Comparative study between Tunneled central venous catheter and Infraclavicular Arterio-arterial Prosthetic loop as an access for Hemodialysis in End stage renal disease (ESRD)

Hussein Ali Mustafa Abdel-Motaleb, Mohammed Ahmed Mohammed Ismail, Islam Mohamed Nabil Atta & Ahmed Mohammed Ahmed Abdel-Rahim*
Department of vascular surgery, Faculty of Medicine- Aswan University

ABSTRACT

Context: *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 and the permanent catheters was presented in this study.* ***Objective:*** *The aim of this work is to compare between the tunneled central venous catheter and the Arterio- arterial prosthetic loop (AAPL) as an access for dialysis in ESRD for whom the conventional Arterio-venous fistula is contraindicated or have no chance for the conventional methods of hemodialysis. The end point of comparison will be: reliability, safety, patency, cardiac function, postoperative flow rate, morbidity and mortality.* ***Methodology:*** *Prospective randomized comparative study had been conducted at vascular surgery department in Aswan university hospital on 40 patients with chronic renal failure in need for vascular access admitted. Patients are divided randomly into two groups: Group A: Includes 20 patients who had undergone Permanent catheter insertion. Group B: Includes 20 patients who had undergone Infraclavicular Arterio- arterial prosthetic loop.* ***Results:*** *Our findings regarding the permcath as permanent vascular access for hemodialysis ,the study group included 20 patient with survival rate 70 %,primary and secondary patency rates at 1 year was 70% and 80% respectively and the main complications encountered in the study were Thrombosis(30%), Infection (10%), Bacteremia(25%),Infective endocarditis (5%),Heart failure exacerbation(10%) and Exit site external bleeding (5%) and Taking into account that 85% of the patients were comfortable in having dialysis through the access. While regarding the Arterio-arterial group, the study included 20 patients with survival rate of 90%, primary and secondary patency rates at 1 year was 95% and the main complications encountered in the study were Thrombosis (10%), Infection (5%) and Hematoma formation (10%) and taking into account that only 55% of patients were comfortable with access and showed good compliance.* ***Conclusion:*** *all arteriovenous fistula/grafts options should be exhausted before hemodialysis is carried out via central venous catheters (CVC) or AALG. CVCs carry high morbidity and mortality risks than an Arterio-arterial prosthetic loop (AAPL) but patients showed better compliance to the access than the AAPL. So CVCs is indicated in patients having no chance for conventional vascular access after AAPL.*

Keywords: *ESRD, Tunneled central venous catheter, Infraclavicular Arterio-arterial Prosthetic loop*

INTRODUCTION

End-stage renal disease (ESRD) is a huge public health problem with significant morbidity, mortality, and cost. Establishing and maintaining hemodialysis access is a cornerstone of long term renal replacement therapy. As hemodialysis techniques have improved sufficiently to allow the survival of patients as long as dialysis access can be maintained so it is justified to say that vascular accesses an access to life [(1)].

The main types of vascular access can be summarized as, The autogenous Arterio- venous fistula (AVF), The Arterio-venous graft (AVG), The double lumen catheter and Arterio-arterial Angioaccess as an alternative pathway [(2)].

Guidelines suggest that the upper extremity should be used as a site for primary access due to lower complications incidence starting distally and preserving proximal vessels for future access if the first one failed, starting with the non-dominant hand if the chances are equal in both

*Corresponding author: Ahmed Mohammed Ahmed Abdel-Rahim; Mobile: (+20)01145947294

limbs. When all the trials have been failed one may try to implant vascular graft as an access [3].

The double lumen catheters are of two types either tunneled or non-tunneled. The non-tunneled central vein catheters (CVCs) are insignificant, as they are only used as temporary access[1].

TDC are provided with a polyester cuff favoring tissue in-growth for fixation of the catheter into the subcutaneous tunnel. TC can be either placed de novo or in exchange for a non-tunneled catheter using the same insertion site without increased risk of infection [4].

