# Arterioarterial prosthetic loop: a new approach for hemodialysis access as an unusual vascular access

Islam Atta[a], Ahmed Sawaby[b], Amr El Abd[c]

[a]Department of Vascular Surgery, Faculty of Medicine, Aswan University, Aswan, [b]Department of Vascular Surgery, Faculty of Medicine, Port Said University, Port Said, [c]Department of Radiodiagnosis, Faculty of Medicine, Alexandria University, Alexandria, Egypt

Correspondence to Islam Atta, Doctorate degree in vascular surgery, 40 Khalil Motran Street, Alexandria, Egypt.
Tel: +20 122 275 1703;
e-mail: islamatta81@gmail.com

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**Background**
Vascular access has always been the Achilles repair of hemodialysis. Developments in health care have carried forward patients requiring management who have no veins appropriate for formation of arteriovenous fistula or insert of central venous catheters. This study reports arterioarterial prosthetic loop (AAPL) graft as an effective access for hemodialysis patients with venous occlusion.
**Objective**
To assess AAPL graft regarding primary and secondary patency rates and incidence of complications.
**Patients and methods**
This study was performed on 20 patients with the end-stage renal diseases. The age of the patients ranged between 47 and 72 years, with a mean age of 57.9 years.
**Results**
The primary patency rates were 100, 100, 95, 90, and 80%, respectively, and the secondary patency rates were 100, 100, 100, 95.0, and 95.0% at 1, 3, 6, 9, and 12 months, respectively.
**Conclusion**
AAPL can offer an efficient access for hemodialysis in such special group of patients with unsuitable arteriovenous access or having cardiac insufficiency.

**Keywords:**
arterioarterial loop, hemodialysis access, unusual dialysis access, vascular access

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## Introduction

Vascular access failure causes substantial morbidity in patients with end-stage renal disease who require long-term hemodialysis [1]. There must be a patent deep vein to ensure that the arteriovenous fistula (AVF) will be functioning [2]. Still, in certain patients, veins can be exhausted owing to multiple long-term indwelling dominant vein catheters (CVC), transvenous pacemakers, or previously failed AV vascular access efforts [2–6]. Stenosis and occlusion of dominant veins can be preserved surgically or by angioplasty to find adequate outflow essential for AV access.

Central subclavian vein obstruction can be reconstructed by different surgical techniques with good results [3,7–11]. However, these processes need an appropriate jugular vein or uninterrupted contralateral venous outflow. Endovascular interventions for the management of central venous obstacle show excellent early achievement, but main patency rates for 1 year are 50%, restenosis rates are high, and long-term results are uncertain [3,4,11–15]. Several uncommon procedures for maintenance of AV grafts at central venous obstruction have been published [16–23].

However, certain of these methods seem insufficient for the formation of vascular access. Symptomatic ischemia distal to an AV fistula occurs in ~4% of patients [24]. In a few number of patients, the arterial status does not let the construction of an AV graft, even if the graft is fed by a central artery.

These patients characterize a group with complex vascular access difficulties that preclude the creation of a conservative vascular access. Tunneled central venous catheters do not offer a suitable long-term alternate [2]. There is a procedure to establish an arterioarterial prosthetic loop (AAPL) for such patients. The AAPL is a polytetrafluoroethylene (PTFE) graft loop interposed in the continuity of the axillary or femoral artery that can be used as the vascular access for hemodialysis.



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## Aim of the work

The aim of this work was to assess AAPL graft regarding primary and secondary patency rates and incidence of complications.

## Patients and methods

### Patients

This study was performed on 20 patients with the end-stage renal diseases. All patients who received an AAPL had approved to undergo the procedure by signing a consent form.

These patients were followed up for 1 year (10 days after surgery and then every 3 months for 1 year). The study included 20 patients with chronic renal failure on dialysis with exhausted upper limb chances for vascular access (unsuitable cephalic and basilic veins) admitted to vascular surgery department in Aswan and Alexandria university hospitals. Personal data were taken from each patient including name, age, and sex, and risk factors like diabetes mellitus, hypertension, smoking, and dyslipidemia.

