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Effect of demographic characteristics and timing of vascular access maturation on patency in Chinese incident haemodialysis patients

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Abstract

Background. Functional, long-lasting vascular access is essential for maintaining effective long-term haemodialysis. Previous studies have documented demographic factors and comorbid conditions associated with long-term vascular access. However, no studies have examined the effect of demography and timing of vascular access maturation on primary patency in Chinese incident haemodialysis patients.

Methods. We retrospectively enrolled 7028 adult incident patients who began haemodialysis between 1 January and 31 December 2002. A total of 5890 patients with mature arteriovenous fistula or arteriovenous graft, before or after beginning regular haemodialysis, were identified between 1 January 2000 and 31 December 2003. The Cox regression hazard model was used to assess the impact of sex, age, diabetes, type of access and timing of vascular access maturation on the duration of primary vascular access patency.

Results. Of the study population, 2920 patients (50%) had diabetes; 4929 patients (84%) received fistulas and 961 (16%) grafts. Grafts, female sex and advanced age were significantly associated with shorter primary vascular access patency duration ($P < 0.05$). Diabetes was a risk factor for shorter primary vascular access patency duration for incident patients with mature fistulas before or after initiation, but not for patients with mature graft. Arteriovenous graft placement and maturation were better when completed >6 months prior to haemodialysis initiation for the duration of primary access patency.

Conclusion. Demographic characteristics and timing of vascular access maturation affect access type and duration of primary access patency among incident patients. Individual programmes for vascular access may be necessary to establish functional long-term access.

Keywords: arteriovenous fistula; arteriovenous graft; haemodialysis; patency; vascular access

Introduction

Functional long-term vascular access is essential for efficient haemodialysis for patients with end-stage renal disease (ESRD). Thus, planning for vascular access is important for a smooth start to haemodialysis (HD). Vascular access may be created at least 3 months before the estimated dialysis start date [1], allowing time for the fistula to mature, and avoiding the need for temporary access and attendant risks such as trauma, septicaemia, venous stenosis and thrombosis [2]. However, receiving the ESRD diagnosis is a stressful life event; patients who present for treatment may be angry, anxious, wary of the future, depressed and in denial about the reality, nature and demands of the illness [3]. Thus, some patients may be reluctant to receive vascular access before starting HD. Also, accurately estimating the dialysis initiation date is often difficult for physicians.

The question of whether timing of vascular access maturation affects access longevity has rarely been researched. The influence of timing of vascular access maturation, and of demographic characteristics on vascular access patency in incident HD patients, is an important issue to investigate. In this study, the historical cohort design was used to investigate the effect of risk factors and timing of vascular access maturation on access patency in incident patients, using national health insurance (NHI) claim data.

Materials and methods

Healthcare system and data source

As in other industrialized nations, the demand in Taiwan for universal healthcare led to the creation of a NHI programme, on 1 March 1995. All medical institutions must submit standard claim documents for medical expenses on a computerized form that includes admission and discharge dates, patient identification number, sex and birth date, and International Classification of Diseases, ninth revision, Clinical Modification (ICD-9-CM) diagnostic codes for the admission. These codes, consisting of the principal and up to four secondary diagnoses for inpatient care and two secondary diagnoses for outpatient care, facilitate health care pattern

