



Comparison of autogenous basilic vein, polytetrafluoroethylene and polycarbonate grafts for haemodialysis access

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Abstract

This study aims to present data obtained by comparing the results of three different kinds of arterio-venous fistula (AVF) in hemodialysis patients. One hundred twenty (120) patients were operated with autogenous brachiobasilic (BBF) AVF, upper arm polytetrafluoroethylene (PTFE) or polycarbonate-urethane (PCU) graft AVF in our centre between January 2015 and January 2018. They were enrolled for a retrospective study into three groups; BBF Group (n=54), PTFE Graft Group (n=36), PCU Graft Group (n=30). Their data was analyzed, primary and secondary patency rates, complications and cannulation time were calculated. Primary patency rates of the 1st, 2nd and 3rd years were recorded to be respectively 81.4%, 72.2% and 59.2% in the Autogenous Arteriovenous Fistula (BBF) Group; 61.1%, 55.5% and 44.4% in the PTFE Group and 63.3%, 60% and 46.6% in the PCU Group. Infections occurred in 3.7% of BBF patients, in 8.3% of PTFE patients and 10% of PCU patients. First cannulation times were: 69± 17 (day) in BBF Group, 20 ± 5 (day) in PTFE Group and 10± 3(day) in PCU Group. BBF was observed to perform better than AVG in terms of primary and secondary patency and to result in low infection rates. On the other hand, first cannulation was performed earlier in both graft AVFs. There was no significant difference between PTFE and PCU in terms of our outcomes.

Keywords: arterio-venous fistula (AVF), basilic vein graft, PTFE dialysis graft, polycarbonate dialysis graft

1. Introduction

Vascular access is of extreme importance in dialysis dependent chronic renal insufficiency patients. Autogenous arteriovenous fistula (aAVF) is the most frequently used and desired access due to high patency rates and low morbidity (1). However, maturation of aAVF requires several weeks to months and it is not always feasible to obtain a healthy aAVF because of previously damaged superficial veins. Distal forearm aAVFs are the first choice and as they become unavailable, they are followed by brachio-cephalic aAVFs, while superficialised brachio-basilic aAVFs, graft AVFs and permanent catheters are later options.

Superficialised brachio-basilic fistula is an aAVF that requires a double staged surgical procedure (4). First the brachio-basilic fistula is created, then it is superficialised to make it accessible for cannulation. Despite the complicity of the procedure, basilic vein offers an adequate diameter for aAVF and thanks to the depth of the location, previous damage due to intravenous injection is less expected.

Arteriovenous fistulas constructed with a synthetic graft anastomosed between a native artery and veins provide an alternative solution when a functional aAVF cannot be obtained (1-3). Easy cannulation and early maturation are some of the advantages of graft AVFs. However, they demonstrate lower patency rates and require more re-interventions

compared to aAVFs. Polytetrafluoroethylene (PTFE) grafts are the most commonly used option and polycarbonate-urethane (PCU) grafts are another valid choice.

There are high number of studies comparing the results and longevity of aAVF, prosthetic grafts (5, 6), and/or autogenous brachiobasilic aAVF (4, 7). Most of them are retrospective studies conducted on different patient populations. However, no literature study has been found to compare autogenous brachiobasilic aAVFs (BBF), Politetra plouro etilen (PTFEgraft AVFs) and Polycarbonate (PCU graft AVFs.) In this parallel, the main aim of this study was to make a retrospective comparison of the use of these three kinds of AVFs in similar patients.

2. Materials and Method

2.1. Ethical Board Approval

Approval was obtained from the Ethical Board of Human Researches of İstinye University on 10.04.2021 (Protocol No 21-81).

2.2. Patient population

One hundred twenty (120) patients who were operated in our centre, Medical Park Samsun Hospital, between January 2015 and January 2018 had been enrolled for a retrospective study. Study participants were chosen from a pool of patients who had previous non-functioning lower arm aAVFs or brachiocephalic

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aAVFs, or who lacked suitable veins for aAVF.

Other inclusion criteria were brachial or basilic vein diameter ≥ 2.5 mm and lack of proximal vein thrombosis/constriction. Study patients were randomized into three groups; BBF Group (n=54), PTFE Graft Group (n=36), PCU graft group (n=30). Written consent was duly obtained, and patients' demographic data and past medical history were recorded.

2.3. Preoperative assessment

All study patients were performed detailed vascular examination, including arterial and venous doppler ultrasonography. Venography was avoided to minimize the risk of phlebitis. MR angiography was performed in 28 patients with previous catheter history to diagnose subclavian vein thromboses or stricture.