### Inclusion criteria

The following were the inclusion criteria:

(1) The unsuitability of large deep veins (defined as the subclavian, internal jugular, and external iliac and femoral veins).
(2) Severe access-related ischemia of an existing AV access without other options of reconstruction of other fistula.
(3) Cardiac inadequacy that is unbearable to the additional cardiac load of a high-flow AV graft and the danger of exacerbation of congestive heart failure.

### Exclusion criteria

The following were the exclusion criteria:

(1) Patients with documented vasculitis.
(2) Patients with upper limb ischemia, impalpable distal pulsations, and hypotension.

## Methods

Special advice was given to the patients and the medical staff at dialysis unit, which included the following:

(1) No medications could be given at this AAPL to avoid acute ischemia caused by intra-arterial injection.
(2) Assessment of the patency of the graft is done by palpation of the distal pulsation or duplex.
(3) Compression is wanted for longer durations for the puncture site likened that needed for usual AV grafts.

Patients were followed up in an outpatient clinic on a monthly regular visit. Duplex assessment was carried out every 3 months to assess patency, flow velocity, and impending failing grafts.

### Operative procedure

The arterioarterial jump graft is like an expansion of the artery by expanded PTFE graft (bypass in loop or in buckle) [25].

The axillary artery jump graft may be performed under local anesthesia, but general anesthesia is preferable. This gives better airway control and ventilation and is usually well tolerated even by debilitated patients. The incision is made about 3 cm below the clavicle and is 10-cm long. The pectoralis major muscle is split, and the pectoralis minor muscle is divided. The axillary vein is currently visible. Ligation of branches to the vein, particularly those crossing in front of the axillary artery, is essential for satisfactory mobilization. Approximately 5–6 cm of the axillary vein must be mobilized. An end-to-end anastomosis is completed between the proximal artery and a PTFE prosthesis having a diameter of at least 8 mm. A circular tunnel is then made on the previous face of the thorax in which the prosthesis is placed, and an end-to-end anastomosis with the distal artery is performed. The clamp on the proximal part of artery is then removed. In the immediate postoperative period, small to moderate hematoma can occur in the tunnel caused by the collateral circulation and aggravated by anticoagulants. The graft can be used the following day (Figs 1 and 2).

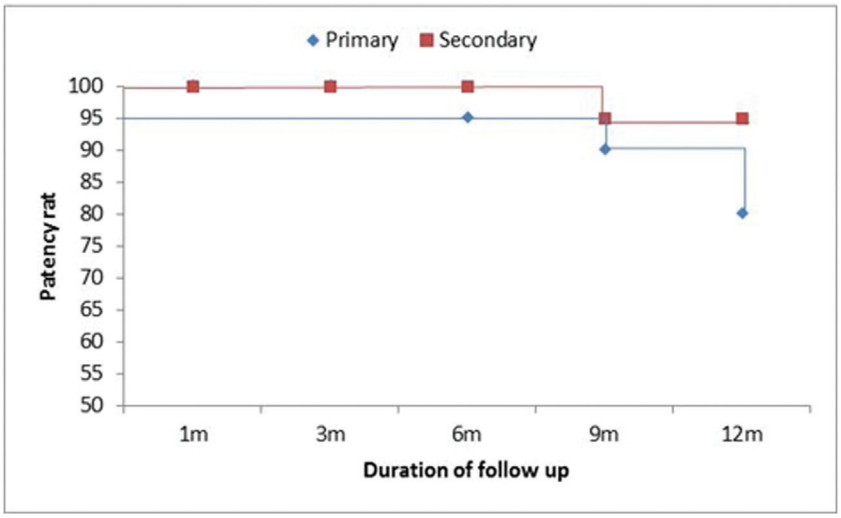
### Statistical analysis

Statistical analysis was performed using SPSS, version 24.0. (IBM Corp., USA). Discrete variables were presented as numbers (counts) and percent. Continuous variables were presented as mean and SD. The Kaplan–Meier method was used to compute graft patency.

## Results

A total of 20 patients had arterioarterial axillary loop in the period from 2016 to 2018. Nine (45.0%) patients were males and 11 (55%) were females. The mean age of our patients was 57.9±12.9 years. Comorbid

**Figure 1**




Demonstration of the tract of the graft.