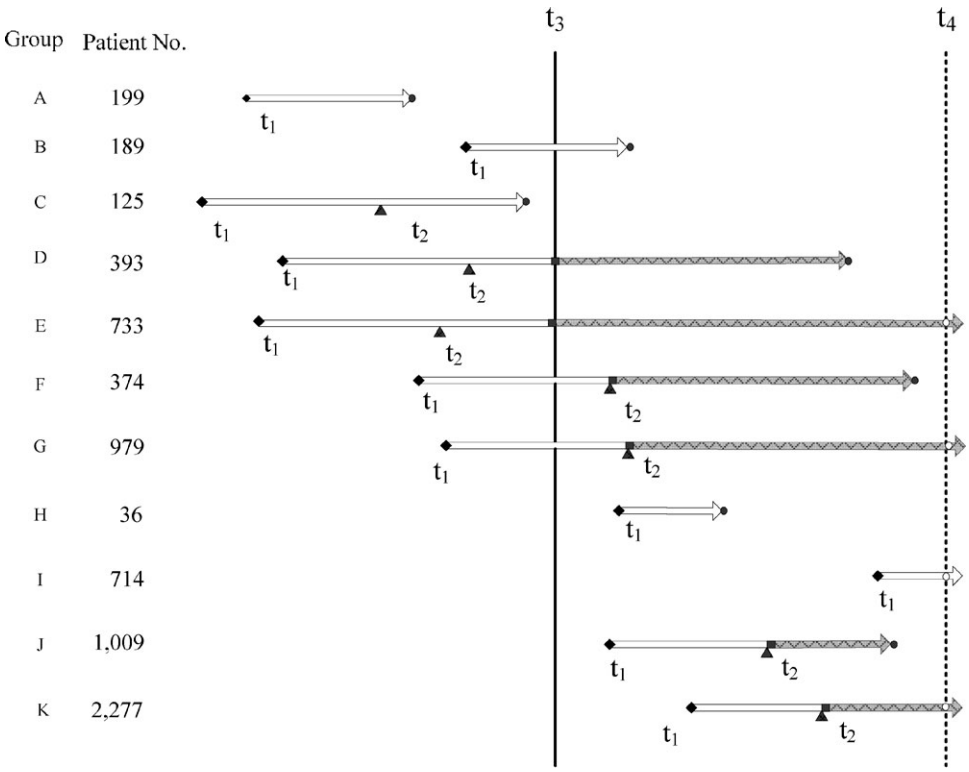

Fig. 1. The different groups of all incident patients according to the time of vascular access placement, maturation time, time of haemodialysis initiation duration and effective duration of primary vascular access patency ($n = 7028$). Maturation time, start from vascular access placement point (♦, t_1) to maturation point (▲, t_2); t_3, haemodialysis initiation time; duration of primary vascular access patency, start from t_2 to vascular access dysfunction point (●) or study end point (○, t_4); effective duration of primary vascular access patency, start from vascular access used point (■) to vascular access dysfunction point (●) or study end point (○). The maturation times were 12 and 6 weeks of arteriovenous fistula and arteriovenous graft, respectively.

analyses. The database also includes codes for treatment procedures and materials, such as arteriovenous fistula (code 69032C) and arteriovenous graft (code 69032C plus the material codes for graft). In 2000, Taiwan's NHI programme included 21 million enrollees, accounting for 96.2% of the population targeted to receive programme benefits [4]. As the NIH programme is available to all residents regardless of age or income, its scope is extensive, and detailed analyses of particular patterns in health care are possible.

Patients

Incident patients aged ≥18 years who began HD (procedure codes 58001C, 58019C-58025C) between 1 January and 31 December 2002 were included in this study. These patients had received regular HD for >3 months. All incident patients with first payment and operation code for arteriovenous fistula (AVF)(69032C, ICD-9-CM: 39.27) and arteriovenous graft (AVG) (69034C) before or after beginning regular HD, indicative of having undergone vascular access surgery, between 1 January 2000 and 31 December 2003, were identified to analyse timing of vascular access placement and maturation. These criteria allowed us to enrol 7028 patients. Although the Taiwanese NHI programme could not provide information about the maturation time of vascular access, the maturation time can be defined by the recommendation of National Kidney Foundation Dialysis Outcomes Quality Initiative (NKFDOQI) guidelines and other reports. NKFDOQI guidelines recommended 3- to 4-month maturation time of AVF and 3–6 weeks of AVG, respectively [5–7]. Under these recommendations, the maturation time was defined as 3 months (12 weeks) for AVF and 6 weeks for AVG after vascular access placement in this study. Under this definition of maturation time, 1138 incident patients were excluded due to immature vascular access. Finally, there were 5890 patients with mature vascular access recruited into this study (Figure 1). Of 5890 patients, 1251 were with mature vascular access before HD initiation, and 4639 with mature vascular access after HD initiation (Table 1).

