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Original Article.

**Assessment of Early Cannulation Arteriovenous Graft
in Hemodialysis Patients**

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ABSTRACT

Background: Patients receiving hemodialysis (HD) who have inappropriate superficial veins often require arteriovenous grafts (AVGs). Standard arteriovenous grafts (sAVGs) still need to be cannulated for the first time approximately two weeks following implantation. To address this limitation, early cannulation arteriovenous grafts (eAVGs) were proposed.

Aim: To assess the clinical outcomes of acuseal arteriovenous graft in Egyptian patients with chronic kidney disease. **Methods:** This prospective cohort study was conducted at Zagazig University Hospitals. Patients who were newly diagnosed with chronic kidney disease and indicated for renal replacement therapy on a regular basis, along with age and gender matched patients with ESRD and having standard arteriovenous shunt were included in the study. Patients were followed up at 1, 2, 4 and 6 weeks then monthly till completion of 6 month after AVG insertion, or AVG dysfunction. **Results:** The mean time of first cannulation was 3.7 days, and primary patency was found in 66.7% (20) cases at 6 months, primary assisted patency was recorded in 70% (21) cases at 6 months and secondary patency were 73.3% (22) of cases after 6 months. Access problems such as hematoma was 10% (3), graft site infection 6.7% (2) pseudoaneurysm 6.7% (2), and venous hypertension 13.3% (4). No grafts were removed because of graft-site infection

Conclusion: Early cannulation arteriovenous graft is a viable and suitable option for patients with compromised vascular anatomy, as well as those requiring immediate vascular access. The findings indicate favorable patency rates and minimal complication rates.

Keywords: Early cannulation; arteriovenous graft; hemodialysis

INTRODUCTION

Diabetic kidney disease (CKD) is a rapidly developing worldwide public health concern. The illness is a part of a new epidemic of chronic ailments that emerged in the 20th century and took the place of infection and hunger as the main causes of death. Over the past 23 years, there has been an increase in age-standardized death rates from CKD [1].

Over the next ten years, the high rate of cardiovascular death and morbidity linked to CKD, as well as the global rise in CKD and kidney failure requiring renal replacement treatment, are expected to approach pandemic proportions [2].

Patients receiving hemodialysis have different health outcomes depending on the type of vascular access they have. As to the guidelines released by many professional associations and societies, patients

undergoing hemodialysis should prioritize arteriovenous fistulas (AVFs) above arteriovenous grafts (AVGs), with central venous catheters (CVCs) being the last alternative[3].

Because it takes 7-8 weeks from the establishment of the access to the first cannulation, AVFs are not appropriate for individuals with inferior vascular problems or those who need vascular access immediately [4].

For patients who are ill-suited to develop an ART or for whom AVF construction proves to be unsuccessful on multiple occasions, AVGs provide an alternative. The most popular graft for hemodialysis is expanded polytetrafluoroethylene (ePTFE), while heparin-bonded ePTFE (HB-ePTFE) graft is also occasionally utilized in clinical settings [5].

In order to prevent severe bleeding and hematoma formation after puncturing, these two types of standard arteriovenous grafts (SAVGs) require at least two weeks for the surrounding fibrous tissue to adhere to the surface of the grafts after implantation [6].

One of the earliest cannulations of an arteriovenous graft (AAVG) has become available recently. AAVG is a tri-layer graft made up of an outside layer of ePTFE, a middle elastomeric layer, and an interior layer of ePTFE bound with heparin. Good elasticity and toughness are provided by the central elastomeric membrane to AAVGs, which can help with hemostasis and lessen blood loss following puncture [4].

Clinical research suggests that within a few months, the inner layer of AAVGs can begin to exhibit a consistent anticoagulant effect, more closely aligning with the characteristics of optimal early cannulation AVGs. The indication of AAVGs is still unknown, nevertheless, as there is no data comparing the long-term clinical results of AAVGs [7].

METHODS

This prospective cohort study was conducted at Zagazig University Hospitals. An informed

consent was obtained from all participation. Approval was taken from Local ethical committee of Faculty of Medicine, Zagazig University and the study was conducted according to Helsinki Declaration.