However, in some patients in addition to absence of accessible superficial veins ,there is central venous stenosis or obstruction or there is cardiac dysfunction and patient cannot tolerate additional cardiac load of a high flow AV graft, these patients need an alternative vascular access other than the conventional accesses and it is the Arterio-arterial loop access [5].

An artery as a permanent vascular access for hemodialysis is not a new procedure. Butt and Kountz reported that a femoro-popliteal jump graft using a bovine carotid artery as vascular access showed a stable and satisfactory result. Giacchino et al also reported Arterio-arterial (AA) jump graft in the upper extremity was a satisfactory hemodialysis access. In 2005, Bunger et al performed axillary-axillary inter-arterial chest loop conduit as an alternative for chronic hemodialysis access. Therefore, it is believed that the AA loops may be established when there is no alternative for AV loop [6].

METHODS AND MATERIALS

Forty patients with chronic renal failure in need for vascular access admitted to vascular surgery department in Aswan university hospital and divided randomly into two groups; Group A: Includes 20 patients who had undergone Permanent catheter insertion and Group B: Includes 20 patients who had undergone Infraclavicular Arterio- arterial prosthetic loop. Written informed consent was taken from all patients before the procedure. The committee of human research approved the study. All patients were initially assessed in our vascular unit. It was essential to use duplex scanning of arteries and veins to define adequacy of arteries and patency of veins. And echo-cardiography to assess cardiac function.

Inclusion criteria were patients with heart failure refractory to therapy. Exhausted upper limb chances for conventional arteriovenous fistula.Central venous system stenosis ((<70% in diameter, >4 cm long) or occlusion for AAPL group

Exclusion criteria were patients Havng a chance for autogenous upper limb AV fistula, patients having widespread infection of the upper limb. Patients with Stenotic arterial inflow or outflow in AAPL group and patients with Past History of upper limb ischemia in AAPL group.

a. For group A :

We used tunnelled cuffed CVCs (Medcomp Ash Split Cath, 14 FR_28 cm with Dacron cuff). The catheters are 28 cm length and 5.9mm_3.3mm external diameter. Each CVC has two parallel lumens. The lumen's internal diameter is 2 mm.The proximal lumen has 1.3, distal lumen 1.4mL priming volume. The proximal lumen ends 2.5 cm from the tip point of catheters. The outside of body, the catheters consist of two channel, ending in color-coded luer locks; red for arterial and blue for venous.

Two grams of 3rd generation cephalosporin antibiotic were administered preoperatively. All of catheters were inserted with the aid of fluoroscopy in operation room. Local anesthesia was used during process. Right internal jugular vein was generally chosen as a first preference for catheter insertion.

Hemodialysis nurses were trained to use CVCs and only trained nurses, utilising sterile gloves and povidone iodine disinfection, opened CVCs. And after each hemodialysis session, first CVCs were flushed with sterile saline solution and then were locked with using pure heparin (arterial lumen: 1.3mL and venous lumen: 1.4 mL).

b. For group B :

All procedures were performed under general anesthesia. Two grams of 3rd generation cephalosporin antibiotic were 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. 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 40 cm. The mean operation time was 102 minutes. Low molecular weight heparin therapeutic dose was administered once a day for five days then was replaced by double antiplatelet (aspirin75mg and clopidogrel 75 mg) for lifelong. The first needle puncture of the graft was carried out not before two weeks after the procedure 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 rein fused blood, pump power about 250-280 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 (intra-arterial 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 twice monthly for the first two months and then once for the rest of the year. 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 Results:

The collected data was revised, coded, and introduced to a PC using Statistical package for Social Science **(SPSS 25).**

Definitions: For Descriptive analysis*:* (Mean and Standard deviation (SD)) were used for parametric numerical data, while Median and Interquartile range (IQR) for non- parametric numerical data and (Frequency and percentage) were used for non-numerical data.

