Long-term patency of autogenous saphenous veins vs. PTFE interposition graft for prosthetic hemodialysis access

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Abstract

Objective: Prosthetic vascular access is the other choice when the superficial venous system is inadequate to perform a simple radio-cephalic and brachio-cephalic fistula.

Methods: This paper reports the outcomes of a prospective cohort study of 54 patients who underwent either saphenous vein (SVI Group, n=29) or PTFE graft (PTFE Group, n=25) interposition surgery for prosthetic hemodialysis access. All patients were evaluated via color Doppler ultrasonography during preoperative course and superficial venous systems of these patients were found inadequate to perform simple radial/brachial artery-cephalic vein anastomosis. Follow-up was performed for every 6-months period. Kaplan-Meier analysis and Log Rank test was used for estimation and comparison of the patency.

Results: In SVI group access failure was observed in 5 of 29 patients (17.2%). In PTFE group, access failure was observed in 13 of the 25 patients (52%). Primary patency rate was 93% in 12th month and 82% in 24th month in SVI group while it was 88% in 12th month and 56% in 24th month in PTFE group. According to the Kaplan-Meier method, mean time of primary patency was significantly higher in SVI group when compared to PTFE group (33.03±1.32 months vs. 28.16±1.91 months, Log Rank chi-square value: 7.01, df:1, p=0.008). Secondary patency rate was 96% in 12th month and 93% in 24th month for SVI group while 96% in 12th month and 84% in 24th month for PTFE group. According to the Kaplan-Meier method, mean time of secondary patency was significantly higher in SVI group when compared to PTFE group (34.27±0.95 months vs. 31.16±1.40 months, Log Rank chi-square value: 7.33, df:1, p=0.007).

Conclusion: Autologous saphenous vein can be preferably chosen as a prosthetic hemodialysis access graft due its higher primary and secondary patency, lower complication rate and cost when compared with PTFE grafts. *(Anadolu Kardiyol Derg 2014; 14: 542-6)*

Key words: arteriovenous fistula, PTFE, saphenous vein, graft patency, hemodialysis, survival analysis

Introduction

The radiocephalic fistula has remained the access for maintenance hemodialysis because of its low incidence of complications and high long-term patency rate. The failing to mature AVF is caused by intrinsically poor native vessels. Poor native vessels relate to the utilization of a suboptimal artery or vein to create the AVF (1, 2). However, previous vascular access procedures, cephalic vein thrombosis or intrinsic arterial disease may render this procedure impracticable. Basilic vein is a superficial vein of the arm; however, it cannot be used as a vascular access to hemodialysis in situ due its deep course along the medial border of the musculus biceps brachii. Therefore, basilic vein should be transposed superficially for easy access during the hemodialysis. This technique requires a large incision on the arm (3, 4). An arterio-venous bridge graft by native and/or prosthetic graft is another alternative. Autologous saphenous vein is commonly preferred as the bridge graft between brachial/radial artery and basilic vein either in straight or loop fashion due its resistance to the infection and satisfactory patency compared with prosthetic grafts such as polytetraflouroethylene (PTFE) (3, 5, 6).

Various reports exist in the literature that compares saphenous grafts with PTFEs, PTFEs with ePTFEs or biological grafts with PTFEs. All of these studies include patient groups with normal superficial venous systems and whose initial vascular hemodialysis accesses were failed. Studies evaluating the patency rates of the different graft types in patients with poor

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superficial venous system quality do not exist in the literature. We hypothesized that long-term patency may be affected by the type of graft selected when the superficial venous system has poor quality. We sought to evaluate the long-term patency outcomes of 54 patients with poor superficial venous system quality who underwent brachial/radial artery-basilic/high brachial vein autologous saphenous vein or PTFE graft interposition as initial hemodialysis vascular access surgery.