Patients who were newly diagnosed with chronic kidney disease and indicated for renal replacement therapy on a regular basis, along with age and gender matched patients with ESRD and having standard arteriovenous shunt were included in the study.

Pediatric patients, patients with moderate to severe central venous stenosis, patients with moderate to severe central venous stenosis and patients who were on central venous catheters were excluded from the study.

Each patient was subjected to the detailed medical history including age, gender, comorbidities (high blood pressure, diabetes mellitus), unique medically significant behaviors (tobacco use), body mass index, and vascular access history (past AVF, AVG, and CVC usage, as well as intervals of past CVC use) and vascular access history (prior access, patient with or needing CVL). They underwent general examination including vital signs, lower limb edema, and signs of volume overload and local examination of the site of graft and patency.

Clinical outcomes:

Thrombosis, infections, fatalities, and abandonment of AVG due to whatever reason. All patients were assessed for timing of first cannulation, incidence of venous hypertension, graft site infection, pseudoaneurysm, hematoma and any cause of AVG dysfunction.

Follow up:

Patients were followed up at 1, 2, 4 and 6 weeks then monthly till completion of 6 month after AVG insertion, or AVG dysfunction.

Patency

The time interval between the installation of the access and any intervention intended to preserve or restore patency, access thrombosis, or the patency measurement was

referred to as primary patency. Primary aided patency, which includes intervening manipulations (surgical or endovascular procedures) intended to preserve the functionality of a patent access, was defined as the period of time from the time of access placement to access thrombosis or the time of measurement of patency. The time interval between the installation of the access and access abandonment, thrombosis, or the measurement of patency, including intervening treatments (endovascular or surgical) intended to restore functionality in thrombosed access, was referred to as secondary patency. Primary patency is the period of time between the installation of the access and any action intended to preserve or restore it, access thrombosis, or the patency measurement time. Primary assisted patency refers to the period of time between the insertion of an access and the development of an access thrombosis or the measurement of patency, which may include intervening procedures (endovascular or surgical) intended to preserve the patency of the access. Secondary patency refers to the period of time between the implantation of an access and its abandonment, thrombosis, or the measurement of patency, which may include intervening procedures (endovascular or surgical) intended to restore function to a thrombosed access.

STATISCAL ANALYSIS

The statistical analysis was carried out utilizing SPSS 22nd version. After normality testing, means were compared using the

student T test, and continuous variables were given as mean \pm standard deviation. Using the Cox hazard proportional test, AVG patency was evaluated and displayed on Kaplan Meier curves. A p-value of less than 0.05 was deemed significant.

RESULTS

In present study, the mean age was 47.9 years and male represented 60% (18) of participants, and hypertension was the most frequent co-morbidity 83.3% (25) (**Table 1**). We found 66.7% (20) of cases had history of prior access and 86.7% (26) were straight graft configuration of the upper arm (**Table 2**).

The mean time of first cannulation was 3.7 days, and primary patency was found in 66.7% (20) cases at 6 months, primary assisted patency was recorded in 70% (21) cases at 6 months and secondary patency were 73.3% (22) of cases after 6 months (**Table 3**). Access problems such as hematoma was 10% (3), graft site infection 6.7% (2) pseudoaneurysm 6.7% (2), and venous hypertension 13.3% (4). No grafts were removed because of graft-site infection (**Table 4**).

Figure (1) shows primary patency is 66.7% (20) cases at 6 months. **Figure (2)** shows primary assisted patency is 70% (21) cases at 6 months. **Figure (3)** shows secondary patency is 73.3% (22) cases after 6 months.

Table 1 : Bassline Characteristics

		Mean	SD
Age (Years)		49.9	10.8
		N	%
Sex	Female	12	40
	Male	18	60
DM		14	46.7
HTN		25	83.3
Smoking		9	30
		Mean	SD
BMI (Kg/m ²)		24.97	3.045

Table 2: Graft Properties

		N	%
Prior Access		20	66.7
Patient with or needing CVL		7	23.3
Graft Configuration	Straight	26	86.7
	Loop	4	13.3

Table 3: Clinical Outcome

		Mean	SD
Time of First cannulation (Days)		3.7	1.7
		N	%
Primary Patency		20	66.7
Primary assisted Patency		21	70
Secondary patency		22	73.3

