Journal of the Association of General Surgeons of Thailand under the Royal Patronage of HM the King
วารสารสมาคมศัลยแพทย์ทั่วไปแห่งประเทศไทยในพระบรมราชูปถัมภ์
Journal homepage : https://he02.tci-thaijo.org/index.php/agstjournal

นิพนธ์ต้นฉบับ

Transposition of femoral vein arteriovenous fistula should be readily considered in hemodialysis patients with exhausted upper arm AV access

Wiwat Yimkosol, M.D.[1,*]

[1]*Department of Surgery, Lamphun Hospital, Lamphun, Thailand*

ABSTRACT

Introduction: In end stage renal disease patients (ESRD), the upper limb is the preferred choice for permanent arteriovenous access creation. But some patients have exhausted upper extremity veins. The lower extremity prosthetic fistula or thigh arteriovenous graft (AVG) raises concern about the infection, patency and ischemic limb complication. Femoral vein transposition arteriovenous fistula (FV tAVF) is an alternative to AVG. The aim of this study was to compare the patency and related outcomes of FV tAVF, upper arm AVG, and thigh AVG.

Materials and Methods: Retrospective data between October 2017 and July 2021 were reviewed. Ninety-three patients underwent AV access. Preoperative clinical findings, intraoperative findings, perioperative outcomes, long-term postoperative complications, and the overall patency of AV access were collected and analyzed by multivariate analysis and Cox proportional-hazards model.

Result: Twenty-one patients underwent FV tAVF, thirty-four patients underwent upper arm AVG, and thirty-eight patients underwent thigh AVG for permanent AV access. The gender ratio was 1.2:1 (male:female). Infection rates were 0%, 11.7% and 2.6%, respectively. Wound and other local complications such as wound evisceration, lymphocele was 19% in patients with FV tAVF. Patients who underwent FV tAVF had more blood loss compared with upper arm AVG (adjusted odds ratio [aOR] 1.05 [95%CI 1.02 - 1.08]; P = 0.003), and thigh AVG (aOR 1.02 [95%CI 1.01 - 1.03]; *P* = 0.003). Patients who underwent FV tAVF had longer operative time compared with thigh AVG (aOR 1.09 [95%CI 1.03 - 1.14]). Patients who underwent FV tAVF had longer length hospital stay compared with upper arm AVG (aOR 4.34 [95%CI 2.00 - 9.09]; *P* < 0.001), and thigh AVG (aOR 3.12 [95%CI 1.37 - 7.15]; *P* = 0.007). The 1-month patency rate was not different between FV tAVF, upper arm AVG and thigh AVG. (93.3%, 96.3% and 97.1%, respectively; *P* = 0.814). However, the 1-year patency rate of FV tAVF was better than other types of AV access (93.3%, 70.3% and 68.5%, respectively; *P* = 0.162) Survival analysis demonstrated the FV tAVF had better 1-year patency than upper arm and thigh AVG (hazard ration [HR] 1.24 [95% CI 0.43 - 3.54]; *P* = 0.190). One-year mortality rate of FV tAVF did not differ from upper arm and thigh AVG (HR 0.38 [95%CI 0.09 - 1.61]; P = 0.190).

Conclusion: FV tAVF caused more blood loss, longer operative time and longer hospital stay than upper arm or thigh AVG, without significantly higher mortality rate. The 1-year overall patency of FV tAVF was better than the other types of AV access. So, FV tAVF should be considered in patients with exhausted upper arm AV access without significant infection or wound complications.

Keywords: Femoral vein transposition arteriovenous fistula (FV tAVF), Lower extremity prosthetic fistula, thigh arteriovenous graft (AVG), upper arm AVG

Submission 11 February 2022| Revised 10 April 2022| Accepted 22 April 2022 | Published online 24 April 2022

Corresponding Authors: Wiwat Yimkosol,
Department of Surgery, Lamphun Hospital, Lamphun, Thailand
E-mail: nurnt125@gmail.com

สมาคมศัลยแพทย์ทั่วไปแห่งประเทศไทย ในพระบรมราชูปถัมภ์ อาคารเฉลิมพระบารมี ๕๐ ปี
เลขที่ 2 ซอยศูนย์วิจัย ถนนเพชรบุรีตัดใหม่ กรุงเทพฯ 10310 โทรศัพท์ : 0-2716-6450, 0-2716-6451

Introduction

In patients requiring hemodialysis, the upper limb is the preferred choice for access creation. Unfortunately, due to lack of an optimal health care system in Thailand, most of the patients for hemodialysis access present late. These patients have failed upper arm arteriovenous fistula (AVF) creation due to multiple venipunctures or previous central catheter insertion that cause central vein stenosis. If the upper extremity central vein is patent, upper arm arteriovenous graft (AVG) is the next option for dialysis access. But in patients who have bilateral upper arm central vein stenosis, lower extremity prosthetic fistula or thigh arteriovenous graft (Thigh AVG) is the next option for dialysis access.[1-5]

Prosthetic graft causes concern about graft and wound infection. Patency is lower because of intimal hyperplasia at the graft venous anastomosis and risk of limb ischemia is higher.[6-8] There are a few reports of arteriovenous fistula in the thigh. A few reports on saphenous vein superficialization demonstrate poor results because of thick wall and multiple valves.[9] Some reports suggest femoral vein trans-position arteriovenous fistula (FV tAVF) as an alternative vascular access in selected patients.[10,11]

The femoral vein (FV) is a good conduit for creating an AV access. It has a thin wall containing fewer valves compared with the great saphenous vein. FV has been utilized as an autogenous fistula in various centers with acceptable results. In appropriately selected patients FV tAVF can provide good patency and low incidence of complica-tions. The primary and secondary patency for this access has been documented as 91% and 84% at one year.[10]

The aim of this study was to compare the patency and related outcomes of FV tAVF, upper arm AVG, and thigh AVG in a Lamphun hospital.