Methods

Study design

Between September 2008 and April 2009, 54 out of 176 (30.6%) patients who received a hemodialysis access for end-stage renal failure were considered ineligible for direct arteriovenous fistula creation. This prospective cohort study comprised of these 54 patients who underwent either saphenous vein or PTFE graft interposition surgery for prosthetic hemodialysis access. This study was approved by the local Ethics Committee. All patients gave written informed consents.

Study population

Autologous saphenous vein was interposed between radial/brachial artery and basilic/high brachial vein in 29 patients (Group 1). PTFE graft was interposed between brachial artery and high brachial vein in 25 patients (Group 2). The preoperative characteristics were similar in both groups (Table 1). PTFE grafts were used for 10 patients with insufficient saphenous vein quality (varicose, small caliber-<1.5 mm), 8 patients who underwent previous saphenous vein surgery (total saphenous vein harvesting due to coronary artery bypass grafting, varicose vein surgery) or according to the patients' choice in 7 cases.

Study protocol

The whole of the study group was evaluated via color Doppler ultrasonography (CDU) during preoperative course and superficial venous systems of these patients were found inadequate (<1.5 mm) to perform simple radial/brachial artery-cephalic vein anastomosis. Patients were routinely evaluated via physical and CDU examination in the first month and called back for every 6 months period.

Assessment of venous system quality and graft patency

In all CDU examinations, LOGIQ 7 system ultrasonography equipment (General Electric Healthcare, Tokyo, Japan) was used. All of the examinations were performed while the patient was in supine position. Both arterial and venous systems were evaluated. Transverse diameters of the superficial venous system were measured. It is found inadequate to use these veins if the diameter of the vein is <1.5 millimeters, proximal vein (such as subclavian vein) stenosis exists or target vein is occluded. Saphenous vein was also evaluated via CDU during the preoperative period and above mentioned criteria were also carried out for the saphenous vein.

Table 1. Preoperative demographics of the patient groups

	SVI Group (n=29, 53.7%)	PTFE Group (n=25, 46.3%)	*P*
Age, years	55.6±12	57.1±16	0.87
Male, n %	10 (34.5%)	8 (32.0%)	0.84
Hypertension, n %	18 (62.1%)	17 (68%)	0.65
Diabetes mellitus, n %	11 (38%)	10 (40%)	0.87
Tobacco use, n %	4 (13.8%)	4 (16.0%)	1.00
PAD, n %	5 (17.2%)	3 (12.0%)	0.71
Hyperlipidemia, n %	9 (31.0%)	7 (28.0%)	0.80

Data presented as mean±SD or number of patients and percentages in brackets. In comparison of continuous variables, independent samples t test for normally distributed values or Mann-Whitney U test for non-normally distributed values were used. Chi-square test or Fisher's exact test were used for comparison of categorical variables. p<0.05 was considered as statistically significant. PAD - peripheral arterial disease, PTFE - polytetrahydroflourene, SVI - saphenous vein interposition

Graft patency was primarily evaluated via CDU during routine follow up. Total intraluminary thrombosis or flow rate of <200 milliliter/minute was documented as graft failure.

Surgical technique

All patients were operated under local anesthesia and mild intravenous sedation. The saphenous vein was marked via CDU and local anesthesia was performed before the incision. Following the visualisation of the vein, additional local anesthetics were administered through the layers of the subcutaneous tissue and saphenous vein fascia. A 10-15 centimeters length saphenous vein graft was harvested below the knee. Brachial artery was found initially via an antecubital transverse incision. Radial artery was used primarily, if its diameter was larger than 5 mm, to perform the proximal anastomosis of the fistula. Then the basilic or high brachial vein was found via a second 2-3 cm incision according to the anatomic features of the vein; such as calibration or side branches nearby the anastomotic site. A straight tunnel was created in the subcutaneous tissue between previously determined arterial and venous anastomotic site. Following the intravenous heparin administration, autologous saphenous vein or polytetrafluoroethylene (PTFE) graft was preserved and both the artery and vein were clamped. The decision of which artery will be used was given according to the size of the selected graft. A 5-7 mm arteriotomy for brachial artery or 10-12 mm arteriotomy for radial artery was performed. After completion of the arterial anastomosis, the graft was passed through the tunnel and the fistula tract was carefully checked for any kink or outer compression. The distal (vein) anastomosis was created after performing the 18-20 mm venotomy. Venous anastomosis was constituted in manner of patch plasty of the graft to prevent further stenosis of the fistula which was commonly observed in this anastomotic site.