**Figure 2**


Anastomosis between the graft and the two ends of the axillary artery.

conditions included coronary artery disease in six patients, dyslipidemia in seven patients, hypertension in nine patients, and diabetes mellitus in eight patients. The duration of diabetes was 17.2±6.01 years. The duration of hemodialysis was 6.52±2.66 years.

Regarding the primary and secondary patency rates in our patients, it was found that the primary patency rate in our patients after 1 year was 80.0% and the secondary patency rate after 1 year was 95.0%. There was no significant

difference between the primary and secondary patency rates.

Postoperative complications were seen in six (30.0%) patients only, and same patient may had more than one complication. These complications were detected in the period between day one after surgery till 1 year of using the AAPL. Only one patient showed hand ischemia and another one had neuropathy. Overall, two cases had graft infection, which was treated by removal of the graft and ligation of artery (the upper limb was compensated after ligation of the artery). Hematoma and seroma formation were found in three cases, which was treated conservatively in one patient and by surgical evacuation in two patients (patients continued to use the AAPL after that) (Figs 3–5, Tables 1–3).

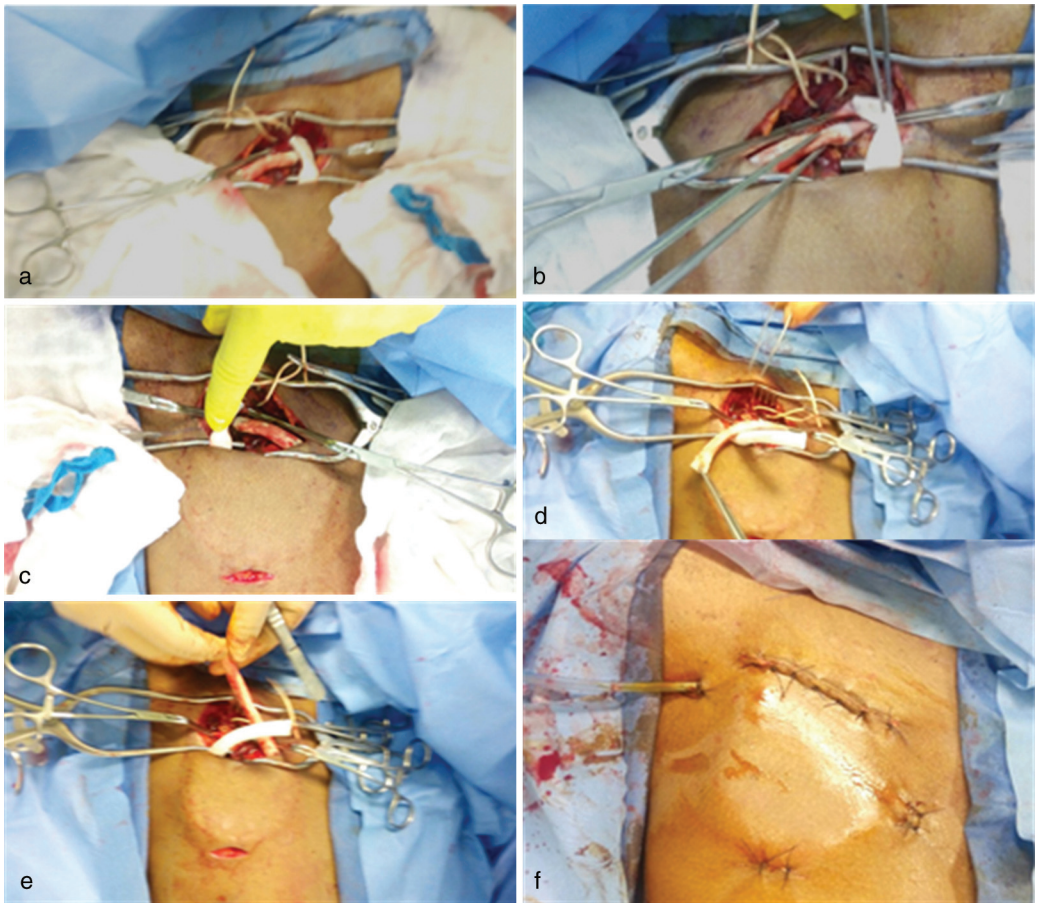
## Discussion

Despite the development of methods such as peritoneal dialysis, the most commonly used treatment is still renal replacement therapy by hemodialysis. When performing hemodialysis, it is necessary to have sufficient access to blood flow, so that the patient's blood with appropriate flow can be provided to the dialysis machine, and thus, a good quality dialysis can be performed. As survival rates for those patients were increased due to the advancement in medical care so they need more accesses for hemodialysis. The recurrent use of central lines for short-term and