Materials and Methods

Patients

This utilized retrospective cohort data. It included patients from October 2017 to July 2021. All the patients had plans for long-term hemodialysis by Femoral vein transposition arteriovenous fistula (FV tAVF) and upper or lower extremkties arteriovenous graft (AVG). And they failed to upper extremitis venous access creation or had not suitable vein for upper extremitis venous access creation.

The data of patients were collected from the hospital database using International Classification of Disease coding system. Data related to patient demographics, comorbidities, pre-operative clinical findings, especially regarding the arterial and venous system of the lower extremities, intra-operative findings and postoperative complications were collected. Patency and complication of access such as AV access thrombosis, steal syndrome, wound complication and AV access infection were also noted.

For standard arteriovenous access creation, upper extremity arterio-venous access is the first choice for long-term hemodialysis. Lower extremity arteriovenous fistulas, including thigh arteriovenous access, are performed only in patients who are not eligible for upper extremity arterio-venous access.[3,9] Patients are initially evaluated for radio-cephalic or brachiocephalic arteriovenous fistulae. These are our first choices. If neither option is available, patients are evaluated for basilic transposition arteriovenous fistulae. If both basilic veins are unavailable, patients are considered for upper arm arterio-venous graft (AVG). But some patients do not have suitable veins for AV access creation. We prefer femoral vein transposition arteriovenous fistulae (FV tAVF) rather than arteriovenous graft (AVG).

In this study, all patients routinely underwent the following before creation of AV access:

• History taking about duration of dialysis, previous vascular access, central venous catheter insertion and associated comorbidities such as diabetes mellitus, hyper-tension, heart disease and peripheral vascular disease.

• Physical examination to check both groin and peripheral pedals pulse.

• Duplex scan to evaluate patency of peripheral arterial system, deep venous system patency and superficial femoral vein mapping (size, course and anatomical varia-tion) of both lower limbs (selection of suitable limb for AV access creation)

Patients who were unfit for surgery, had absent or weak pedal pulse or ABI < 0.9, decompensated heart failure or end stage of malignancy were excluded from vascular access creation. All patients were divided into three groups as follows; upper arm AVG, thigh AVG, and FV tAVF.

Operative Methods

Upper arm AVG

The procedure was done under general anesthesia. The patients received first-generation cephalosporin prophylactic antibiotic. Transverse skin incision was done over proximal brachial artery in the patients who underwent loop upper arm AVG. Arterial anastomosis was created at proximal brachial artery by 6-0 polypropylene. Venous anastomosis was created at upper end of brachial vein by 6-0 polypropylene. Some patients who underwent bridge upper arm AVG, had two small longitudinal skin incisions over proximal and distal brachial artery. (Figure 1) Arterial anastomosis was created at distal brachial artery by 6-0 polypropylene and venous anastomosis was created at upper end of brachial vein by 6-0 polypropylene. A 6-mm. Poly-Tetra-Floro-Ethylene (PTFE) synthetic graft was tunneled loop or bridge subcutaneously in anterolateral upper arm through two skin incisions as shown in figures, carefully so that no kink or twist occurred. Both techniques limited arterial anastomosis to no

Figure 1 two skin incision in bridging upper arm AVG and configuration of graft after finished operation

more than 6 mm. Blood loss was secured. Subcutaneous tissue was sutured by vicryl 3/0 and skin by 4/0 nylon. Post operatively, patients received oral antibiotics for 7 days, and stitches were removed 2 weeks after surgery. The graft was used for dialysis at least 2 weeks after stitches were removed. Thrill and the distal pulse were felt immediately postoperative in all patients. Long-term surveillance was performed by vascular surgeon every 3-6 months

Thigh AVG

The procedure was done under general anesthesia. The patients received first-generation cephalosporin prophylactic antibiotic. Transverse groin incision was done over the femoral artery in all patients. The saphenofemoral junction was identified and dissected. This junction was to be venous anastomosis by 6-0 polypropylene. Arterial anas-tomosis was created at upper end of superficial femoral artery by 6-0 polypropylene. Arterial anastomosis was not more than 6 mm. in length. A 6-mm. polytetrafluoroethylene (PTFE) synthetic graft was tunneled loop subcutaneously in anterolateral thigh through two skin incisions, carefully so that no kink or twist occurred. Blood loss was secured. Subcutaneous tissue was sutured by vicryl 3/0 and skin by 4/0 nylon. Post operatively, patients received oral antibiotics for 7 days, and stitches were removed 2 weeks after surgery. The graft was used for dialysis at least 2 weeks after stitches were removed. Thrill and the distal pulse were felt immediately postoperative in all patients. Long-term surveillance was performed by vascular surgeon every 3-6 months.

