Original Research Article

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Axillary artery loop interposition graft (AALG) as unusual access for hemodialysis

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ABSTRACT

Background: Life expectancy of end stage renal disease patients continues to lengthen and with the limited durability of vascular accesses, repeat fistula construction at different levels of the upper limb is often necessary and leads ultimately to exhaustion of autogenous vascular access sites. Our experience with alternative vascular access procedures namely the arterio-arterial loop graft in the first part of axillary artery was presented in this study.

Methods: From June 2013 to Aug 2017, arterio-arterial interposition loop graft procedures (AALG) for vascular access were performed in 15 patients with end-stage renal disease. Inclusion criteria were patients with unsuitable large deep veins or with cardiac insufficiency intolerable to high-flow arterio-venous fistula.

Results: The achieved primary and secondary patency was 73.3 % and 86.6% at 1 year and 53.3 % and 66.7 % at 3 years. Severe infection in whole graft occurred in two patients (13.3%) after 11, 27 months. One patient died six months after operation due to unrelated cause. two patients had pseudoaneurysms after 20 and 28 months at sites of repetitive needle puncture and were treated successfully by segmental replacement.

Conclusions: In selected cases and with proper indication the AALG can offer efficient alternative for vascular hemodialysis access and can improve the survival rate of such patients.

Keywords: AALG, Angioaccess, ESRD, Hemodialysis

INTRODUCTION

The number of patients with end-stage renal disease (ESRD) requiring hemodialysis is constantly rising worldwide.¹ Vascular hemodialysis access is considered the lifeline for patients with end-stage renal disease, and arteriovenous fistula (AVF) has been the golden standard access for hemodialysis.² In Europe, over 25% of all hospital admissions for ESRD are for the construction or maintenance of a patent vascular hemodialysis access.³

While the life expectancy of ESRD patients continues to lengthen and with the limited durability of vascular accesses, repeat fistula construction at different levels of the upper limb is often necessary and leads ultimately to exhaustion of autogenous vascular access sites.⁴ Use of a synthetic prosthesis is currently the recommended treatment alternative for patients who have exhausted all native fistulas access options, however, such grafts have lower patency rates and shorter lifetimes than autogenous arteriovenous fistulas.⁵

The use of an artery as permanent vascular access for hemodialysis is not a new procedure; Brittinger et al, used the subcutaneously fixed superficial femoral artery for needle puncture.⁶ Butt and Kountz reported satisfactory results with an arterial femeropopliteal graft that used a bovine carotid artery as vascular access in seven patients.² Our experience with alternative vascular access procedures namely the arterio-arterial loop graft in

the first part of axillary artery was presented in this study.

METHODS

From June 2013 to Aug 2017, arterio-arterial interposition loop graft procedures (AALG) for vascular access were performed in 15 patients with end-stage renal disease. All patients were initially assessed in our vascular unit clinic in Menoufia University Hospital. It was essential to use duplex scanning of arteries to define adequacy of arteries. Written informed consent was taken from all patients before the procedure. The committee of human research approved the study.

Inclusion criteria were patients with unsuitable large deep veins (subclavian, internal jugular, and femoral veins), either all six veins, or five out of six veins in younger patients with good prognosis (the last suitable vein should be reserved as an access for a central venous catheter in emergency). A vein is considered unsuitable if an occlusion or high-grade long stenosis (<70% in diameter, >4 cm long) of the vein or the venous outflow obstruction is detected and cannot be treated promisingly by any interventions. Patients with cardiac insufficiency that is intolerable to the additional cardiac load of a high-flow AV fistula were also enrolled.

Exclusion criteria were patients with chronic ischemia of the limb, infection or huge ugly scar at loop site.

All procedures were performed under general anesthesia. Two grams of 3rd generation antibiotic was administered with induction of anesthesia. The operative procedures included exposure of the first part of axillary artery, after separation of the artery, a PTFE graft with a 6- or 8-mm diameter (adapted to the diameter of the artery) was interposition after configuration of a subcutaneously tunneled loop on the chest wall (Figure 1).

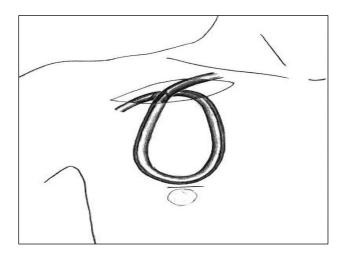


Figure 1: Demonstrating draw for axillary loop interposition graft.

A 6/0 polypropylene suture was used in the creation of an end-artery to end-graft anastomoses between the ends of

prosthesis and the first part of axillary artery (Figure 2). The length of the implanted graft was between 30 and 40cm. The mean operation time was 102minutes. Low molecular weight heparin therapeutic dose was administered once a day for five days then was replaced by oral anticoagulation warfarin for lifelong. The first needle puncture of the graft was carried out not before two weeks after the procedure.