For Comparative analysis:

1. **Student T-test** was used to assess the statistical significance of the difference between two study group means.
2. **Mann Whitney** Test (U test) was used to assess the statistical significance of the difference of a non-parametric variable between two study groups.
3. **Chi-Square test** was used to examine the relationship between two categorical variables.
4. **Fisher's exact test** was used to examine the relationship between two categorical variables when the expected count is less than 5 in more than 20% of cells.

P- value: level of significance: P>0.05: Non significant (NS) and P< 0.05: Significant (S).

RESULTS

Forty patients (22 females and 18 males) with a mean age of 60.23 ± 9.84 had participated in this study and divided randomly into two groups group(A) had the permcath as vascular access and group (B) had AAPL in the period from June 2017 to Jan 2019.Comorbid conditions included Diabetes mellitus (62.5%), HTN (55%), Hyperlipidemia (57.5%) and smoking (37.5%). Comparative analysis of the demographic data and risk factors as shown in table (1) showed no significant result.

Table (1): Demographic data and Co-morbidity of the two groups

		Group		Chi-Square test	
		Permcath	**Arterio-Arterial**		
		Mean ± SD N (%)	**Mean ± SD N (%)**	**P-Value**	**Sig.**
Age		61.85 ± 10.48	58.6 ± 9.13	0.302(T)	NS
Sex	Female	13 (65%)	9 (45%)	0.204	NS
	Male	7 (35%)	11 (55%)		
Diabetic		12 (60%)	13 (65%)	0.744	NS
HTN		12 (60%)	10 (50%)	0.525	NS
IHD coronary artery disease		6 (30%)	7 (35%)	0.736	NS
Hyperlipidemia		12 (60%)	11 (55%)	0.749	NS
Smoking		5 (25%)	10 (50%)	0.102	NS
Pre-dialysis Hypotension		4 (20%)	8 (40%)	0.168	NS

❖ ***Indications of surgery of the two groups:***

Table (2): Indications of surgery of the permcath and Arterio-arterial groups

		Group		Fisher's Exact test	
		Permcath	**Arterio-Arterial**		
		N (%)	**N (%)**	**P-Value**	**Sig.**
Indication for surgery	No accessible superficial veins	20 (100%)	12 (60%)	<0.001	S
	Total thrombosis of bilateral central veins	0 (0%)	9 (45%)		
	Decompensated heart failure	3 (15%)	5 (25%)		
	More than one indication of the previous three	7(35%)	9 (45%)	0.519(C)	NS

Comparing the two groups regarding the indication of surgery showed significant result as patients with total thrombosis of the central veins are excluded from group A while any other patient was randomly included so we had 45% of patients in group B with total thrombosis in central veins.

Postoperative complications of the two groups:

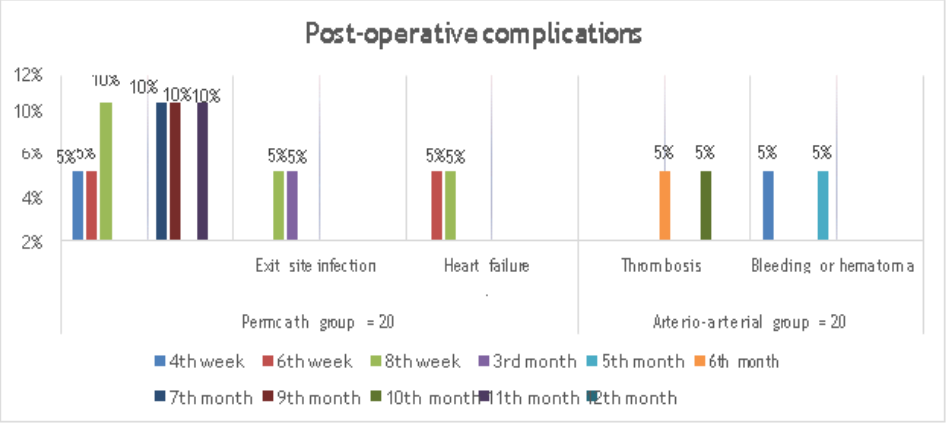

Fig. (1): Post-operative complications of the permcath and the Arterio-arterial groups (Analytic description)