Femoral vein transposition AVF

Longitudinal incision from just below the inguinal crease to just above the knee, mobilization of the femoral vein from the adductor hiatus up to its junction with the deep femoral vein, transposition of the vein in a straight subcutaneous tunnel over the anterior of thigh, lateral to the skin incision, and construction of a direct side to end anastomosis to the distal superficial femoral artery were performed. (Figure 2) The femoral vein was sutured directly onto the superficial femoral artery, without any attempt to enlarge anastomosis. No tapering or banding of the vein was performed. Arterial anastomosis was not more than 6 mm. in length. Drain was inserted. (Figure 3) No stocking postoperatively. An antibiotic (first-generation cephalo-sporin) was systemically injected preoperatively. Postoperative deep vein thrombosis was avoided by early ambulation and optimal pain control.

Figure 2 Left femoral vein transposition after harvesting femoral vein

Figure 3 Left femoral vein transposition operation after finished anastomosis

The postoperative result was checked by clinical and duplex scan. Success was defined by availability of the fistula for hemodialysis sessions. The first puncture was authorized after 1 postoperative month. Long-term surveillance was performed by vascular surgeon every 6 months. (Figure 4)

Figure 4 Left femoral vein transposition at follow up 6 months

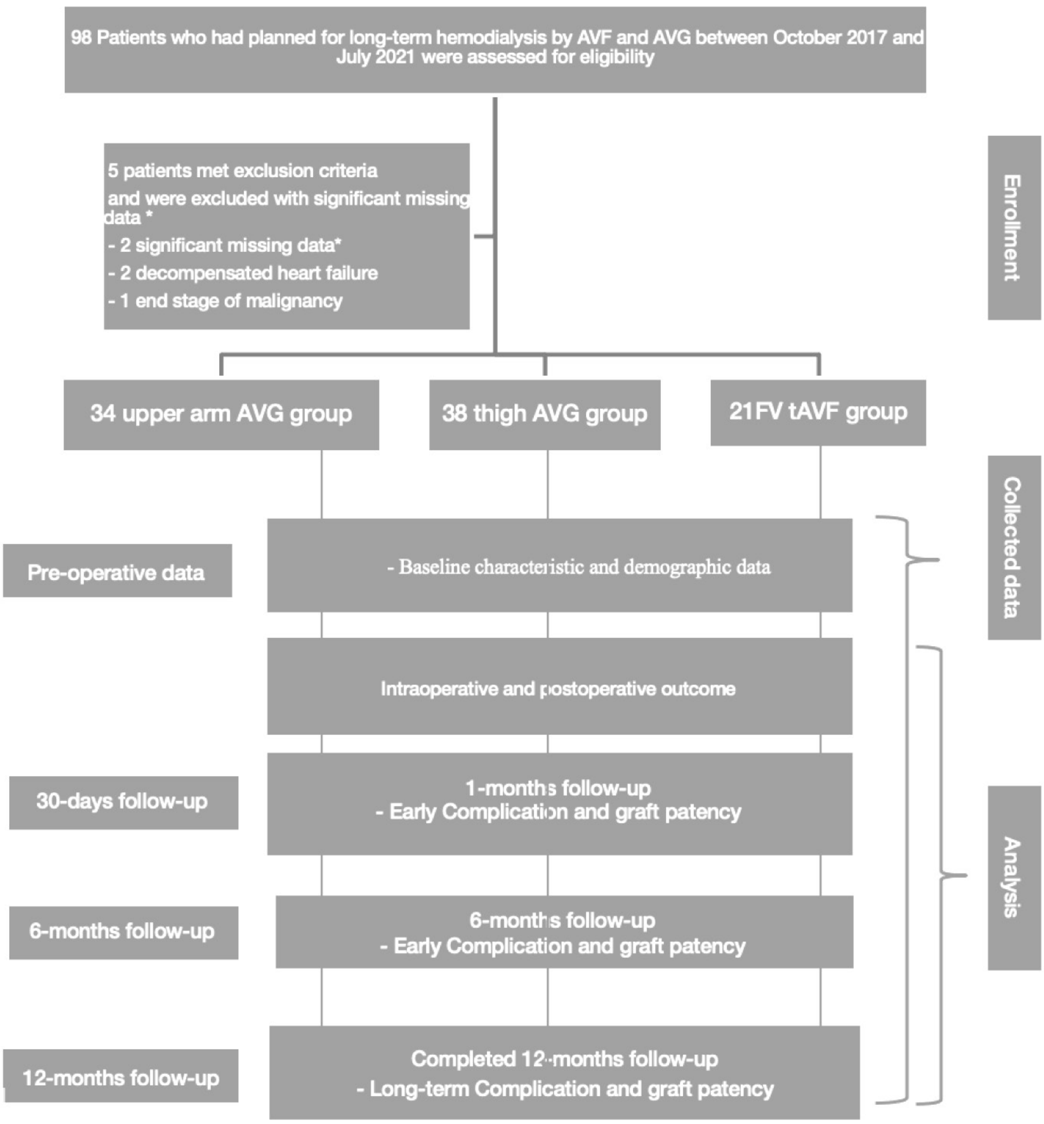
Statistical analysis

Associations between the baseline clinical data, all-cause mortalities, vascular access patency and type of access were assessed with a univariate two-sample t-test for continuous data and a chi-squared/Fisher exact test for categorical data, and data were presented as the mean and standard deviation (SD). For the distribution-free group, data were presented as the median value with interquartile range (iqr) and multivariate analysis was carried out using the one-way ANOVA and Kruskal–Wallis test for continuous data. $P < 0.05$ was considered significant. The power was 0.80.