Table 4: Post operative complications

		N	%
Venous hypertension		4	13.3
Systemic bacteremia		3	10
Pseudoaneurysm		2	6.7
Graft site infection		2	6.7
Hematoma		3	10

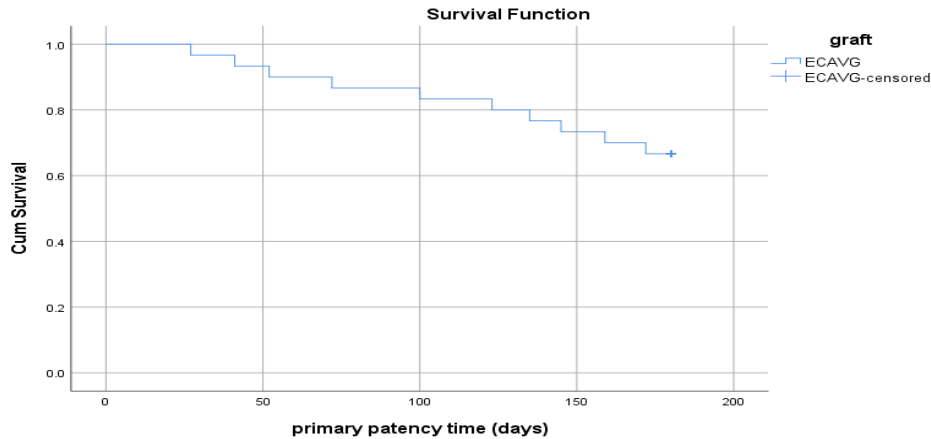


Figure 1: Survival Analysis (primary patency) with Kaplan Meier

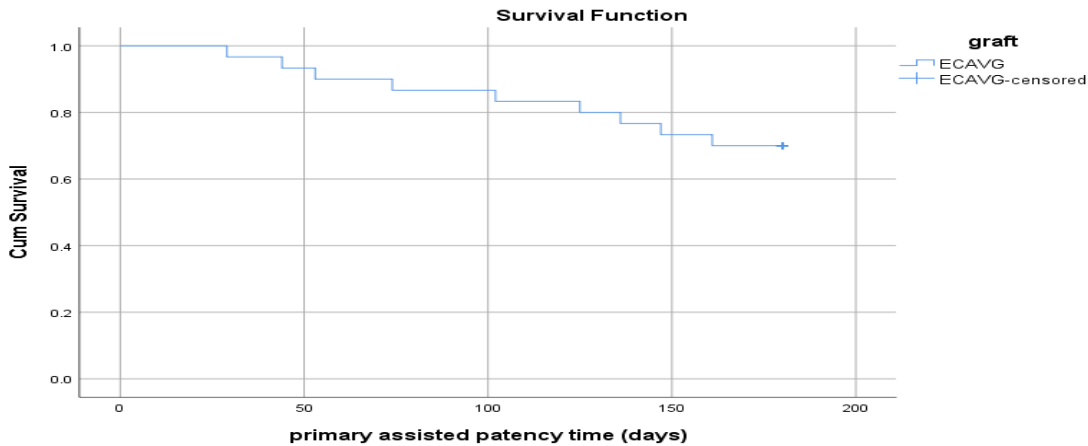


Figure 2: Survival Analysis (primary assisted patency) with Kaplan Meier.

DISCUSSION

Dialysis (PD), hemodialysis (HD), or kidney transplantation are forms of renal replacement therapy that are necessary for patients with acute renal failure or end-stage renal disease [8].

An autogenous anastomosis between an artery and a vein is known as an AVF, while a VA that uses a prosthetic graft is known as an AVG. Interventional radiologists and vascular surgeons made an effort to define the language surrounding HD access at the start of this millennium[9].

VA professionals are still debating these definitions and have changed some of them and made further improvements. However, the definitions that are thought to be now acknowledged by the majority of clinicians

are listed below: Primary VA: Establishing the first-ever operational VA. Secondary VA: After a primary VA fails, ordinary VA creation with AVF or AVG at any site (tertiary VA excluded). Tertiary VA: VA that translocates to the arm or leg via the femoral vein (FV) or great saphenous vein (GSV). This category includes unusual VA operations including upper or lower limb arterio-arterial loops [10].