Statistical analysis

Statistical analyses were performed with SPSS 17.0 software (SPSS Chicago, Illinois). Continuous variables were

Table 2. The complications related with arteriovenous fistula

	SVI Group (n=29)	PTFE Group (n=25)	*P*
Thrombosis, n %	2 (6.9%)	13 (52.0%)	0.001
Infection, n %	0	0	1.00
Insufficient flow, n %	3 (10.3%)	0	0.24
CHF, n %	1 (3.44%)	0	1.00
Bleeding, n %	3 (10.3%)	10 (40%)	0.011
Hematoma, n %	8 (27.6%)	2 (8.0%)	0.08
Pseudoaneurysm, n %	1 (3.44%)	0	1.00

Data presented as number of patients and percentages in brackets. Chi-square test or Fisher's exact test were used for data comparison. P<0.05 was considered as statistically significant. CHF - congestive heart failure, PTF - polytetrahydroflourene, SVI - saphenous vein interposition

expressed as mean and±standard deviation; categorical variables were defined as numbers and percentages in brackets. The categorical variables were compared with chi-square and Fisher's exact test. Functional patency rates were estimated with Kaplan-Meier analysis. SVG and PTFE graft overall patency rates differences were estimated with Log-Rank test. All p values less than 0.05 were considered statistically significant.

Results

The diameter and quality of the superficial venous system were inadequate to perform a simple AVF while radial and brachial arteries were patent with natural flow pattern in all patients. Preoperative mean transverse diameter of the cephalic vein was 1.0 mm at wrist and 1.3 mm at elbow level in the study group. Basilic and high brachial vein diameters were larger than 5 mm in the study population.

Patients were evaluated in routine control periods. Mean follow up period was 30 months (8 to 36 months). Early death within 30 days of surgery was not occured. One patient died in each group during the remaining follow up.

Primary patency

In saphenous vein interposition (SVI) group fistula failure was observed in 5 of 29 patients (17.2%). Primary patency rate was 93% in 12th month and 82% in 24th month. In PTFE group, arteriovenous fistula failure was observed in 13 of the 25 patients (52%). Primary patency rate was 88% in 12th month and 56% in 24th month. According to the Kaplan-Meier method, mean time of primary patency was significantly higher in SVI group when compared to PTFE group (33.03±1.32 months vs. 28.16±1.91 months, Log Rank chi-square value: 7.01, df:1, p=0.008) (Fig. 1).

5 AVFs failed during the follow up in SVI group. Thrombectomy was performed for the two of them. Arterial anastomoses of the AVFs were revised in remaining three patients. Two patients in reoperated SVI group utilized from the reoperation while remaining three reoperated patients underwent other vascular access procedures. Thrombectomy or thrombolysis was performed for the 13 failed AVFs in PTFE group and only two of these AVFs remained functional.

The reasons of failure of the AVFs and related complications were demonstrated in Table 2. Thrombosis was more frequent in PTFE group while all insufficient graft flow (<200 mL/minute) cases were in SVI group. The numbers of puncture site complications were similar; however, bleeding was more frequent in PTFE group (p=0.011). None of the patients showed clinical signs or symptoms of graft infection. Edema of the hand and ischemia of the distal arm were not documented. One patient suffered form congestive heart failure in SVI group.