Table 1. Patients characteristics

	AVF (n=54)	PTFE (n=36)	PCU (n=30)
Age	56.3 \pm 8.5	54.2 \pm 10.3	57.1 \pm 9.8
Male	36 67%	26 72%	21 70%
Female	18 33%	10 28%	9 30%
Primary disease			
DM	31 (57.4%)	19 (52.7%)	15 (50%)
GN	12 (22.2%)	9 (25%)	8(26.6%)
Other	11 (20.37%)	8 (22.2%)	7 (23.3%)
Comorbidity			
HT	33 (61.1%)	23 (63.8%)	20 (66.6%)
IHD	6 (11.1%)	6 (16.6%)	4 (13.3%)
PAD	4 (7.4%)	2 (5.5%)	2 (6.6%)
Smoking history	34 (62.9%)	23 (63.8%)	20 (66.6%)

2.4. Surgical technique

All operations were performed under supraclavicular block anaesthesia. In BBF Group (n=54), a two-stage surgery was performed. At first stage, aAVF was created between the brachial artery and basilic vein at antecubital fossa. End-to-side anastomoses was performed using 6/0 polypropylene. The second stage of the operation was completed 30 \pm 2 days later and included basilic vein mobilization and superficialisation from the deep fascia. Skin was incised longitudinally from antecubital fossa till axilla, just above the basilic vein. The basilic vein was gently separated from the cutaneous antibrachial nerve to avoid injury, and branches were ligated.

In PTFE Group (n=36), a 6mm PTFE graft (WL Gore and Associates Inc, Phoenix, Arizona, USA and Bard Inc, Tempe, Arizona, USA) was anastomosed between the brachial artery and axillary vein, in a straight configuration. Two different skin incision were made, arterial one being at the antecubital fossa and venous one at the axilla. Graft was tunnelled under the skin. End-to-side anastomoses were performed using 6/0 polypropylene. The same technique was applied also to the

PCU Group (n=30) with the one single difference of the graft material used *AVflo™ graft (NICAST, Lod, Israel)*. Distal limb perfusion was monitored by pulse oximeter in all procedures.

3. Results

Statistical analysis was performed using the Statistical Analysis System (SAS Institute Inc., Cary, NC). Results were presented as mean \pm standard deviation for continuous and as frequency (percent) for categorical variables.

Major outcomes of the present study are related to the primary patency (time period from the access placement until the first thrombosis or reintervention to maintain patency) and secondary patency (time period from placement until abandonment of access due to permanent occlusion).

Primary patency rates of the 1st, 2nd and 3rd years were recorded to be respectively 81.4%, 72.2% and 59.2% in the autogenous arteriovenous fistula (BBF) Group; 61.1%, 55.5% and 44.4% in the PTFE Group and 63.3%, 60% and 46.6% in the PCU Group (Table 2). This finding demonstrates that BBF has a significantly higher primary patency rate than both PTFE and PCU (Table 2) while no significant difference was noticed between the PTFE and PCU grafts.

Table 2. Patency rates and other outcomes

Primary patency			
1 year	44 (81.4%)	22 (61.1%)	19 (63.3%)
2 year	39 (72.2%)	20 (55.5%)	18 (60%)
3 year	32 (59.2%)	16 (44.4%)	14 (46.6%)
Secondary patency			
1 year	50 (92.5%)	29 (80.5%)	25 (83.3%)
2 year	47 (87%)	27 (75%)	23 (76.6%)
3 year	40 (74%)	19 (52.7%)	16 (53.3%)
Other outcomes			
Haemorrhage	2 (3.7%)	2 (5.5%)	1 (3.3%)
Infection	2 (3.7%)	3 (8.3%)	3 (10%)
Seroma	0	0	0
Surgical banding	3	0	0
Surgical plication	0	1	1
1st cannulation	69 \pm 17 days	20 \pm 5 days	10 \pm 3 days

The average primary patency duration was 881.7 \pm 593.2 days for autogenous arteriovenous fistula, 473.5 \pm 393.2 days for PTFE graft and 481.5 \pm 432.7 days for polycarbonate graft (p=0.0000), which points a significant difference. BBF graft produced better results than the synthetic grafts due to its high both primary and secondary patency rates as well as reduced complications such as infection. However, no significant difference was found between the PTFE and PCU grafts.

4. Discussion

It is not easy to establish and maintain an adequate permanent haemodialysis access. Autogenous AVFs, grafts and permanent catheters have been valid options applied in this scope. Autogenous AVFs have been used widely for years due to their simplicity and low morbidity. Lower arm aAVFs and brachiocephalic aAVFs are excellent examples. However, lack of suitable veins or failure of present access force the surgeon

to seek alternative solutions accompanied by higher complexity and morbidity rates. Permanent catheters are generally used as a last resort because of their high risk for infective endocarditis and venous thromboses.

Superficialised BBF is an aAVF created by a double-staged procedure. It was first reported by Dagher (8) in 1976 and has regained popularity lately with the widely spread of autologous grafts. After a short superficial segment, the basilic vein dives deep under the fascia, which protects it from injections and injuries, making it a preferable graft for aAVF (9). It also has a sufficient diameter for a good run-off (10) and is durable to infection as an autogenous graft (9,11).