Table 1. The timing of vascular access maturation of all incident patients ($n = 5890$)

	All		Vascular access			
			Fistula		Graft	
	n	%	*n*	%	*n*	%
All	5890	100	4929	84	961	16
Before haemodialysis initiation	1251	21	1011	81	240	19
>1 year	199	3	163	82	36	18
>6 months	185	3	155	84	30	16
>3 months	233	4	191	82	42	18
>1 month	345	6	272	79	73	21
< = 1 month	289	5	230	80	59	20
After haemodialysis initiation	4639	79	3918	84	721	16
0–1 month	353	6	257	73	96	27
>1 month	3336	57	2764	83	572	17
>3 months	885	15	856	97	29	3
>6 months	65	1	41	63	24	37

Vascular access

Duration of primary vascular access patency was defined as the time from vascular access maturation to the time of any intervention designed to

maintain or re-establish patency or to access thrombosis or study end point. Effective duration of primary vascular access patency was defined as the time from vascular access use for HD to the time of any intervention designed to maintain or re-establish patency or to access thrombosis or study end point (Figure 1). Patients who died or whose vascular access remained patent after 31 December 2003 were censored. Vascular access dysfunction was identified based on the diagnostic code for vascular thrombosis (ICD-9-CM 996.73, other complications due to renal dialysis device implant and graft) and operative procedures for vascular thrombotic occlusion (thrombectomy, procedure code 38.0; reconstruction of access, procedure code, 69032C, 69034C; permanent catheter 47059B, 47061B; temporary catheter 69006C, 69007B; embolectomy, arterial, 69001B; embolectomy, arterial catheter, 69002B; thrombectomy, venous, 69003B) at a subsequent admission or outpatient visit.

Demographic data

Demographic data included age, sex and type of vascular access (fistula or graft). We defined patients with diabetes as incident patients with a primary or secondary diagnosis of diabetes before HD initiation.

Statistical analysis

Statistical analysis was performed using SPSS for Windows (version 15.0). Kaplan–Meier survival analysis was used to present mean survival time and standard errors. A two-tailed P-value <0.05 was considered statistically significant. The Cox regression hazard model was used to assess the impact of sex, age, diabetes, type of access and timing of vascular access maturation on the duration of vascular access patency.

Results

Timing of mature vascular access

Of 5890 patients, 1251 (21%) and 4639 (79%) patients' vascular access was matured before and after HD initiation, respectively; 634 (11%) of 1251 and 4574 (78%) of 4639 patients' vascular access was matured within 3 months before HD initiation and within 6 months after HD initiation, respectively. Fistulas were placed for 4929 patients (84%) and grafts for 961 patients (16%). The timing of maturation was similar as above to the patients with fistula or graft (Table 1).

Demographics and characteristics of vascular access

Overall, the probability of receiving fistula was higher for men than for women (87% versus 81%), for age <65 years than for ≥ 65 years (88% versus 77%) and for non-diabetic than for diabetic patients (86% versus 82%) ($P < 0.001$, Table 2). This phenomenon was also shown in the patients with mature vascular access before or after HD initiation (Tables 3 and 4, respectively). Vascular access lasted longer for patients with fistulas, men, patients aged <65 years and non-diabetic patients ($P < 0.01$, Tables 2 and 4). For all patients, the estimated mean duration and effective duration of primary vascular patency were 380.32 ± 232.19 and 355.59 ± 203.29 days, respectively (Table 2). Estimates were 497.10 ± 307.49 and 383.46 ± 229.94 days for patients with mature vascular access before HD initiation (Table 3), and 348.83 ± 195.71 days for patients with mature access after HD initiation (Table 4).

For all cases and AVF patients, after controlling for all other variables, graft ($P < 0.001$), female sex ($P < 0.005$), age >65 years ($P < 0.001$) and diabetes ($P < 0.005$) were risk factors associated with shorter duration of primary vascular access patency, but not the timing of vascular access maturation (Table 5). However, there was a trend to longer duration of primary vascular access patency [hazard ratio (HR) <1] for patients with mature AVF >1 month after HD initiation. For AVG patients, age >65 years (HR 1.26, $P < 0.01$) was a significant risk factor for shorter patency duration, but not the sex and diabetes. The duration of primary access patency was significantly longer for patients with mature AVG >6 months prior to HD initiation (HR $<$ 0.5, $P < 0.05$, Table 5).