Journal of the Association of General Surgeons of Thailand under the Royal Patronage of HM the King
วารสารสมาคมศัลยแพทย์ทั่วไปแห่งประเทศไทยในพระบรมราชูปถัมภ์
Journal homepage : https://he02.tci-thaijo.org/index.php/agstjournal

All the statistical analyses were performed with STATA/SE 16.0 for Windows (Stata Corp LP, TX, USA). The patency of AV access and mortality rate of these patients were collected and illustrated in a Kaplan–Meier curve. Comparison of the survival rates and patency rate in event-time for each type of access were also analyzed by Cox proportional hazard model.

The retrospective data was available from medical records between October 2017 and July 2021. The 1-year primary patency of thigh AVG and FV tAVF were 68.57% and 93.33%, respectively.



AVF, rteriovenous fistula; AVG, arteriovenous graft; FV tAVF, femoral vein transposition arteriovenous fistula

*Important outcome data cannot assess and missing data > 80% in individual patients due to loss to follow up and other reason.

Figure 5 the study flow diagram of cohort study (STROBE Statement (2008))

The sample size with 0.2 of beta error is 34 per group of FV tAVF, thigh AVG and upper arm AVG. So, our study sample size is not large enough to conclude the results of our study. We performed a power calculation from previous data which had become available from a medical record. For a one-sided significance level of 5% with sample size of 34, 38 and 21 patients for upper arm AVG, thigh AVG and FV tAVF, respectively, the power calculated result is 60% with alpha error 0.05.12-14 A larger sample size would be needed for a more valid study. However, comparative studies between FV tAVF and thigh AVG or other types of access are lacking. Our study is a pilot study which results in more evidence than previous descriptive case series.

Our study process and report followed the strengthening of the reporting of observational studies in epidemiology (STROBE) statement for reports of cohort studies (Figure 5).[15,16] The authors planned to manage loss of follow-up patients and missing data by omitting those cases and analyzing the remaining data. However, after data collection, no lost follow-up cases were detected during first year.

Results

During this study, ninety-three patients underwent Arteriovenous graft and Femoral vein transposition arteriovenous fistula from October 2017 to July 2021. Twenty-one patients underwent FV tAVF, thirty-four patients underwent upper arm AVG and thirty-eight patients underwent thigh AVG for permanent AV access. The mean age of the patients was 63 years (Figure 5). There were fifty-one (54.84%) males and forty-two (45.16%) females. Thirty-three (35.48%) patients were diabetic, seventy-five (80.66%) patients had hypertension, fifteen (16.13%) patients had dyslipidemia, eleven (11.83%) patients had gout and three (3.23%) patients had cardiovascular disease. None of the patients had clinical peripheral vascular disease. Most of the patients had more than one disease as shown in Table 1.

Perioperative details and post-operative outcomes are shown in Tables 2 and 3. All patients had general anesthesia. Infection rates were 0% of FV tAVF, 11.76% of upper arm AVG and 2.63% of thigh AVG. Wound and other local complications, such wound evisceration and lymphocele, was 19% in patients with FV tAVF. One patient needed to return to the operation room for wound suturing; the others had no need for the operation room. Patients who underwent FV tAVF had more blood loss compared with upper arm AVG (adjusted odds ratio [aOR] 1.05 [95%CI 1.02 - 1.08]; P = 0.003), and thigh AVG (aOR 1.02 [95%CI 1.01 - 1.03]; P = 0.003). Patients who underwent FV tAVF had longer operative time compare with thigh AVG (aOR 1.09 [95%CI 1.03 - 1.14]). Patients who underwent FV tAVF had longer length of hospital stay compared with upper arm AVG (aOR 4.34 [95%CI 2.00 - 9.09]; P < 0.001), and thigh AVG (aOR 3.12 [95%CI 1.37 - 7.15]; P = 0.007). One patient

Journal of the Association of General Surgeons of Thailand under the Royal Patronage of HM the King
วารสารสมาคมศัลยแพทย์ทั่วไปแห่งประเทศไทยในพระบรมราชูปถัมภ์
Journal homepage : https://he02.tci-thaijo.org/index.php/agstjournal

Table 1 Patients characteristics

Variables	Upper arm AVG N = 34	Thigh AVG N = 38	FV tAVF N = 21	Total N = 93	*P*-value
Average age in years (SD) (0.983[a],< 0.001[b,c])	65.71 (8.76)	65.66 (10.11)	53.19 (10.13)	62.86 (10.87)	< 0.001[d]
Sex (Male/Female)	19 (55.88%)/ 15 (44.12%)	19 (50%)/ 19 (50%)	13 (61.90%)/ 8 (38.10%)	51(54.84%)/ 42 (45.16%)	0.671
Diabetes mellitus	12 (35.29%)	16 (42.11%)	5 (23.81%)	33 (35.48%)	0.372
Hypertension	27 (79.41%)	32 (84.21%)	16 (76.19%)	75 (80.66%)	0.737
Dyslipidemia	7 (20.59%)	4 (10.53%)	5 (23.81%)	15 (16.13%)	0.349
Cardiovascular disease	0 (0%)	3 (7.89%)	0 (0%)	3 (3.23%)	0.106
Gout	4 (11.76%)	4 (10.53%)	3 (14.29%)	11 (11.83%)	0.912
Mean BMI (kg/m^2) (SD)	20.82 (0.50)	21.71 (0.60)	21.36 (0.67)	21.31 (3.29)	0.527