Secondary patency

Secondary patency rate was 96% in 12th month and 93% in 24th month for SVI group while 96% in 12th month and 84% in 24th month for PTFE group. 3 AVFs in SVI group and 11 AVFs in PTFE group remained nonfunctional in the end of the follow up period. According to the Kaplan-Meier method, mean time of secondary patency was significantly higher in SVI group when compared to PTFE group (34.27±0.95 months vs. 31.16±1.40 months, Log Rank chi-square value:7.33, df:1, p=0.007) (Fig. 2).

Discussion

Main result of our study was long-term patency benefit of the saphenous vein was higher when compared to that of the PTFE graft for prosthetic hemodialysis access in patients with inadequate superficial venous system quality. Both groups were similar in terms of baseline characteristics. In all patients, cephalic vein was not suitable to create a direct arteriovenous fistula in terms of both flow dynamics and anatomic diameter.

Endogenous arteriovenous fistula (AVF) was first described in 1966 (2), remains the optimal vascular access for chronic dialysis. The distal radial-cephalic anastomosis just above the wrist is still the best site for an internal AVF. When an AVF permanently failed, other vascular access options are to create another AVF from the proximal site of the failed AVF, using central veins to insert permanent tunneled hemodialysis catheters or to interpose a graft into an artery and functional central vein. PTFE and autologous saphenous vein grafts are commonly used for that purpose. PTFE graft interpositions provide a fast vascular access following the surgery; however, thrombosis and infections may be more frequently seen when compared with autologous saphenous vein (6-8).

The definition of the infection of an AVF includes induration, swelling, redness, increase in temperature on AVF tract and drainage from needle or incision site with or without fever and/or bacteraemia. Diversely from recent reports any local infection was recorded in both groups in this study (5-9). All patients underwent hemodialysis in our institutional hemodialysis centre by the same nurse team. This may have a role in the absence of AVF infections. Insufficient flow, congestive heart failure due to increased flow, hematoma and pseudoaneurysm were the com-

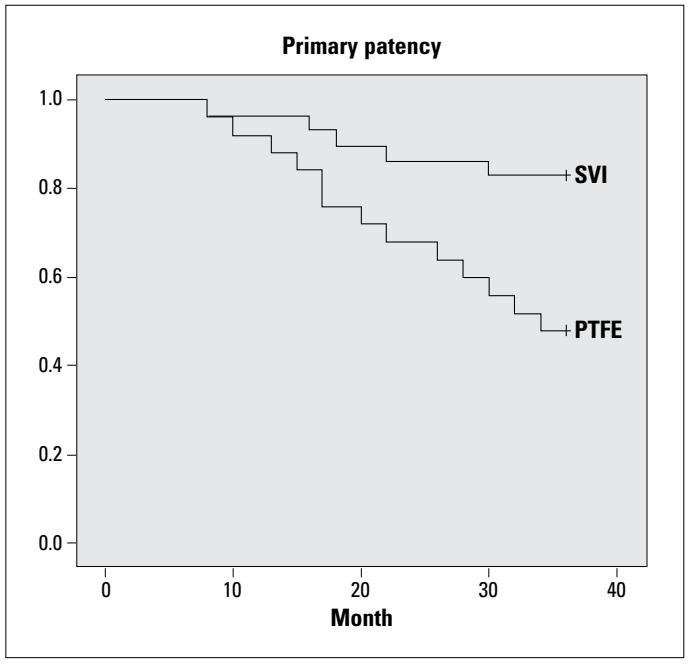

Figure 1. Kaplan-Meier survival curves with log-rank analysis show primary patency over months by graft type (p=0.008)
PTFE - polytetraflouroethylene; SVI - saphenous vein interposition