For patients with mature access before HD initiation, after controlling for all other variables, diabetes (HR 1.35, $P = 0.005$) and female sex (HR 1.43, $P < 0.05$) were risk factors associated with shorter duration of primary vascular access patency for AVF and AVG patients, respectively (Table 6). Graft maturation >6 months before HD initiation was a protective factor for AVG patients (HR < 0.5). For patients with mature access after HD initiation, after controlling for all other variables, female sex (HR 1.23, $P < 0.005$), age >65 years (HR 1.44, $P < 0.001$) and diabetes (HR 1.16, $P < 0.05$) were risk factors associated with shorter duration of primary vascular access patency for AVF patients. Fistula maturation after HD initiation seemed to be a protective factor for AVF patients (HR < 1). Age >65 years (HR 1.23, $P < 0.05$) and vascular access maturation after HD initiation (HR >1) were risk factors for AVG patients (Table 6).

The association between female sex and duration of primary access patency of AVF was not statistically significant before HD initiation (Table 6). However, the HR was >1 for the patients with mature AVF after HD initiation [HR 1.16, 95% confidence interval (CI) 0.94–1.45 versus HR 1.23, 95% CI 1.08–1.39; Table 6]. Although female sex was not a risk factor for overall AVG patients (Table 5), female sex was a risk factor for shorter duration of primary vascular access patency for AVG patients whose grafts matured before HD initiation (HR 1.43, 95% CI 1.01–2.00, $P < 0.05$) (Table 6). The impact patterns of age, diabetes, type of access and time of vascular access maturation were similar to those in Table 5.

Discussion

In this study, there were 4639 of 5890 (79%) incident patients with mature vascular access after HD initiation, possibly indicating that many patients postpone treatment until the appearance of uraemia and other complications such as pulmonary oedema, infection, nausea and general weakness (Table 1).

In this study, 4929 of 5890 (84%) incident patients with mature vascular access received fistulas. This percentage is similar to percentages in Japan (91–93%), Australia and New Zealand (72–77%) and European countries (58–90%) [8]. In our entire study population (patients whose vascular access was mature before and after HD initiation), a significantly higher proportion ($P < 0.001$) of women, elderly and diabetes patients tended to receive AVG. Our findings showed significantly longer fistula duration than graft, as reported in previous studies [9–16].

Table 2. Demographic and vascular access characteristics, all incident patients with mature access[a] ($n = 5890$)

			Vascular access					Primary vascular access patency			
	All		Fistula		Graft			Duration[b] ($n = 5890$)		Effective duration[c] ($N = 5765$)	
	n	%	*n*	%	*n*	%	*P*	Mean (days)	SD	Mean (days)	SD
All	5890	100	4929	84	961	16		380.32	232.19	355.59	203.29
Vascular access											
Fistula	4929	84	4929	84				399.62[d]	225.09	375.01[d]	195.70
Graft	961	16			961	16		281.34	242.71	255.37	212.14
Sex[e]							0.000				
Women	3044	52	2454	81	590	19		374.92	240.22	345.26[d]	205.86
Men	2843	48	2473	87	370	13		386.25	223.17	366.66	199.95
Age (years)							0.000				
<65	3540	60	3120	88	420	12		401.49[d]	223.28	378.02[d]	197.50
≥65	2350	40	1809	77	541	23		348.43	241.57	321.36	207.24
Diabetes											
No	2970	50	2548	86	422	14	0.000	403.49[d]	237.87	372.19[d]	201.24
Yes	2920	50	2381	82	539	18		356.75	223.86	338.74	204.01

SD, standard deviation of survival duration of primary vascular access patency.
[a]Patients with mature vascular access, who began regular haemodialysis for >3 months between 1 January and 31 December 2002.
[b]Estimated mean survival time, by Kaplan–Meier analysis. Duration of primary vascular access patency was defined as the time from vascular access maturation to the time of any intervention designed to maintain or re-establish patency or to access thrombosis or study end point. Effective duration of vascular access patency was defined as the time from mature access use for haemodialysis to the time of any intervention designed to maintain or re-establish patency or to access thrombosis or study end point.
[c]One hundred and twenty five incident patients with mature vascular access but dysfunction before haemodialysis initiation were excluded from the calculation of effective duration of vascular access patency.
[d]$P < 0.001$.
[e]Sex was not recorded for three patients.