AVG, arteriovenous graft; BMI, body mass index; SD, standard deviation;
[a], upper extremity AVG vs thigh AVG; b, thigh AVG vs femoral vein transposition; c, femoral vein transposition vs upper extremity AVG
[d], one way ANOVA in normal distribution data
[e], non-parametric test (Kruskal-Wallis test)

Table 2 perioperative details and post-operative outcome

Variables	Upper arm AVG N = 34	Thigh AVG N = 38	FV tAVF N = 21	Total N = 93	*P*-value
Estimate blood loss (ml)	34.12 ± 37.59 Median 20 iqr (20,20)	37.89 ± 55.32 Median 20 iqr (20,20)	133.76 ± 64.05 Median 100 iqr (100,200)	58.16 ± 65.71 Median 20 iqr (20,100)	$P < 0.001$[e] $P = 0.868$[a] $P < 0.001$[b,c]
Operative time (min)	91.32 ± 30.36	88.68 ± 19.37	143.57 ± 39.75	102.04 ± 36.54	$P < 0.001$[d] $P = 0.658$[a] $P < 0.001$[b,c]
Length of hospital stay (Days)	1.26 ± 0.86 Median 1 iqr (1,1,)	1.26 ± 1.18 Median 1 iqr (1,1,)	5 ± 1.52 Median 4 iqr (5,6)	2.11 ± 1.95 Median 1 iqr (1,3)	$P < 0.001$[e] $P = 0.598$[a] $P < 0.001$[b,c]
Time for the beginning of hemodialysis (weeks)	4.35 ± 0.71 Median 4 Iqr (4 ,4)	4.43 ± 0.74 Median 4 Iqr (4,5)	5.37 ± 0.96 Median 5 Iqr (5,6)	4.61 ± 0.87 Median 4 Iqr (4,5)	$P < 0.001$[e] $P = 0.614$[a] $P < 0.001$[b,c]
Wound complication	0 (0%)	0 (0%)	4 (19.05%)	4 (4.3%)	*P* = 0.001 *P* = N/Aa *P* = 0.005b *P* = 0.008c

AVG, arteriovenous graft ; SD, standard deviation ; N/A, not applicable ; iqr, interquartile range
[a], upper extremity AVG vs thigh AVG; [b], thigh AVG vs femoral vein transposition; [c], femoral vein transposition vs upper extremity AVG
[d], one way ANOVA in normal distribution data
[e], non-parametric test (Kruskal-Wallis test)

Table 2 perioperative details and post-operative outcome (con't)

Variables	Upper arm AVG N = 34	Thigh AVG N = 38	FV tAVF N = 21	Total N = 93	*P*-value
Graft infection (%)	4 (11.76)	1 (2.63)	0 (0)	5 (5.38)	*P* = 0.900
One-month patency (%)	97.06	97.37	95.24	96.77	*P* = 0.900
Re-intervention (%)	44.12	34.21	14.29	33.33	*P* = 0.073
Overall death (%)	5 (15.15)	13 (34.21)	1 (4.76)	19 (20.65)	*P* = 0.017

AVG, arteriovenous graft ; SD, standard deviation ; N/A, not applicable ; iqr, interquartile range
[a], upper extremity AVG vs thigh AVG; [b], thigh AVG vs femoral vein transposition; [c], femoral vein transposition vs upper extremity AVG
[d], one way ANOVA in normal distribution data
[e], non-parametric test (Kruskal-Wallis test)

Table 3 multivariate analysis of the outcomes between upper extremity AVG, thigh AVG and femoral vein transposition AVF

Variables	Upper arm AVG (n = 34)	Thigh AVG (n = 38)	FV tAVF (n = 21)	Upper arm AVG vs Thigh AVG		Thigh AVG vs FV tAVF		FVT vs Upper arm AVG	
				Adjusted OR	*P*-value (95% CI)	Adjusted OR	*P*-value (95% CI)	Adjusted OR	*P*-value (95% CI)
Age (years)	65.71 ± 8.76	65.66 ± 10.11	53.19 ± 10.13	0.98	0.56 (0.93-1.04)	0.94	0.30 (0.84-1.06)	0.92	0.28 (0.78-1.07)
Operative time (min)	91.32 ± 30.36	88.68 ± 19.37	143.57 ± 39.75	0.99	0.62 (0.97-1.02)	1.09	0.001 (1.03-1.14)	1.01	0.61 (0.97-1.04)
Estimate blood loss (ml)	34.12 ± 37.59 Median 20 iqr (20,20)	37.89 ± 55.32 Median 20 iqr (20,20)	133.76 ± 64.05 Median 100 iqr (100,200)	1.00	0.86 (0.99-1.01)	1.02	0.003 (1.01-1.03)	1.05	0.003 (1.02-1.08)
Length of hospital stay (Days)	1.26 ± 0.86 Median 1 iqr (1,1,)	1.26 ± 1.18 Median 1 iqr (1,1,)	5 ± 1.52 Median 4 iqr (5,6)	1.04	0.87 (0.59 - 1.86)	3.12	0.01 (1.37-7.15)	4.34	*P* < 0.001 (2.00-9.09)

AVG, arteriovenous graft; FV tAVF, Femoral vein transposition arteriovenous fistular; iqr, interquartile range; SD, standard deviation; N/A, not applicable; CI, confident interval; OR, odd ratio