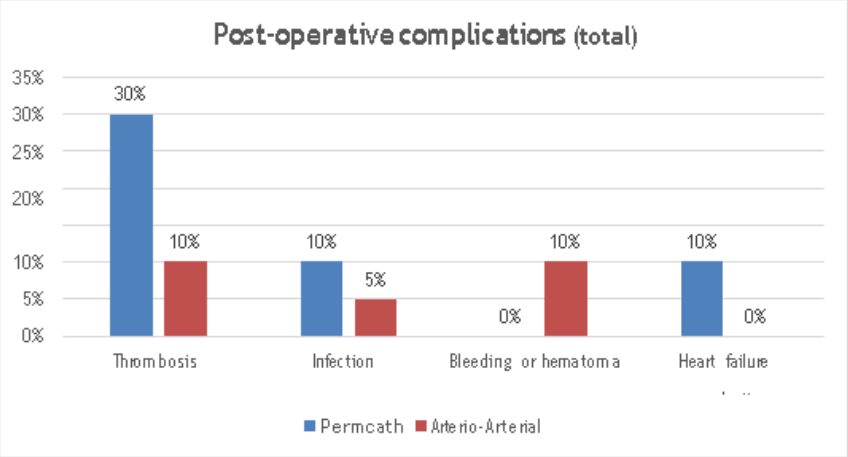

Fig. (2): Post-operative complications of the permcath and the Arterio-arterial groups (Total description)

☐ ***So comparing the two groups according to incidence of complications:***

1. Thrombosis: 6 (30%) patients of group A were Thrombosed at 4th,6th ,8th week, 7th months compared to 2(10%) patients Thrombosed in group B at 6th and 10th month.
2. Infection: Patients in group A had 10% (2 patients) infection rate at the exit site of the permcath at the 8th week and the 3rd month compared to 5% incidence in the patients of group B.
3. Heart failure exacerbation: follow up of the cardiac functions and valve lesions using the echo cardiograph revealed that 10% (2 patients) of patients in group A had progressive ***decrease in cardiac function with exaggeration of the symptoms of Ht failure compared to 0% of the patients in group B.***
4. External bleeding or hematoma formation: 10% (2 patients) of the patients in group B had hematoma formed postoperatively at 4th week and 5th month compared to 0% incidence in group A.

Survival rate:

Table (3): Survival rate of the permcath and Arterio-arterial groups

	Permcath =20		**Arterio-Arterial =20**		**Fisher's Exact test**	
	At 6th Month	**At 1st year**	**At 6th Month**	**At 1st year**		
	N (%)	N (%)	N (%)	N (%)	P-Value	Sig.
Death	3 (15%)	3 (15%)	0 (0%)	2 (10%)	0.464	NS
Survival rate	14 (70%)		18 (90%)		0.235	NS

Comparing the total survival rate of the two groups showed 70 % in group A to 18% in group B with no significant value.

Pump flow rate and Patient Comfort ability with the access :

Table (4): Pump flow rate and patient comfort ability to access between Permcath and Arterio- arterial groups.

		Group		Fisher's Exact test	
		Permcath	**Arterio-Arterial**		
		Mean ± SD N (%)	**Mean ± SD N (%)**	**P-Value**	**Sig.**
Pump flow rate post-surgery		300 ± 0	266 ± 12.73	<0.001[(T)]	S
Patient comfortability with the access	Not Comfortable	3 (15%)	9 (45%)	0.038[(C)]	S
	Comfortable	17 (85%)	11 (55%)		

[(T)] Student t-test of significance.
[(C)] Chi-Square test of significance.