Table 3. Demographic and vascular access characteristics, incident patients with mature vascular access before haemodialysis initiation ($n = 1251$)

			Vascular access					Primary vascular access patency			
	All		Fistula		Graft			Duration[a] ($n = 1251$)		Effective duration[b] ($n = 1126$)[c]	
	n	%	*n*	%	*n*	%	*P*-value	Mean (days)	SD	Mean (days)	SD
All	1251	100	1011	81	240	19		497.10	307.49	383.46	229.94
Vascular access											
Fistula	1011	81	1011	81				523.50[§]	301.84	406.69[§]	223.93
Graft	240	19			240	19		385.91	306.80	285.01	229.54
Sex[d]											
Women	708	57	556	79	152	21	0.0199	493.21	320.33	367.98**	235.87
Men	542	43	454	84	88	16		502.78	290.02	403.62	220.59
Age (year)											
<65	673	53.8	573	85	100	15	<.0001	526.89[§]	299.55	405.76[§]	228.74
≥65	578	46.2	438	76	140	24		462.43	313.18	356.52	228.71
Diabetes											
No	708	56.59	589	83	119	17	0.0148	532.8[§]	310.77	404.50[§]	225.31
Yes	543	43.41	422	78	121	22		450.57	297.04	355.55	233.26

SD, standard deviation of survival duration of primary vascular access patency.
[a]Estimated mean duration of vascular access patency for patients with mature vascular access before haemodialysis initiation of haemodialysis, by Kaplan–Meier analysis. Duration of primary vascular access patency was defined as the time from vascular access maturation to the time of any intervention designed to maintain or re-establish patency or to access thrombosis or study end point. Effective duration of primary vascular access patency was defined as the time from mature access use for haemodialysis to the time of any intervention designed to maintain or re-establish patency or to access thrombosis or study end point.
[b]Estimated mean effective duration of primary vascular access patency in patients with mature vascular access before haemodialysis initiation, by Kaplan–Meier analysis.
[c]125 incident patients with mature vascular access but dysfunction before haemodialysis initiation were excluded in the calculation of effective duration of vascular access patency.
[d]Sex was not recorded for one patient.
[§]$P < 0.001$, **$P < 0.01$.

Table 4. Demographic and vascular access characteristics, incident patients with mature vascular access after haemodialysis initiation ($n = 4639$)

			Vascular access					Duration of primary vascular access patency[a] ($n = 4639$)	
	All		Fistula		Graft			Mean (days)	SD
All	4639	100	3918	84	721	16		348.83	195.71
Vascular access									
Fistula	3918	84	3918				<0.0001	367.65[§]	187.80
Graft	721	16			721	16		246.53	206.01
Sex[b]									
Women	2336	50	1898	81	438	19	<0.0001	339.07**	196.48
Men	2301	50	2019	88	282	12		358.80	194.43
Age (year)									
<65	2867	62	2547	89	320	11	<0.0001	372.06[§]	189.63
≥65	1772	38	1371	77	401	23		311.24	199.55
Diabetes									
No	2262	49	1959	87	303	13	<0.0001	363.02[§]	192.93
Yes	2377	51	1959	82	418	18		335.32	197.40

SD, standard deviation of survival duration of primary vascular access patency.
[a]Estimated mean duration of primary vascular access patency for all patients with mature vascular access after haemodialysis initiation, by Kaplan–Meier analysis. Duration of primary vascular access patency was defined as the time from mature access to any intervention designed to maintain or re-establish patency or to access thrombosis or study end point.
[b]Sex was not recorded for two patients.
[§]$P < 0.001$, **$P < 0.01$

Table 5. Variables included in the proportional hazard models to analyse primary vascular access patency ($n = 5890$)