Table 3 multivariate analysis of the outcomes between upper extremity AVG, thigh AVG and femoral vein transposition AVF (con't)

Variables	Upper arm AVG (n = 34)	Thigh AVG (n = 38)	FV tAVF (n = 21)	Upper arm AVG vs Thigh AVG Adjusted OR	P-value (95% CI)	Thigh AVG vs FV tAVF Adjusted OR	P-value (95% CI)	FVT vs Upper arm AVG Adjusted OR	P-value (95% CI)
Time for the beginning of emodialysis (weeks)	4.35 ± 0.71 Median 4 Iqr (4 ,4)	4.43 ± 0.74 Median 4 Iqr (4,5)	5.37 ± 0.96 Median 5 Iqr (5,6)	1.24	0.58 (0.57-2.74)	1.30	0.59 (0.50-3.44)	0.1	0.12 (0.01-2.84)
Wound complication	0	0	4/21 19.05	N/A		N/A		N/A	
Overall death	5/33 15.15	13/38 34.21	1/21 4.76	2.91	0.07 (0.81-11.79)	0.96	0.360 (0.002-0.768)	0.28	0.24 (0.01-2.85)

AVG, arteriovenous graft; FV tAVF, Femoral vein transposition arteriovenous fistular; iqr, interquartile range; SD, standard deviation; N/A, not applicable; CI, confident interval; OR, odd ratio

Table 4 arteriovenous access patency rate between upper extremity AVG, thigh AVG and femoral vein transposition AVF 1-year loss of patency (graft thrombosis and abandon (= loss of secondary patency)

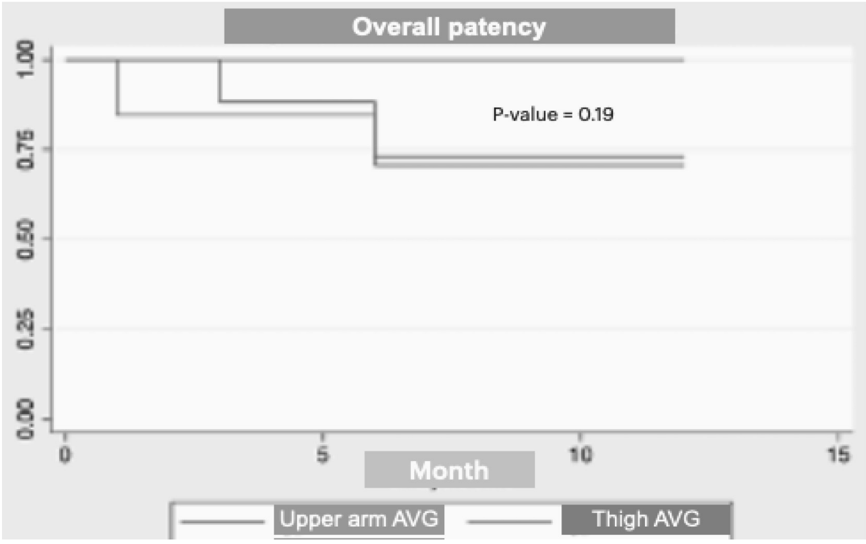
Variables	HRa	P-value	95% confident interval
Type of permanent access	1.24	0.19	0.43 - 3.55
• Upper arm AVG	0.72	0.56	0.24 - 2.15
• Thigh AVG	1.51	0.46	0.51 - 4.50
• FV tAVF	N/A		

[a]HR, hazard ratio by Cox proportional model analysis; AVG, arteriovenous graft; N/A, not applicable

Table 5 arteriovenous access short and long term patency rate between upper extremity AVG, thigh AVG and femoral vein transposition AVF

	Upper arm AVG (n = 27)	Thigh AVG (n = 35)	FV tAVF (n = 15)	Total	P-value
1-month patency (%)	26 (96.3)	34 (97.14)	14 (93.33)	74 (96.10)	0.814
3- months patency (%)	22 (81.48)	34 (97.14)	14 (93.33)	70 (90.91)	0.097
6- months patency (%)	22 (81.48)	30 (85.71)	14 (93.33)	66 (85.71)	0.575
1-year patency (%)	19 (70.37)	24 (68.57)	14 (93.33)	57 (74.03)	0.162

AVG, arteriovenous graft; FV tAVF, Femoral vein transposition arteriovenous fistular



AVG, arteriovenous graft
a, upper extremity AVG vs thigh AVG; b, thigh AVG vs femoral vein transposition; c, femoral vein transposition vs upper extremity AVG

