosus and rheumatoid arthritis. *Arthritis Res Ther* **21**, 34, doi:10.1186/s13075-018-1796-4 (2019).
16. Quencer, K. B. & Friedman, T. Declotting the thrombosed access. *Tech Vasc Interv Radiol* **20**, 38–47, doi:10.1053/j.tvir.2016.11.007 (2017).
17. Bick, R. L. Antiphospholipid thrombosis syndromes. *Clin Appl Thromb Hemost* **7**, 241–258, doi:10.1177/107602960100700401 (2001).

18. Garcia, D. & Erkan, D. Diagnosis and management of the antiphospholipid syndrome. *N Engl J Med* **378**, 2010–2021, doi:10.1056/NEJMra1705454 (2018).
19. Petri, M. Epidemiology of the antiphospholipid antibody syndrome. *J Autoimmun* **15**, 145–151, doi:10.1006/jaut.2000.0409 (2000).
20. Reynaud, Q. *et al.* Risk of venous and arterial thrombosis according to type of antiphospholipid antibodies in adults without systemic lupus erythematosus: a systematic review and meta-analysis. *Autoimmun Rev* **13**, 595–608, doi:10.1016/j.autrev.2013.11.004 (2014).
21. Borowoy, A. M. *et al.* Neuropsychiatric lupus: the prevalence and autoantibody associations depend on the definition: results from the 1000 faces of lupus cohort. *Semin Arthritis Rheum* **42**, 179–185, doi:10.1016/j.semarthrit.2012.03.011 (2012).
22. Gustafsson, J. T. *et al.* Cigarette smoking, antiphospholipid antibodies and vascular events in Systemic Lupus Erythematosus. *Ann Rheum Dis* **74**, 1537–1543, doi:10.1136/annrheumdis-2013-205159 (2015).
23. Grönhagen-Riska, C., Teppo, A. M., Helanterä, A., Honkanen, E. & Julkunen, H. Raised concentrations of antibodies to cardiolipin in patients receiving dialysis. *BMJ* **300**, 1696–1697, doi:10.1136/bmj.300.6741.1696 (1990).
24. Phillips, A. O., Jones, H. W., Hambley, H., Hillis, A. N. & Hendry, B. M. Prevalence of lupus anticoagulant and anticardiolipin antibodies in haemodialysis patients. *Nephron* **65**, 350–353, doi:10.1159/000187511 (1993).
25. Prakash, R., Miller, C. C., 3rd & Suki, W. N. Anticardiolipin antibody in patients on maintenance hemodialysis and its association with recurrent arteriovenous graft thrombosis. *Am J Kidney Dis* **26**, 347–352, doi:10.1016/0272-6386(95)90656-8 (1995).
26. Haviv, Y. S. Association of anticardiolipin antibodies with vascular access occlusion in hemodialysis patients: cause or effect? *Nephron* **86**, 447–454, doi:10.1159/000045833 (2000).
27. Quereda, C. *et al.* Lupus-like in vitro anticoagulant activity in end-stage renal disease. *Nephron* **49**, 39–44, doi:10.1159/000184984 (1988).
28. Brunet, P. *et al.* Antiphospholipids in hemodialysis patients: relationship between lupus anticoagulant and thrombosis. *Kidney Int* **48**, 794–800, doi:10.1038/ki.1995.352 (1995).
29. Calvo-Alén, J. *et al.* Systemic lupus erythematosus in a multiethnic US cohort (LUMINA). XXV. Smoking, older age, disease activity, lupus anticoagulant, and glucocorticoid dose as risk factors for the occurrence of venous thrombosis in lupus patients. *Arthritis Rheum* **52**, 2060–2068, doi:10.1002/art.21149 (2005).
30. Bataille, S. *et al.* Antiphospholipids antibodies and hemodialysis: a frequent association linked to arteriovenous fistula thrombosis. *Nephrol Ther* **11**, 27–33, doi:10.1016/j.nephro.2014.08.005 (2015).
31. García-Martín, F. *et al.* Anticardiolipin antibodies and lupus anticoagulant in end-stage renal disease. *Nephrol Dial Transplant* **6**, 543–547, doi:10.1093/ndt/6.8.543 (1991).
32. Wahl, D. G. *et al.* Risk for venous thrombosis related to antiphospholipid antibodies in systemic lupus erythematosus–a meta-analysis. *Lupus* **6**, 467–473, doi:10.1177/096120339700600510 (1997).
33. Smilowitz, N. R., Katz, G., Buyon, J. P., Clancy, R. M. & Berger, J. S. Systemic lupus erythematosus and the risk of perioperative major adverse cardiovascular events. *J Thromb Thrombolysis* **45**, 13–17, doi:10.1007/s11239-017-1591-0 (2018).
34. Lin, C. Y. *et al.* Increased risk of acute myocardial infarction and mortality in patients with systemic lupus erythematosus: two nationwide retrospective cohort studies. *Int J Cardiol* **176**, 847–851, doi:10.1016/j.ijcard.2014.08.006 (2014).
35. Hanly, J. G. *et al.* Cerebrovascular events in systemic lupus erythematosus: results from an international inception cohort study. *Arthritis Care Res (Hoboken)* **70**, 1478–1487, doi:10.1002/acr.23509 (2018).