Group A patients had pump flow rate of 300ml/min while group B patients had pump flow rate of 250-280 ml/min with a mean of 266 ± 12.73 which is a significant result as it affects the time of the dialysis session and reflected on comfotrability of the patient on the session as shown in table 7. As shown in the figure 85% of group A are comfortable with the access while only 55% of group B are comfortable.

Dialysis schedule pre and post-surgery:

Table (5): Dialysis schedule pre and post-surgery between Permcath and Arterio-arterial groups.

	Dialysis schedule prior to surgery		**Dialysis schedule post-surgery**			
	3 times per week 3hrs each	**2 times per week 3.5hrs each**	**3 times per week 3hrs each**	**2 times per week 3.5hrs each**	**3 times per week 4hrs each**	**2 times per week 4.5hrs each**
Permcath	13 (65%)	7 (35%)	13 (65%)	7 (35%)	0 (0%)	0 (0%)
Arterio-Arterial	18 (90%)	2 (10%)	0 (0%)	0 (0%)	14 (70%)	6 (30%)
P-Value	0.127[(F)]		<0.001[(F)]			
Sig.	NS		S			

[(F)] Fisher's Exact test of significance.

Dialysis schedule post-surgery did not affected in group A as the pump flow rate did not changed as previously shown in table 18 while that of group B was affected and so there was an increase in time of dialysis session which had a significant result.

Patency rate:

Table (6): Patency rate between Permcath and Arterio-arterial groups.

	1ry patency		**2ry patency**	
	At 6 months	**At 1 year**	**At 6 months**	**At 1 year**
Permcath = 6	16 (80.0%)	14 (70%)	19 (95%)	16 (80%)
Artero-arterial = 2	19 (95%)	19 (95%)	20 (100%)	19 (95%)

At six months duration, the primary patency rate and the secondary patency rate of group A were 80% and 95% respectively while that of group B were 95% and 100% respectively. At 12 months duration , the primary patency rate and secondary patency rate of group A were 70% and 80% respectively while that of group B were 95% and 95% respectively.

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 [(7)].

Although life-sustaining, hemodialysis is marked by persistently high mortality, morbidity, and health care use. Worldwide, over 1.5 million persons are treated with hemodialysis, and 10%–25% of them die each year[(8)].

Performance of a successful hemodialysis procedure requires a functional vascular access. Unfortunately, hemodialysis vascular access dysfunction is one of the most important causes of morbidity in the hemodialysis population[(9)].

Studies over several decades consistently demonstrate that native fistula accesses have the best four- to five-year patency rates and require the fewest interventions compared with other access types[(10)]. Patients should ideally have native fistulas followed by prosthetic grafts if fistula placement is not possible[(11)].

All Arterio-venous fistula (AVF) options should be exhausted before hemodialysis is carried out via a central venous catheter (CVC). In some cases, the lack of suitable vessels for AVF and in some others due to complications of these fistulae, such as, thrombosis or bleeding, it is impossible to do dialysis through the fistulae. In such a clinical setting long-term central venous catheters are used for hemodialysis. Permcath made from softer material, which leads to less endothelial damage, and therefore, will be less associated with the possibility of thrombosis [(12, 13)].

What is important about using these catheters is the limited number of available sites that have a possibility of inserting them. As it has been mentioned previously in the guidelines, the best location for placement of these catheters is the internal jugular vein. If using the right internal jugular vein is not possible due to thrombosis, the second choice will be using the internal jugular vein of the opposite side. Subsequently, thrombosis of the left internal jugular vein can lead to the inability of establishing further AV fistulae or grafts. CVCs carry high morbidity and mortality risks and in some patients, the

central veins could be exhausted. In these patients, an Arterio-arterial prosthetic loop (AAPL) or straight graft can be the only option for hemodialysis[(13)].