Figure 5 overall patency in all groups

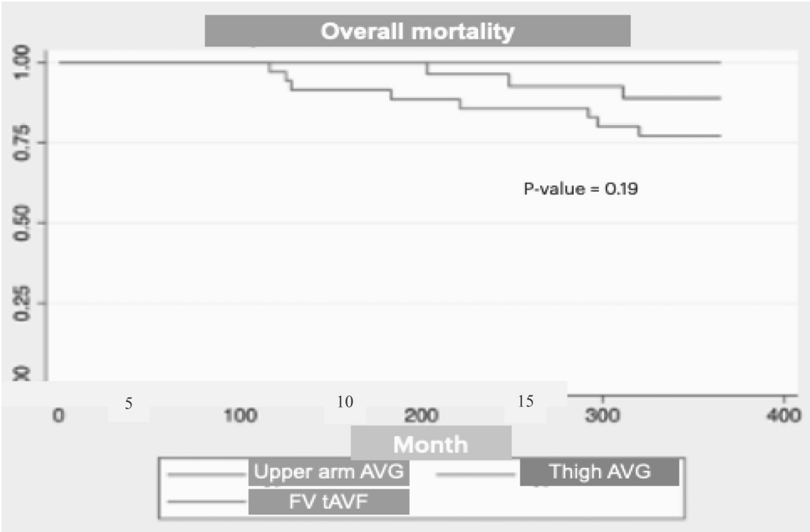
who underwent FV tAVF developed distal arterial ischemia at 5 months. That required banding of FV tAVF. FV tAVF patients had fistular maturation within 6 weeks. The mean time for the beginning of hemodialysis was 5.37 +/- 0.96 weeks.

The one-month patency rate did not differ between FV tAVF, upper arm AVG and thigh AVG. (93.3%, 96.3% and 97.1%, respectively; *P* = 0.814) as shown in Tables 4 and 5. However, the 1-year patency rate of FV tAVF was better than the other types of AV access (93.3%, 70.3% and 68.5%, respectively; *P* = 0.162). In Figure 6, Survival analysis demonstrated that FV tAVF had better 1-year patency than upper arm and thigh AVG (hazard ration [HR] 1.24 [95% CI 0.43 - 3.54]; *P* = 0.190).

One-year mortality rate of FV tAVF did not differ from upper arm and thigh AVG (HR 0.38 [95%CI 0.09 - 1.61]; *P* = 0.190) as shown in Table 6.

Table 6 mortality rate between upper extremity AVG, thigh AVG and femoral vein transposition AVF

Variables	HRa	*P*-value	95% confident interval
Type of permanent access	0.38	0.19	0.09 - 1.61
• Upper arm AVG	0.31	0.15	0.07 - 1.51
• Thigh AVG	3.47	0.12	0.71 - 16.84
• FV tAVF	N/A		



a HR, hazard ratio by Cox proportional model analysis; AVG, arteriovenous graft; N/A, not applicable

Figure 6 survival rate of patients between upper arm AVG, Thigh AVG and FV tAVF

Discussion

Patients who need long term hemodialysis, require permanent vascular access that delivers an efficient blood flow rate for hemodialysis, good patency and low complication rate.[6] The distal radio-cephalic arteriovenous fistula at the wrist of the non-dominant upper extremity is the gold standard for vascular access. If the distal forearm veins are unavailable, this can be performed more proximally.[17] When the upper extremity arteriovenous fistula (AVF) is no longer possible or the vein is unavailable for vascular access creation, PTFE graft in an upper arm is the next option. However, in patients who have bilateral upper extremity central vein stenosis, the lower extremity prosthetic fistula or thigh arteriovenous graft (Thigh AVG) are usually considered.[18,19]

Prosthetic grafts still raise concern about infection and venous anastomosis stenosis. Use of the great saphenous vein (GSV) has been reported, but it is rarely used for vascular access due to small size, lack of dilatation and poor patency.[20] Femoral vein has been used for vascular access because it is an autogenous arteriovenous hemo-dialysis access with low risk of infection and reasonable long term patency.[10,11]

This study was done to evaluate results of upper arm AVG, thigh AVG and FV tAVF at hospital. Patients who underwent FV tAVF had more blood loss, longer operative time, and longer length hospital stay compared with upper arm AVG, and thigh AVG because these operations have deep and long skin surgical wounds that cause post operative drain care and long length hospital stay.

For upper arm AVG, the study showed higher rates of reintervention (44.12%) and graft infection (11.76%). These results may be from a venous anastomosis stenosis or previous central catheter placement. For thigh AVG, the study showed 34.21% rate of reintervention and 2.63% rate of graft infection, while FV tAVF had lower rates of reintervention (14.29%) and graft infection (0%). Similarly, Rehman et al reported that appro-priate patient selection for FV tAVF can be provided good patency and low incidence of complications.[11]

For FV tAVF, four patients had wound-related complications (19%). In Faber et al., 4 (19%) patients had wound complications, the same as in our study. The wound complications were related to obese patients.[21] It was difficult to harvest femoral veins, which require long skin incisions. To decrease this complication, a small skin incision technique has been suggested.[22] Two patients needed intervention after vascular access creation. One had severe compartment syndrome and needed immediate fasciotomy and closure of FV tAVF. The cause was severe stenosis of iliac vein from previous femoral catheter insertion. Some studies suggest preoperative venogram in patients who have history of femoral catheter insertion,[11] but it is not available in our hospital. Computed Tomography Venography (CTV) was done in this patient and significant stenosis of iliac vein was not reported. We suggest avoiding vascular access creation in lower extremities that have history of femoral catheter insertion. The other had distal limb ischemia. That needed banding of FV tAVF to decrease its flow rate. From this finding, we suggest tampering of the vein in patients who have discrepancy between the diameter of FV and the artery, and exclusion of patients who have peripheral arterial occlusive disease in lower extremities, that is diagnosed by palpation of distal pulse preoperatively.