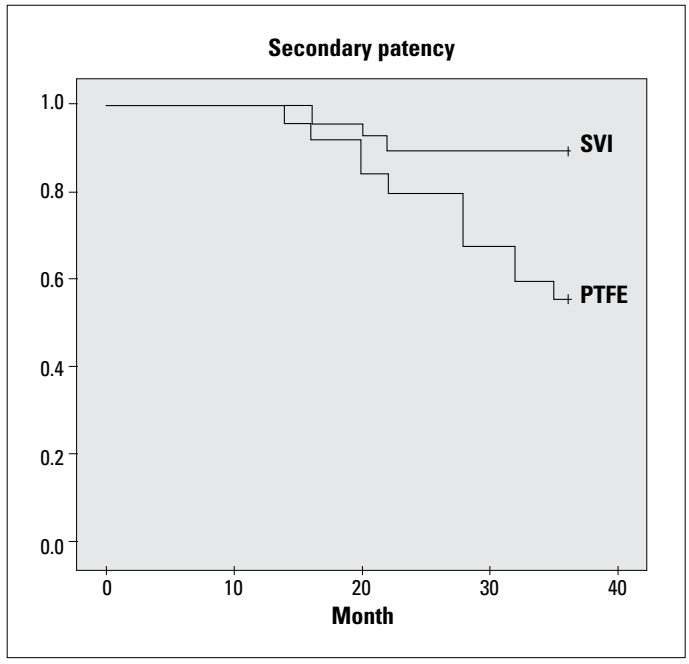

Figure 2. Kaplan-Meier survival curves with log-rank analysis show secondary patency over months by graft type (p=0.007)
PTFE - polytetraflouroethylene; SVI - saphenous vein interposition

plications that no statistical difference was observed between two groups in these issues. Prolonged bleeding from the needle puncture site was predominantly observed in PTFE group. Local compression or simple suturing over the puncture site was enough to stop bleeding. Thrombosis of the graft is a serious complication threatening the patency of the graft and was diagnosed in 13 patients in PTFE group and 2 patients in SVI group. Thrombectomy was performed for these patients. 2 AVFs in each group remained functional following thrombectomy. The primary and secondary patency of the SVI group was significantly higher in 12^{th} and 24^{th} months.

Native superficial veins were inadequate to perform an AVF in the study group and patients underwent graft interposition surgery. Preoperative mean transverse diameter of the cephalic vein was 1.0 mm at wrist and 1.3 mm at elbow level in the study group. The patients' poor superficial vein quality may be related with the high incidence of diabetes, anatomical variances and elder age of the study population. It has been noted that arteries less than 1.5 to 2 mm and veins less than 2 to 2.5 mm in diameter are associated with poor AVF maturation (10-13). Silva et al. (1) had minimum of 2.5 mm for vein size as predictable for fistula success. Lauvao et al. (14) had eight patients with the smallest diameter on Doppler ultrasonography between 1.5 and 2 mm that went on to mature their fistulas and three did not. Their experience shows that vein size is the major predictor for a successful fistula.

Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines report that radio-cephalic and brachio-cephalic AVFs are the first and second choice for vascular access (15). When these options are not suitable, other methods of vascular access for hemodialysis should be evaluated in an algorithm. Basilic vein transpositions (BVT), radio-basilic and brachio-brachial vein synthetic or biological bridge graft interposition are some of the other surgical vascular access procedures. BVT does not require a graft and has satisfactory outcome, however this technique is a bit challenging surgical procedure compared with graft interposition surgery and needs larger incision on the arm and longer time for maturation (4, 5). Interpositioning of a bridge graft between upper arm artery and basilic/brachial veins is the other method which was performed either with synthetic or biological grafts. There are various studies comparing the PTFE grafts with biological grafts according to the infection, patency rate, complications etc. Huber et al. (6) recommend native AVFs as the first step of treatment and in other circumstances offer autologous solutions as possible primary and secondary patency, lower complication rate and cost when compared with PTFE grafts.

Study limitations

Main limitation of the study is the limited cohort size and relatively short follow up. The other issue is the type of the PTFE graft. We used standard PTFE grafts which are the old fashion graft types if compared with brand new ones.

Conclusion

Methods for vascular access during hemodialysis should be evaluated in an algorithm. If the usage of a graft interposition is neccesary, autologous saphenous vein graft can be preferred due satisfactory patency rate, low infection risk and cost when compared with synthetic ones.

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