In Cetinkaya et al.[(14)], a prospective study of the survival,complications and failure rates of 92 CVCs on 85 (50 females, 35 males) chronic hemodialysis patients (the mean age:

56.6 ± 14.1 years), compared to group A of our study 20 (13 females, 7 males) patients (the mean age: 61.85 ± 10.48. CVCs were inserted in patients in whom other VA modalities were unavailable or had been multiple failed attempts of creating PVA and ones with advanced congestive heart failure or malignancies which are the same indications of permcath insertion in our study.

In Cetinkaya et al.[(14)] study, Twenty- five (29.4%) patients were diabetic compared to twelve (60%) patients in our study and that difference may be because all our patients ages above 45 years old compared to 43 (50.5%) patients were older than 60 years and 11 (12.9%) patients were younger than 40 years. CVCs were used, as a first PVA, in 48 (56.4%) patients compared to only one patient in our study and the 19 patients had previous access trials with a median (IQR) of 4(2-4.5) and prior central vein cannulation of median (IQR) 4.5(2-6) and that is because of the older age of the majority of our patients and so the longer history with the dialysis and absence of awareness of most of our patients to the necessity of permanent vascular access instead of temporary catheters. Thirty-six (42.3%) patients had a cardiovascular disease compared to 6 (30%) in our study.

In a study evaluating the axillary artery interpositioning graft done in Egypt at Faculty of Medicine- Menoufia University, (60%) were females with mean age 58 ± 13 compared to (45%) females with mean age 58.6 ± 9.13 in Arterio-arterial prosthetic loop group in our study[(15)].

*Corresponding author: Ahmed Mohammed Ahmed Abdel-Rahim; Mobile: (+20)01145947294

In a study done in Egypt by Khafagy et al. [16] and puplished in the Eur J of vascular surgery in 2016, Thirty-five brachial AAPL were created between January2011 and December 2014. The age of patients, with a mean age of 52.8 years. Of the patients, 45.7% were male and 54.3% were female. Comorbidities included diabetes mellitus (54.2%), coronary artery disease (45.7%), hypertension (48.5%), heart failure (8.5%), dyslipidemia, (34.2%), and hypercoagulability (20%) [74].

In Fareed et al.[15], study done at faculty of medicine Menoufia University assessing the axillary artery loop interpositioning graft as vascular access on 15 patients, Post-operative Complications, encountered were Thrombosis, Infection and Bleeding or hematomas occurred in (46.7%), (20%) and (13.3%) of patients

respectively Compared to (10%), (5%) and (10%) in our study respectively. The significant difference in complication incidence may be because of the longer time of patient follow up in Fareed et al (four years).

Zanow et al. [17] reported that if the whole graft becomes infected, it is mandatory to remove the graft and reconstruct the artery, which didn't happen in this study because the tissues were severely infected and friable and not suitable for reconstruction of the artery so the graft was scarified and the artery ligated.No critical limb ischaemia was revealed as patient was observed postoperatively for possible reconstruction after subsiding of infection or doing extra- anatomical bypass.

In **Forauer *et al.*** [18]**,** study internal jugular vein occlusion was diagnosed on sonography in all eight patients. Nine tunneled catheters and one temporary catheter. No periprocedural complications, such as excessive bleeding or hematoma, air embolus, pneumothorax, arrhythmia requiring treatment, or carotid artery puncture, were found. One catheter (12%) was removed as a result of bacteremia and positive blood cultures for gram-positive cocci after 115 days. Compared to our study there were no periprocedural complications and 25% of patients had bacteremia with positive blood cultures and received medical treatment and the catheter was preserved.This difference in result (12%) to 25% in our study may be related to using incomplete aseptic precautions in dealing with the access in our rural patients.

In another study, assessing the incidence of jugular vein thrombosis by Agraharkar et al. [19], 96 patients who were subjected to 144 separate vein insertion episodes has identified

7 patients with what are presumed to be catheter induced vein occlusion. Patients found by Doppler studies out of 15 veins cannulated with permcath, 5 veins had developed a jugular vein thrombosis, an incidence of 33%.

Compared to our study which had 30% Thrombosed CVCs and 15% (3 patients) had the catheters removed with catheter induced vein occlusion.