The 1-month patency rate did not differ between FV tAVF, upper arm AVG and thigh AVG. However, the 1-year patency rate of FV tAVF (93.30%) was better than the other types of AV access. Survival analysis demon-strated that FV tAVF had better 1-year patency than upper arm and thigh AVG. Long term results of FV tAVF were first reported by Bourquelot et al. with 45% nine-year primary patency rate and 56% nine-year secondary patency rate. One-year mortality rate of FV tAVF did not differ from upper arm and thigh AVG.[10]

This study is a retrospective study that had a selection bias and a short period of follow up (about one year follow up). Thus, patency rate and mortality rate in FV tAVF did not differ from the other types of AV access.

Conclusion

FV tAVF caused more blood loss, longer operative time and longer hospital stay than upper arm or thigh AVG, without significantly higher mortality rate. The 1-year overall patency of FV tAVF was better than the other types of AV access.

So, FV tAVF should be considered in patients with exhausted upper arm AV access without significant infection or wound complications.

Disclosure statement

There is no conflict of interest noted.

Funding sources

The authors disclosed no financial relationships to this publication.

References

1. Gradman WS, Cohen W, Haji-Aghaii M. Arteriovenous fistula construction in the thigh with transposed superficial femoral vein: our initial experience. J Vasc Surg. 2001;33(5): 968-75.
2. Gradman WS, Laub J, Cohen W. Femoral vein transposition for arteriovenous hemodialysis access: improved patient selection and intraoperative measures reduce postoperative ischemia. J Vasc Surg. 2005;41(2):279-84.
3. Antoniou GA, Lazarides MK, Georgiadis GS, Sfyroeras GS, Nikolopoulos ES, Giannoukas AD. Lower-extremity arteriovenous access for haemodialysis: a systematic review. Eur J Vasc Endovasc Surg. 2009;38(3):365-72.
4. Chanthip A. Optimized Native Arteriovenous Fistulae for Chronic Hemodialysis. Thai J Surg [Internet] 2015 Dec 30 [cited 2022 Apr 10];36(4) 2015.
5. Suwitchakul C. Outcome of Autogenous Arteriovenous Fistula for Hemodialysis in Elderly Patients with End Stage Renal Disease. Thai J Surg [Internet] 2010 Dec 31 [cited 2022 Apr 10];31. 2010.
6. Rosas SE, Feldman HI. Synthetic vascular hemodialysis access versus native arteriovenous fistula: a cost-utility analysis. Ann Surg. 2012;255 (1):181-6.
7. Lazarides MK, Argyriou C, Koutsoumpelis A, Georgakarakos EI, Georgiadis GS. Thigh arteriovenous grafts. Quantitative comparison with alternative options: A meta-analysis. J Vasc Access. 2018;19(5):430-5.
8. Kim D, Bhola C, Eisenberg N, Montbriand J, Oreopoulos G, Lok CE, et al. Long-term results of thigh arteriovenous dialysis grafts. J Vasc Access. 2019;20(2):153-60.
9. Schulman ML, Badhey MR, Yatco R. Superficial femoral—popliteal veins and reversed saphenous veins as primary femoropopliteal bypass grafts: A randomized comparative study. J Vasc Surg. 1987;6(1):1-10.
10. Bourquelot P, Rawa M, Van Laere O, Franco G. Long-term results of femoral vein transposition for autogenous arteriovenous hemo-dialysis access. J Vasc Surg. 2012; 56(2):440-5.
11. Rehman ZU, Arham A, Sophie Z. Femoral Vein Transposition Arteriovenous Fistula is a Feasible Option in “Selected” Patients as Hemodialysis Access. Ann Vasc Dis. 2019;12(1):25-9.
12. Bernard R. Fundamentals of biostatistics (5th ed.). Duxbery: Thomson learning. 2000. p. 384-5.
13. Fleiss JL, Levin, B., Paik, M. C. Statistical methods for rates and proportions (3rd ed.). John Wiley&Sons. 2003:76.
14. Ngamjarus C. CV. n4Studies: Sample size and power calculations for iOS. The Royal Golden Jubilee Ph.D. Program - The Thailand Research Fund&Prince of Songkla Universit. 2014.
15. von Elm E AD, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epide-miology (STROBE) statement: guide-lines for reporting observational studies. J Clin Epidemiol. 2008:61:344-9.
16. Vandenbroucke JP vEE, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. Int J Surg. 2014:12: 1500-24.
17. Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin AS, Abreo K, et al. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. Am J Kidney Dis. 2020;75(4 Suppl 2):S1-s164.

18. Geenen IL, Nyilas L, Stephen MS, Makeham V, White GH, Verran DJ. Prosthetic lower extremity hemodialysis access grafts have satisfactory patency despite a high incidence of infection. J Vasc Surg. 2010;52(6):1546-50.
19. Parekh VB, Niyyar VD, Vachharajani TJ. Lower Extremity Permanent Dialysis Vascular Access. Clin J Am Soc Nephrol. 2016;11(9):1693-702.
20. Pierre-Paul D, Williams S, Lee T, Gahtan V. Saphenous vein loop to femoral artery arteriovenous fistula: a practical alternative. Ann Vasc Surg. 2004;18(2):223-7.
21. Farber A, Cheng TW, Nimmich A, Jones DW, Kalish JA, Eslami MH, et al. Femoral vein transposition is a durable hemodialysis access for patients who have exhausted upper extremity options. J Vasc Surg. 2020;71(3):929-36.
22. Alcocer F, Perez S, Martinez C. Small skin incision and fistula elevation for hemodialysis using the femoral vein. J Vasc Surg. 2012;56(3):753-6.