**Figure 4**

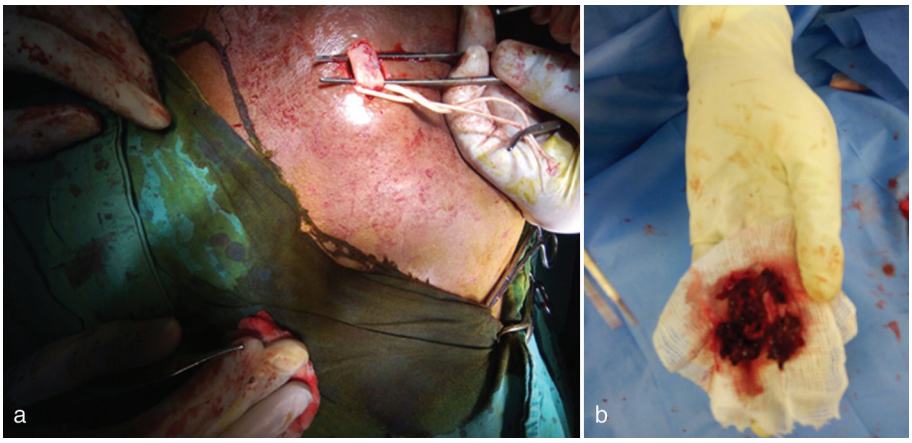
Hematoma formation after first time of usage of AAPL after dialysis session even before removal of the stitches. AAPL, arterioarterial prosthetic loop.

**Figure 3**




Kaplan–Meier curve for primary and secondary patency rates.

**Figure 5**




(a) Exposure of the graft for thrombectomy to restore its patency. (b) Freshly formed thrombus.

**Table 1 Basic characteristic feature of the studied patients**

| Variables | *n* (%) |
|---|---|
| Sex | |
| Male | 9 (45.0) |
| Female | 11 (55.0) |
| Age (years) | |
| <50 | 7 (35.0) |
| >50 | 13 (65.0) |
| Range | 47–72 |
| Mean±SD | 57.9±12.9 |
| Comorbidity | |
| Coronary artery disease | 6 (30.0) |
| Hyperlipidemia | 7 (35.0) |
| Hypertension | 9 (45.0) |
| Diabetes mellitus | 8 (40.0) |
| Diabetes duration (years) [mean±SD (range)] | 17.2±6.01 (1–36) |
| Duration of hemodialysis (years) [mean±SD (range)] | 6.52±2.66 (3–16) |

**Table 2 Primary and secondary patency rates all over the period of follow-up**

| | Primary [*n* (%)] | | Secondary [*n* (%)] |
|---|---|---|---|
| After 1 month | 20 (100.0) | | 20 (100.0) |
| After 3 months | 20 (100.0) | | 20 (100.0) |
| After 6 months | 19 (95.0) | | 20 (100.0) |
| After 9 months | 18 (90.0) | | 19 (95.0) |
| After 12 months | 16 (80.0) | | 19 (95.0) |
| $\chi^2$ | | 0.042 | |
| *P* | | 0.996 | |

**Table 3 Incidence of complications in the studied patients all over the period of follow-up**

| Complication | *n* (%) |
|---|---|
| Hand ischemia | 1 (5.0) |
| Neuropathy | 1 (5.0) |
| Infection | 2 (10.0) |
| Hematoma formation | 3 (15.0) |
| Seroma formation | 3 (15.0) |

long-term admission in hospitals has also amplified the weight of patients with central venous occlusion. Although synthetic grafts and hemodialysis reliable outflow devices have solved the problem of lack of veins appropriate for AV fistula construction, they still require presence of good outflow, which is absent in these patients [26,27].