In the study done at Sina Hospital, Tehran University of Medical Sciences Of 68 patients in the study, infection and thrombosis of the catheter occurred in 4 (6%) and 5 (8%) of the cases. All the infections occurred during the third month, while all the thrombosis occurred during the second month. Thrombosis of the subclavian developed in one patient and manifested with upper extremity edema. While in our study infection and thrombosis occurred in 2 (10%) and 6 (30%) of the cases respectively and the infections occurred in 8th week and 3rd month and the thrombosis occurred in 4th,6th,8th week and the 7th month[20].

In García et al. [21] study, 32 patients were studied and categorized patients into two groups: group I (G I) was made up of patients scheduled to AVF creation and group II (G II) was made up of 15 patients scheduled to placement of a tunneled catheter in the jugular vein. Complications detected in G II: Infection (29.4%), thrombosis (30%), ischemia (33.3%)

and bleeding (25%). Compared to 10%, 30%, 0%, and 0% respectively in our study. The high infection rate in García study may be due to bad manipulations of the nursing staff and bad hygiene of the patients.

In a study done by Beigi et al. [7], evaluating permcath insertion through the external jugular vein , (36%) of patients had the catheter Thrombosed and (14%) were infected compared to (50%) and (10%) respectively in our study.

In Khafagy et al. [16], and Bünger et al. [22], the primary and secondary patency rates at one year were (87.9%) and (90.7%) at Khafagy

respectively And was (61.7%) and (95%) at Bünger CM respectively, compared to (95%) and (95%) in group B in our study.

In the study by Zanow et al.[17], the postoperative flow rate was 284 mL/min compared to 266 ± 12.73 mL/min in group B in our study with 70%, 30% had 12 hours and 9 hours respectively average hours on dialysis machine.

Zanow et al. [17], 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. Fareed et al. [15] had a dialysis flow rate of 300 mL/min, and the painful reperfusion was not observed. In present study, the desired sufficient extracorporeal blood flow was 260- 280 ml/min and painful reperfusion observed above 280 ml/min.

Most of the studies documented survival rate for one-year post-operative period. This ranged from 71% to 93%. (93.3%) in Fareed et al. [15] study Compared to our study which was (90%) in AAPL group[56].

In a study done Beigi et al. [7], study. Survival rate after one-year was (89.8%) compared to (70%) in Permcath group in our study.

Quality of life has rarely been the focus of access studies, which instead tend to use morbidity and mortality as the primary outcomes. However, it is becoming increasingly evident that patients place higher priority on quality of life than on traditional clinical outcomes[23].

In the present study, patient comfortability (compliance) was detected between two study groups. (85 %) of patients were comfortable with permcath, while (55%) with AAPL because of the need of increasing the dialysis session time with the AAPL group to compensate or the decrease in the pump flow rate. Patients with AAPL must have two large bore needles placed and secured in their access thrice weekly or more a process that may be uncomfortable and anxiety provoking.

With time, the development of aneurysms that we have not met in our study may negatively impact body image and self-esteem.

In Afsar et al.[24], Patients with CVC had lower physical functioning (P: 0.044), role-emotional (P: 0.044) and mental health scores (P: 0.04) when compared to patients with AVG.

CONCLUSION

In conclusion, all arteriovenous fistula/grafts options should be exhausted before hemodialysis is carried out via central venous catheters (CVC) or AALG. CVCs carry high morbidity and mortality risks than an Arterio-arterial prosthetic loop (AAPL) but patients showed better compliance to the access than the AAPL. So CVCs is indicated in patients having no chance for conventional vascular access after AAPL.

Recommendations:

According to our study and other studies, we strongly recommend the Arterio-arterial prosthetic loop as an access for hemodialysis over the tunneled central venous catheters in patients having no chance for the conventional vascular access and repeating this study on a large number and scale of patients regarding the same inclusive and exclusive criteria.

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