When treating individuals with end-stage renal disease (ESRD), the first course of care frequently to prepare for dialysis begins with a tunneled dialysis catheter (TDC). This is mostly because a sustained surgical intervention is involved for the creation of an arterio-venous fistula (AVF) or arterio-venous graft (AVG). However, an AVF takes time to

mature before it can be effectively used for hemodialysis, which often leads to dependence on TDCs. The incidence of TDC placement ranges from 75% to 80% and becomes pertinent in cases of delays in referral, noncompliance, or inability to ascertain timely intervention. Reliance on TDCs in patients with ESRD for dialysis is often associated with complications due to infections with high rates of morbidity and mortality. It has been reported that patients who use a TDC for dialysis have a sevenfold risk of infection, emphasizing the need for an AVG that can be cannulated earlier to reduce or avoid dependence on a TDC for dialysis. The FDA-cleared GORE® ACUSEAL Vascular Graft is designed to be cannulated within 24 hours of implantation and represents a promising option to overcome the TDC challenges [6].

By lowering the prevalence and duration of TDCs, the GORE ACUSEAL Vascular Graft has had an economic impact on both practice and the health care system by decreasing hospitalization rates from catheter-related bacteremia, sepsis, and need for long-term antibiotics for the treatment of these catheter-related events. The benefits are also felt at the dialysis units with lower catheter rates and decreased use of antibiotics. Reimbursement rates are positively impacted by decreased TDC prevalence at outpatient dialysis units and home dialysis programs. Furthermore, reimbursement rates are potentially increased if patients have fewer days with a TDC [11].

Our study mean age of patients was 49.9 ± 10.8 , (12) were female and (18) were male. **Tawfik et al. [12]** stated that mean age was 48.6 ± 14.0 , (129) were male and (112) were female. **Wagner et al. [13]** stated that mean age was 60.7, (34) were male and (28) were female. **He et al. [7]** stated that mean age was 61.2 ± 13.4 , (63) were male and (80) were female.

Our study according to number of patients with DM, HTN and smoking revealed that DM was 14 (46.7%), HTN was 25 (83.3%) and smoking was 9 (30%). **Tawfik et al. [12]** showed that patients with DM were 104 (43.2%), HTN 234 (97.1%) and smoking

94 (39.0%). **Wagner et al. [13]** showed that patients with DM were 24 (63.2%), HTN 56 (91.8%) and smoking 10 (16.3%). **He et al. [7]** showed that patients with DM were 54 (37.8%), HTN 116 (81.1%) and 24 (16.8%).

Our study revealed that mean BMI was 24.97 ± 3.045 . **Tawfik et al. [12]** showed that mean BMI was 22.1 ± 2.3 . **Wagner et al. [13]** showed that median BMI 27.9 (15.0-51.9). **He et al. [7]** showed that median BMI 22.5 (20.0-25.0).

Our study revealed that according to number of patients with prior access were 20 (66.7%), with or needing CVL were 7 (23.3%), graft configuration were (Straight) 26 (86.7%) & (Loop) 4 (13.3%) and mean time of first cannulation (Days) was 3.7 ± 1.7 .

Tawfik et al. [12] revealed that according to number of patients with prior access were 189 (78.4), with or needing CVL were 56 (23.2), graft configuration were (Straight) 210 (87.1) & (Loop) 31 (12.9) and median time of first cannulation (Days) was 3.0 (1.0-9.0). **Wagner et al. [13]** revealed that median of patients with prior access were 1.71 (0-6) and number of graft configuration were (Straight) 37 (63.8%) & (Loop) 21 (36.2%) and median time of first cannulation (Days) was 6.0 (1.0-19.0). **He et al. [7]** revealed that according to number of patients with prior access were 55 (38.5%), with or needing CVL were 112 (78.3%), graft configuration were 35 (24.5%) and median time of first cannulation (Days) was 3 (1-15).

Our study revealed that primary patency was found in 66.7% (20) cases at 6 months, primary assisted patency was recorded in 70% (21) cases at 6 months and secondary patency were 73.3% (22) of cases after 6 months.