	Adjusted rate of duration of primary vascular access patency		AVF ($n = 4929$)		AVG ($n = 961$)	
Variable	Hazard ratio (95% CI)	*P*-value	Hazard ratio (95% CI)	*P*-value	Hazard ratio (95% CI)	*P*-value
Vascular access type (base, fistula)	2.86 (2.58–3.16)	0.0000				
Sex (base, male)	1.15 (1.05–1.27)	0.0029	1.22 (1.09–1.35)	0.0006	1.00 (0.85–1.18)	0.9649
Age (base, <65 years)	1.35 (1.23–1.48)	0.0000	1.38 (1.24–1.54)	0.0000	1.26 (1.07–1.48)	0.0063
Diabetes (base, no diabetes)	1.15 (1.05–1.26)	0.0027	1.21 (1.08–1.35)	0.0009	1.03 (0.87–1.21)	0.7295
Associations of timing of vascular access maturation with HD initiation (base, 1 month before initiation)						
>1 month before	1.07 (0.83–1.38)	0.5881	1.14 (0.82–1.57)	0.4371	0.94 (0.62–1.42)	0.7685
>3 months before	1.03 (0.78–1.35)	0.8351	1.23 (0.87–1.72)	0.2380	0.72 (0.45–1.16)	0.1769
>6 months before	0.87 (0.65–1.17)	0.3534	1.11 (0.78–1.59)	0.5535	0.48 (0.27–0.85)	0.0112
>12 months before	0.84 (0.63–1.12)	0.2257	1.13 (0.8–1.59)	0.4813	0.40 (0.23–0.7)	0.0013
0–1 month after	0.95 (0.74–1.23)	0.7205	1.17 (0.84–1.62)	0.3564	0.71 (0.47–1.07)	0.1041
>1 month after	0.96 (0.79–1.17)	0.6918	0.95 (0.74–1.23)	0.7154	0.98 (0.71–1.35)	0.8911
>3 months after	0.84 (0.66–1.06)	0.1391	0.86 (0.65–1.14)	0.2980	1.03 (0.58–1.85)	0.9136
>6 months after	0.94 (0.56–1.58)	0.8244	0.91 (0.42–1.99)	0.8198	0.89 (0.44–1.79)	0.7466

CI, confidence interval; HD, haemodialysis; AVF, arteriovenous fistula; AVG, arteriovenous graft.

We noted a significantly increased risk for shorter duration of primary vascular access patency for women, elderly or diabetic patients (Tables 2 and 4). Similar results have been reported for patients in Western societies [17–20]. This shorter longevity may relate to the smaller diameters of female blood vessels and atherosclerotic changes in elderly patients [8,21–31].

In Kalman's study, the presence of diabetes was found to be a risk factor for shorter duration of primary vascular access patency [32]. When we used the same variables of vascular access type (AVF versus AVG) and diabetes as of Kalman's study, our study had a similar finding. However, when patients were further stratified by vascular access type, diabetes was still a risk factor for shorter duration of AVF patency, but not for AVG patency (Tables 5 and 6). This finding showed that diabetes had an interaction effect with access type. The AVG could overcome the issue of diabetes.

Did gender affect the duration of AVF patency? In Table 6, the association between female sex and duration of primary access patency was not statistically significant in patients with mature AVF before HD initiation. However, HR of sex was around 1.15–1.23 for all incident patients (Table 5) or patients with mature AVF before or after HD initiation (Table 6). It showed a tendency of gender difference on the duration of primary AVF patency. This tendency was consistent with some [19,33–35] and opposite to other reports [36–38], but gave us more confidence to say that gender was significantly associated with worse survival of the AVF.