Figures

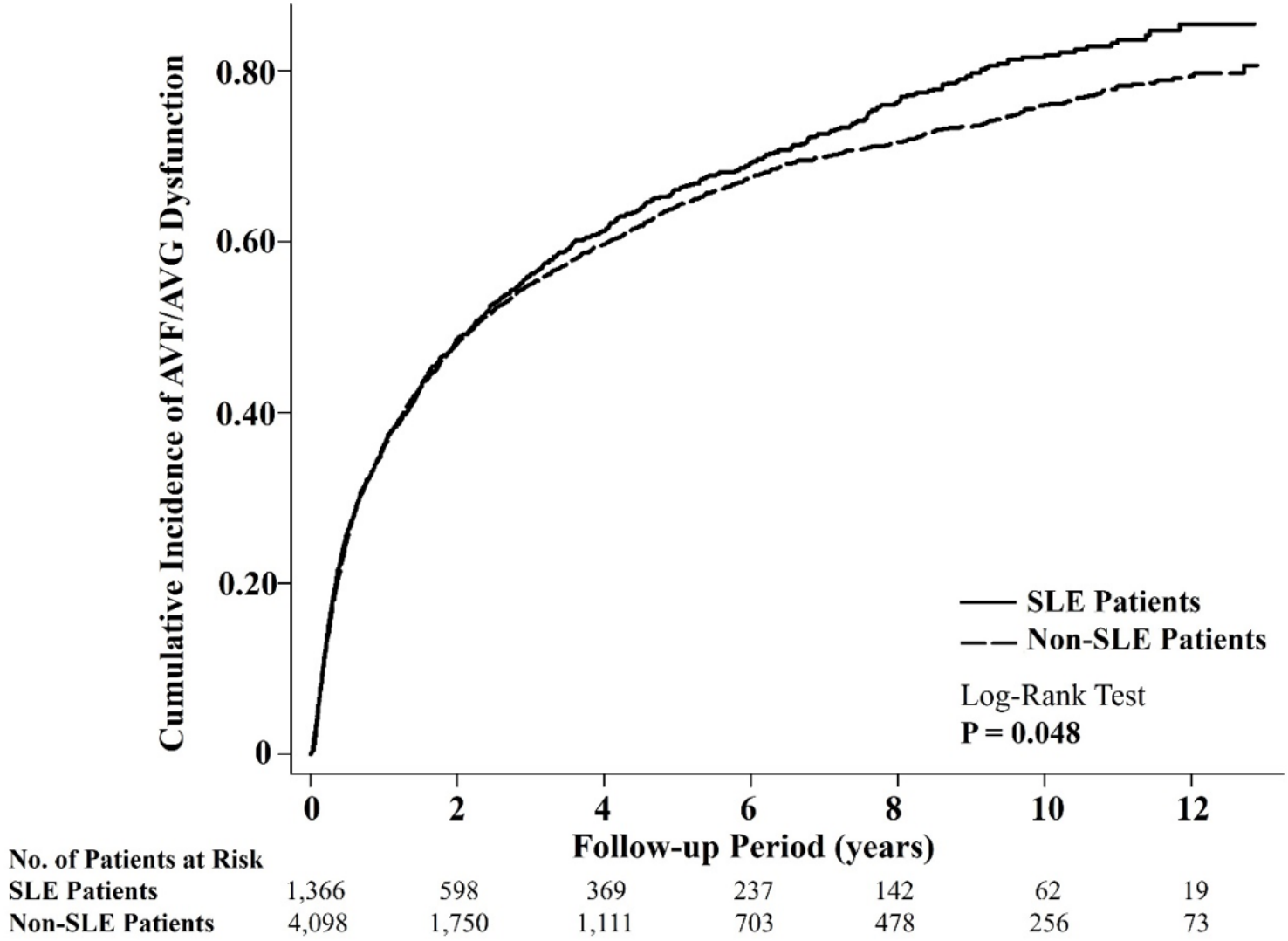

Figure 1

Kaplan-Meier survival estimates showed the cumulative incidence of AVF/AVG dysfunction between SLE and non-SLE patients over 10 years where there was a statistically significant difference between the two groups (P = 0.048).

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