This study was carried out to assess AAPL graft regarding primary and secondary patency rates and incidence of complications.

In our study, nine (45.0%) patients were males and 11 (55%) were females. The mean age of our patients was 57.9±12.9 years. Comorbid conditions included coronary artery disease in six (30%) patients, dyslipidemia in seven (35%) patients, hypertension in nine (45%) patients, and diabetes mellitus in eight (40%) patients. The duration of diabetes was 17.2±6.01 years. The duration of hemodialysis was 6.52±2.66 years. In agreement with our results, the study by Khafagy *et al.* [26], showed the early results of brachial AAPL for hemodialysis. In the study by Khafagy *et al.* [26], the age of patients ranged between 27 and 72 years, with a mean age of 52.8 years. Of these patients, 45.7% were males and 54.3% were females. In a study evaluating the axillary artery interpositioning graft done in Egypt Faculty of Medicine, Menoufia University, 60% of patients were females and 40% were males, with a mean age of 58±13 years. The patients had different comorbidities: 60% had coronary artery disease, 66.7% had diabetes mellitus, 53.3% had hyperlipidemia, and 61% had hypertension [28].

In this study regarding the primary and secondary patency rates in our patients, it was found that the primary patency in our patients after 1 year was 80.0% and the secondary patency after 1 year was 95.0%. There was no significant difference between the primary and secondary patency rates.

In agreement with our study, in systemic review carried by Grima *et al.* [29], the primary and secondary patency rates at 1 year ranged from 61 to 75% and 83 to 96%, respectively. These values are similar to those quoted in the study by Akoh [30]. Akoh quotes 1- and 2-year cumulative graft patency rates of 50–90% and 50–82%, respectively. This may have implications for further studies to investigate the use of AAPL as a potential alternative before the use of a Central venous catheter (CVC). Given the satisfactory patency rates of AAPL and the high risk of infection and complications from venous access in the lower limb [31], the authors note that future registry-based studies to compare AAPL with prosthetic grafts in the lower limb extremity and/or CVC as a permanent access (as no suitable alternative access site is present) might be the way forward. In three [32–34] of the five studies which quoted the secondary patency rates, surveillance using a duplex scan was carried out every 3 months, and only one study carried surveillance every 6 months [35]. Given these satisfactory results, the use of a 3-monthly duplex may be one of the reasons for these results. However, a 6 monthly scan in the study by Zanow *et al.* [35] produced the same satisfactory outcomes even up to 3 years of follow-up. However, information collected during surveillance was not in agreement with all the studies. Apart from clinical and duplex examination, studies checked urea reduction percentage ratio [32,35], whereas Zanow *et al.* [35] checked the Kt/V ratio as well.

Regarding complications that occurred since construction of AAPL till 1 year of using it, they were seen in six (30.0%) patients only, and more than one complication in the same patient. Only one (5%) patient showed hand ischemia and another one (5%) neuropathy, two (10%) cases had infection, and hematoma and seroma formation were found in three (15%) cases. The incidence of complications was comparable with the percentage of complications in the study by Khafagy *et al.* [26]. In the study by Fareed and colleagues done at Faculty of Medicine, Menoufia University, postoperative complications encountered were thrombosis, infection and bleeding, or hematomas occurred in 46.7, 20, and 13.3% of patients, respectively. This difference in complication incidence may be because of the longer time of patients follow up in the study by Fareed and colleagues (4 years) compared with our study in which follow-up period was 1 year to detect the early (short-term) outcome of AAPL.

## Conclusion and recommendations

In selected cases and with proper indication, we can offer AAPL as an efficient alternative for vascular hemodialysis access which can improve the survival rate of such patients. Axillary-axillary loop could be recommended as a "last resort" access for selected patients. We recommend to do further studies with longer duration of follow up and with larger numbers of patients.

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Nil.

### Conflicts of interest

There are no conflcits of interest.

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