Table 6. Variables included in the proportional hazard models to analyse primary vascular access patency, incident patients with vascular access maturation before and after haemodialysis initiation

	Adjusted rate of duration of primary vascular access patency			
	Fistulas matured before initiation ($n = 1011$)		Grafts matured before initiation ($n = 240$)	
Variable	Hazard ratio (95% CI)	*P*-value	Hazard ratio (95% CI)	*P*-value
Maturation before initiation				
Sex (base, male)	1.16 (0.94–1.45)	0.152	1.43 (1.01–2.00)	0.0417
Age (base, <65 years)	1.23 (1.00–1.52)	0.052	1.32 (0.96–1.83)	0.0910
Diabetes (base, no diabetes)	1.35 (1.10–1.67)	0.005	1.06 (0.77–1.45)	0.7324
Association of timing of vascular access maturation with HD initiation (base, 1 month before)				
>1 month before	1.14 (0.82–1.57)	0.442	1.03 (0.68–1.56)	0.8921
>3 months before	1.23 (0.87–1.72)	0.237	0.72 (0.44–1.16)	0.1763
>6 months before	1.11 (0.78–1.59)	0.554	0.47 (0.27–0.83)	0.0097
>12 months before	1.13 (0.80–1.59)	0.501	0.38 (0.22–0.67)	0.0008
	Fistulas placed after initiation ($n = 3918$)		Grafts placed after initiation ($n = 721$)	
Maturation after initiation				
Sex (base, male)	1.23 (1.08–1.39)	0.0018	0.89 (0.74–1.08)	0.2309
Age (base, <65 years)	1.44 (1.27–1.64)	0.0000	1.23 (1.02–1.49)	0.0322
Diabetes (base, no diabetes)	1.16 (1.02–1.31)	0.0271	1.02 (0.84–1.23)	0.8468
Association of timing of vascular access placement with HD initiation (base, 1 month after)				
>1 month	0.82 (0.65–1.03)	0.0853	1.36 (1.02–1.83)	0.0387
>3 months	0.73 (0.56–0.95)	0.0209	1.43 (0.81–2.52)	0.2113
>6 months	0.78 (0.36–1.68)	0.5218	1.23 (0.62–2.43)	0.5573

CI, confidence interval; HD, haemodialysis.

When focusing on the timing of vascular access maturation for all patients, we found that timing of vascular access maturation was not a risk factor for duration of primary access patency (Table 5). However, after stratification of patients by vascular access type, an HR value <1 was noted for patients with mature AVF after HD initiation (Tables 5 and 6). This indicated that the patients with mature AVF after HD initiation tended to have longer duration of primary access patency. In contrast, patients with mature AVG for >6 months prior to HD initiation (HR < 0.48) were found to have significantly longer duration of primary access patency ($P < 0.05$; Tables 5 and 6). This suggested that it is better to complete AVG placement and maturation as early as possible before HD initiation for the duration of primary access patency. This finding has not been mentioned before and needs further investigation of large numbers of incident patients for the clinical implication.

We conclude that grafts, female sex and advanced age were associated with shorter duration of primary vascular access patency. Diabetes was a risk factor for shorter duration of primary AVF patency, but not for primary AVG patency in our study. It is better to complete AVG placement and maturation as early as possible before HD initiation. Timing of vascular access placement should be considered along with other factors such as sex, age, history of diabetes and access type to establish functional long-term vascular access survival.

Study limitations

This study has several limitations that should be noted. Firstly, there may be inaccuracies in the recording of the diagnostic and therapeutic codes. A previous study of a Taiwanese medical centre indicated consistency between patient records and claims data of about 95% [39]. Secondly, our analysis could not explain why the fistulas and grafts malfunctioned. This limitation could be partially solved by the exclusion of the patients with immature vascular access before or after HD initiation. Finally, because our analysis depended on claims data, it could not show vascular access maturation time. However, the vascular access maturation time can be accomplished with the recommendation of National Kidney Foundation Dialysis Outcomes Quality Initiative (NKFDOQI) guidelines. In particular, we had no information on medical condition, severity of disease, surgeon's experience, patient compliance, patient education regarding vascular access maintenance, or laboratory data.

Notwithstanding these possible limitations, our study has several strengths. First, claims data from universal coverage in Taiwan allow identification of samples free from selection bias and of a sufficient size to document outcomes. Second, insurance records can be used to unambiguously analyse the timing of vascular access placement and failure. Finally, in our large patient population of new uraemic patients, we found a strong graded association between timing of vascular access maturation and patency.

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Conflict of interest statement. None declared.

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