Tawfik et al. [12] revealed that primary patency was found in 164 (68.0%) cases at 6 months, primary assisted patency was recorded in 168 (69.7%) cases at 6 months and secondary patency were 178 (73.9%) of cases after 6 months.

Wagner et al. [13] revealed that Primary patency was at 1 year 56.7% & at 18 months was 43.7% and Secondary patency was at 1 year 52.1% & at 18 months 46.3%. **He et al. [7]** revealed that primary patency was found in 51.1% cases at 12 months, primary assisted patency was recorded in 57.7% cases at 12 months and secondary patency were 70.4% of cases after 12 months.

Our study revealed that number of patients with hematoma was 10% (3), graft site infection 6.7% (2) pseudoaneurysm 6.7% (2), and venous hypertension 13.3% (4) and systemic bacteremia (3) 10%.

Tawfik et al. [12] revealed that number of patients with hematoma was 22 (9.1%), graft site infection 11 (4.6%), pseudoaneurysm 14 (5.8%), and venous hypertension 13 (5.4) and systemic bacteremia 27 (11.2%). **Glickman et al** revealed that number of patients with hematoma was 6 (4%), graft site infection 15 (11%) pseudoaneurysm was 0. **He et al. [7]** revealed that number of patients with thrombosis was 49 (34.3%), infection 7 (4.9%) and any cause of death 20 (13.4%).

Conclusion:

This study provides evidence that early cannulation arteriovenous graft is a viable and suitable option for patients with compromised vascular anatomy, as well as those requiring immediate vascular access. The findings indicate favorable patency rates and minimal complication rates.

Conflicts of interest: None

Financial disclosures: None

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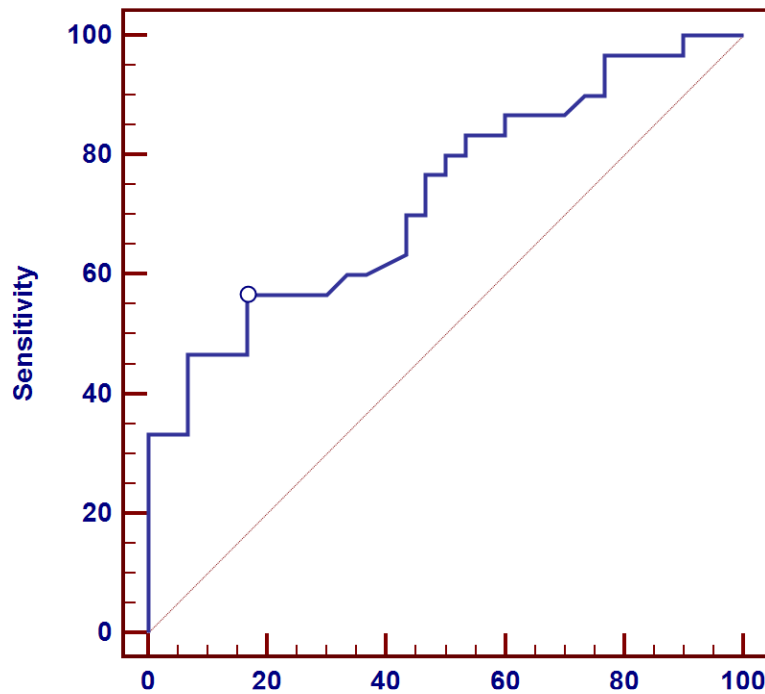


Figure S1: Receiver operating characteristic curve (ROC) between patients’ group and control group regarding adropin in hemodialysis patients

Table S1: Multiple linear regression model of independent predictors for serum adropin levels

Predictors	B	p-value	OR	95% CI	
				Lower limit	Upper limit
Cholesterol mg/dl	- 0.161	0.026*	0.851	0.739	0.981
HDL (mg/dl)	- 0.323	0.043*	0.724	0.529	0.990
Age	- 0.035	0.891	0.965	0.584	1.596
BMI	1.839	0.047*	6.290	0.944	41.895
CRP	0.019	0.067	1.019	0.999	1.041

B: Binary regression analysis OR: Odd ratio

HDL: high density lipoprotein, BMI: Body mass index, CRP: C reactive protein

Citation:

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