Figure 2: Anastomosis of loop ends to axillary artery.

After discharge, the graft we assessed during dialysis sessions to ensure its patency. Written instructions were sent to the nephrologists about the specifics of this access; temperature of the reinfused blood, pump power about 300 ml/min, compression of the puncture site should be at least 15 minutes after the removal of the needle, cautions about any infusion of medications (intraarterial injection), and the heparin supply should be continuing until 30 minutes before finishing hemodialysis. In addition, instructions about puncture sites change were given.

All patients were followed up in our vascular unit every 3 months. We carried out surveillance including graft blood flow (ml/min), clinical examination and duplex ultrasound scanning. If there was any sign of graft dysfunction, Duplex ultrasound was performed as the first-line investigation then trial to retain patency was done according to the problem.

Statistical analysis

Statistical analysis performed using SPSS v. 24.0. (IBM Corp., USA). Discrete variables presented as numbers (counts) and percent. Continuous variables presented as mean and standard deviation (SD). Student T-test was used for intergroup comparisons to test the significance of difference between two different variables. P<0.05 was considered statistically significant. The Kaplan-Meier method was used to compute graft patency.

RESULTS

Fifteen patients had arterio-arterial axillary loop grafts in the period from 2013 till 2017 which represent about 0.3% of all vascular accesses done during this period in our department. The ePTFE Grafts were used for hemodialysis two weeks following the surgery. The mean patient age was 58 ± 13 years; 60% were women. Comorbid conditions included diabetes mellitus (66.7%), coronary artery disease (60%), and hyperlipidemia (53.3%) (Table 1).

Table 1: Patients' demographic and clinical data.

Variable	N
Age (years, mean±SD)	58±13 (range 45-71)
Sex (M/F)	6/9
Co-morbidity	
Coronary artery disease	9 (60%)
Diabetes mellitus	10 (66.7%)
Hyperlipidemia	8 (53.3%)
Hypertension	39 (61%)
Diabetes type 1/2	2/8
Diabetes duration (years,	17.9±5.8 (range 0.1-
mean±SD)	47)
Vascular access for dialysis	
Temporary central venous catheter	9 (60%)
Femoral vein catheter	4 (26.6%)
Badly function A-V shunt	2 (13.3%)

The study patients have been receiving regular hemodialysis for periods ranging from 5 to 40 months. The median duration of use of arterio-arterial prosthetic access was 18 months.

The patients had undergone different modalities of hemodialysis accesses (6 ± 2) (range, 1 to 9). The patients undergone dialysis through a temporary central venous catheter placed in the jugular vein (60%), femoral vein (26.6%), or through a badly function AV graft (13.3%).

Table 2: Follow up complications.

Complication	Total no. of patients (15)	
	No.	%
Thrombosis	7	46.7%
Pseudoaneurysm	2	13.3%
Infection	3	20%
Mortality	1	6.7%
Cumulative survival rate	14	93.3%

AALG was reserved only for selected cases in which a conventional access not possible. All of patients had unsuitable superficial veins for the creation of a native AV fistula, or had congestive heart failure. AALG placement was indicated in fifteen patients, in five patients, one suitable vein (jugular or femoral vein) was found, where a CVC was placed, four patients had unsuitable large deep veins and Congestive heart failure was the indication in six patients.

Overall technical success was achieved in 15 (100%) cases, no complications were observed in the early postoperative course. All AALG were cannulated two weeks postoperatively.

The achieved primary and secondary patency was 73.3 % and 86.6% at 1 year and 53.3 % and 66.7 % at 3 years (Figure 3). Thrombosis of the graft during treatment with warfarin occurred in three cases in the first year on the day 20, in 47 days, and after nine months; two underwent thrombectomy successfully and one failed. Thrombosis of the graft occurs in two patients after 23 and 31 months and trial of thrombectomy failed.

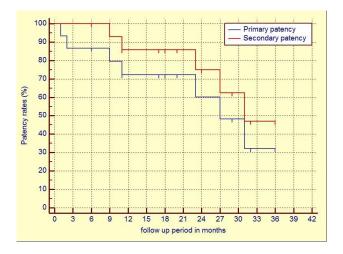


Figure 3: Curves calculated by the Kaplan-Meier method for primary and secondary patency and their negative standard error bars.



Figure 4: Multiple pseudoaneurysms over the graft.