While the autogenous grafts are more advantageous in general, graft usage is a helpful tool and more advantageous in patients in urgent need of vascular access as they enable immediate use.

While the most common cause of AVF failure is venous stenosis, it may rarely result from arterial stenosis. In such cases, reduced thrill or replacement of thrill by pulsation, edema in the arm, clogged dialysis needle and post-dialysis prolonged bleeding from the dialysis needle point are recorded. Graft thrombosis is the most important reason of graft failure and occurs due to stenosis related to intimal hyperplasia. Treatment consists in surgical or endovascular intervention. According to the results of a study published in 2009, there is no difference between the early-stage results of thrombectomy with surgical intervention and endovascular intervention (12). Success of the procedure depends on its capacity to target the stenosis that may develop during the procedure. Intervening particularly in the stenosis in the venous anastomosis segment of the graft increases the patency chance of the graft by preventing repeated thromboses. To ensure secondary patency, the grafts were performed thrombectomy using fogarty catheter under local anaesthesia. In cases of suspected post-thrombectomy stenosis; 0.035-inch hydrophilic wire was passed for venous lesions and 0.025-inch hydrophilic wire for arteriyel lesions under fluoroscopy and, angioplasty was performed during the same session. The key point in preventing recurrent thrombosis and increasing patency rate is removal of stenosis.

In graft infections, generally local temperature increase and tenderness are experienced at the needle access site on the graft. Sometimes such systemic symptoms as fever and bacteraemia. Graft infection is mainly related to gram (+) bacteria and, staphylococcus aureus is the most frequent pathogen (50-90%). (13) Empiric broad spectrum antibiotic therapy is started without waiting for blood culture results. Low virulence infections generally occur in punction sites and are cured with antibiotherapy and local resection. In the present study, local infection developed in the needle access points of 2 cases (3.7½ %) in the autogenous graft group; of 3 cases (8.3%) in the PTFE group; and of 3 cases (10%) in the polycarbonate group. The infections were contained using

antibiotics. Minor outcomes are related to the acute haemorrhage in early postoperative period leading to surgical revision, infection (requiring removal of the access) and first cannulation time (decided by the nephrologist after judging maturation of access). In rare conditions, infection occurs near anastomotic site and can lead to life threatening haemorrhage. Graft removal should be considered in these cases. We did not experience any potential threatening graft infection during this study. No significant difference was noted between the study groups regarding early haemorrhage.

BBF group showed significantly lower infection rates than both grafts while the comparison between the PTFE and PCU groups produced similar infection rates. On the other hand, first cannulation time was significantly lower in both graft groups compared to BBF, but no such difference was recorded between the PTFE and PCU groups.

Perigraft seroma is a rare complication of PTFE grafts. It consists in a fibrotic pseudo-capsule created by sterile serum extravasation from graft and can lead to graft resection. No such complication was encountered during this study; thus, it is not included in Table 2.

Dialysis grafts may be in positioned in a straight or loop configuration. We applied a straight configuration in all our patients. Artery was explored right above antecubital fossa and vein was explored in axillar fossa. Graft was passed under the skin and heparin was administered. Arterial anastomose was performed followed by venous anastomose.

Synthetic grafts are suitable to be used after 2-4 weeks. Although early cannulation grafts (including first 24 hours) are available, their usage is limited only in emergent situations due to high risk of haemorrhage or thrombosis.

Distal hand ischemia may develop in extremities with AV graft. Generally, hand pain and coldness occur 1 hour after starting dialysis and, tissue loss can happen in serious ischemia, especially in diabetic patients with poor vascular bed. (14) Proximal arterial stenosis, if exists, can be treated with endovascular procedures, while surgical banding or plication can be performed in high flow conditions. We performed surgical banding with 6mm PTFE in three patients in BBF group, and plication in one patient in PTFE and one patient in PCU group (Table 2).

When applied, neural blockade leads to venous dilation, which itself results in high quality anastomose and increased early patency rate. Prophylactic broad-spectrum antibiotics decreases (15) graft infection, and all our patients received prophylactic antibiotics before surgery.

Study patients had their first follow-up by the vascular surgeon at the end of the 1st month of placement of the access and subsequent check-ups annually.

In conclusion, the present study demonstrates superiority of BBF compared to AVG in terms of primary and secondary

patency, and low infection rates. On the other hand, AVG leads to notable early first cannulation. Comparison of PTFE and PCU grafts points out no significant difference in any of the study outcomes. In this framework, this study suggests that vascular access in complicated patients should be planned on individual basis, taking into consideration condition of the proximal arm veins, urgency of haemodialysis and general state of patient.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgments

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Ethical Approval

The study was approved by the Ethics Committee for Research on Human Sciences of İstinye University (date: 04.10.2021, No. 21-81).

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