One patient died six months after operation due to unrelated cause. two patients had pseudoaneurysms (Figure 4) formed after 20 and 28 months at sites of repetitive needle puncture, and were treated successfully by segmental replacement (Figure 5). Whole graft infection and thrombosis occurred after 11month, and we sacrificed the shunt due to severe infection with tissues friability unsuitable for axillary artery reconstruction. One patient had infection at the puncture site after 17 months and treated conservatively by intravenous antibiotic according to the results of culture and sensitivity.



Figure 5: Postoperative after segmental replacement.



Figure 6: Postoperative contralateral loop interposition graph in patient with infected graft on the opposite side.

After 27 month another patient had whole graft infection with thrombosis and was treated by removing the graft and reconstructing axillary artery, patient passed postoperative period without any complications and underwent another AALG on the opposite side in chest wall (Figure 6). The cumulative survival rate for all patients was 93.3% at 3 years. No deaths were related to the AALG.

DISCUSSION

The arterio-arterial interposition graft is an old idea. Butt and Kountz described it for the first time in 1976. In 1979 Zingraffs et al, proposed a femoro-popliteal bypass with a carotid bovine graft on a girl on hemodialysis who developed thrombosis of the superficial femoral artery. Over a period of 38 months, Zanow et al performed this procedure on 16 patients at the femoral site (n= 3) and the subclavian site (n=13) without any post-operative complications. In the present study, we established AALG for hemodialysis in those patients who had

problems with conventional vascular access. The indication for AALG application was strictly controlled in our study, we defined two main indications for AALG access; exhausted upper and lower extremities accesses options including central venous occlusion and Cardiac insufficiency intolerable to additional cardiac load of a high-flow AV graft.

Those patients had alternative other options as right atrial bypass grafting, axillorenal arteriovenous graft but the loop needed anastomosis to the right atrial appendage through a median sternotomy or to the renal vein, and these were thought to be complex accesses configurations. ^{9,10} The arterio-arterial grafts on thigh were also described well previously, but thrombosis rate of the femoro-inguinal arterioarterial prosthetic loop was high. ^{11,12}

In the present study, the demographic character of the patients showed the mean patient age was 58±13 years; 60% were women. Comorbid conditions included diabetes mellitus (66.7%), coronary heart diseases (60%), hyperlipidemia (53.3%). Additionally, most patients had a history of several vein occlusions after temporary CVC placement and multiple failed vascular accesses, thus we expect an increased risk of thrombosis after AALG procedure, postoperative oral anticoagulants routinely applied in our study

Zanow et al, reported that the differences between AALG for vascular access in hemodialysis and conventional arterio-venous access were that a suitable vein was not needed, there wasn't any affection on distal perfusion and the cardiac load was not increased. These differences were compatible with the observations of our study.8 Present study demonstrated that the AALG graft achieved primary and secondary patency rates at one year of 73.3 % and 86.6% respectively and this is compatible with the secondary patency rate that was over 70% recommended by the National Kidney Foundation.¹³ Although the secondary patency rate of 66.7% at three years was lower than that reported in previously published studies, it was still acceptable with regard to the poor vascular conditions and the missing alternatives for vascular access.14

The patency and intervention rate of 0.3 procedures per patient per year are comparable with results of AV grafts and meet the demands of the National Kidney Foundation Dialysis Outcomes and Quality Initiative Guide- lines. 13 Although AALG is a reliable and safe procedure for establishing vascular access for hemodialysis, it should be noted that some complications may accompany it. Five patients in our study had thrombosis of the graft, three of them occurred in first year and two later on. Thrombectomy was done for all of them with success rate 40%, but patients with failed thrombectomy passed smoothly without any ischemic manifestations. This might be due to good collateral circulation in this region and this was agreed with Butt and Kountz reports. 2

If the whole graft becomes infected, it is mandatory to remove the graft and reconstruct the artery. A severe infection in whole graft occurred in two patients (13.3%) after 11, 27 months. We suggest that mobilization of longer distance of the artery during the construction of AALG makes the potential reconstruction easier. Two patients had pseudoaneurysms formed after 20 and 28 months respectively at sites of repetitive needle puncture, treated successfully by excision and segmental replacement.

Zanow et al, reported that a painful reperfusion was observed in an AALG with the proximal axillary or the femoral artery as a vascular access for hemodialysis at a dialysis blood flow rate of >400 mL/min, and they believed that the effect was probably caused by the higher pressure on the arterial wall. In present study, the desired sufficient extracorporeal blood flow was 300 mL/min, and the painful reperfusion was not observed.

CONCLUSION

In selected cases and with proper indication the AALG can offer efficient alternative for vascular hemodialysis access and can improve the survival rate of such patients

Axillary-axillary loop grafting could be recommended as a "last resort" access for selected patients.

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Ethical approval: The study was approved by the

Institutional Ethics Committee

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