Pediatric vascular access for hemodialysis: Feasibility and outcome

Original Article

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ABSTRACT

Objective: This study was conducted to evaluate different vascular accesses for hemodialysis in the pediatric age group in our locality as regards feasibility, complications, and outcomes.

Patients and Methods: This was a prospective, descriptive, longitudinal nonrandomized study with an analytical component that was conducted on pediatric patients suffering from chronic renal failure. Patients were divided into two groups according to the clinical evaluation and duplex assessment. Group 1 was submitted to arteriovenous fistula (AVF). This group included 79 cases, while group 2 was submitted to a permanent central venous catheter (CVC). This group included 41 cases.

Results: Primary patency among the studied groups was 88.6% for AVFs and 92.7% for permanent catheters at 3 months (*P=0.4*). At 6 months, 82.3% of AVFs remained patent compared to 85.4% for permanent catheters (*P=0.6*). At 9 months, AVFs had a patency of 79.7%atent versus 70.7% for permanent catheters (*P=0.2*). At 12 months, AVFs had a patency of 78.5% compared to 51.2% for permanent catheters (*P=0.002*). At 18 months, AVFs had a patency of 62% compared with 24.4% for permanent catheters (*P≤0.001*). At 24 months, AVFs had a patency of 54.4%whereas permanent catheters had a patency of 4.9% (*P≤0.001*). There were 22.8% with thrombosis and 0% with infection in AVFs and 34.15% with thrombosis and 26.83% with infection in permanent catheters.

Conclusion: CVCs permit less effective hemodialysis and are accompanied by much higher complications and access failure rates in comparison to AVFs, resulting in earlier consumption of the vascular access reserve in patients facing years of renal replacement therapy. The detected high rate of transient uncuffed CVCs used temporarily in patients with AVF proposes frequent suboptimal vascular access planning in these patients.

Key Words: Arteriovenous fistula, central venous catheters, end-stage renal disease, hemodialysis, vascular access.

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INTRODUCTION

The 2006 report of the United States Renal Data Systems showed that the frequency of end-stage renal disease (ESRD) in pediatric patients (age 0–19 years) had increased from 8.6 cases/million population in 1980 to 14.1 cases/million population in 2004. The arteriovenous fistula (AVF) best fits this definition. Unfortunately, the access used most frequently in children in the USA is the central venous catheter (CVC), unlike an AVF or arteriovenous graft (AVG). Despite the increasing focus on the possible morbidity associated with CVCs, their frequency of use at the beginning of hemodialysis has increased in recent years, with usage rates of 89% for children under 13 years of age and 64% in those aged 13–19 years[1].

Although the Kidney Disease Outcomes Quality Initiative guidelines recommending the selection of AVF as the primary vascular access, and the proof directing to increased morbidity and mortality of cases with CVCs, five studies have revealed that the majority of children still begin hemodialysis through a CVC, as a substitute of AVF or synthetic graft[2].

The first AVF was labeled by Brescia *et al*.[3] in 1966 and later has come to be the best vascular access in both children and adults. This is generally because of its low complication rates and longer survival[4]. In the last years, several studies have been published focusing on the criteria for predicting successful distal radiocephalic fistula creation. These studies show that apart from age, obesity, diabetes, and vascular disease are all common risk factors for vascular access surgery[5].

However, the first choice is assumed to be the nondominant upper extremity, eventually, vessel diameter emerges as the most significant element in location choice. If the location with the biggest likely venous size is selected, there will be a better possibility of effective use of the AVF.

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While specific recommendations regarding minimal vessel diameter do not occur, consensus suggests a favored minimum of 2.5 mm venous size[6].

Better results have been gained with distal radiocephalic fistula creation, as revealed by other studies. Here, the use of preventive hemostasis and microsurgery has resulted in a primary failure rate of between 5 and 10% in pediatric people[5].

Probable advantages of AVF formation consist of inferior thrombosis and stenosis frequency, inferior infection rate, and better freedom with concerns to daily activities. Infection rates for AVFs and synthetic grafts are nearly sevenfold inferior to those for CVCs. Six months after starting hemodialysis, just 5% of children dialyzing through AVFs have settled a vascular access infection, in contrast to 36% of those receiving hemodialysis through CVCs[7].

Drawbacks of AVG usage consist of infection, thrombosis, and stenosis. Ramage and colleagues stated long-standing complications of AVF in contrast to AVG in research directed over 20 years. Interference frequency was described as 17.8% for AVFs and 33% for AVGs. Causes of cessation of AVF use were thrombosis (73%), infection (20%), and scheduled cessation of usage (6.7%)[1].

Thrombosis and infection are the most common obstacles associated with CVCs. Moreover, these complications harm the patient's medical condition and threaten the forthcoming vascular access. Besides, every vascular access has its interval of survival, and every case has a restricted number of places for AVF creation, without more offered locations after prolonged time on hemodialysis is a common problem[8]. So, this study was conducted to evaluate different vascular accesses for hemodialysis in the pediatric age group in our locality as regards feasibility, complications, and outcomes.

PATIENTS AND METHODS:

This was a prospective, descriptive, longitudinal, nonrandomized study with an analytical component that was conducted on pediatric patients suffering from chronic renal failure who attended the Vascular Surgery Department at Mansoura University Hospital between January 2017 and December 2018 and were selected for the creation of vascular access with AVFs and permanent CVC after taking a written and informed consent.

All cases were subjected to careful history taking including age, sex, residence, and age of onset of dialysis duration of renal failure, cause of renal failure, previous access creation, duration of hemodialysis, previous peritoneal dialysis, associated comorbidities. Clinical examination and evaluation for proper selection of the access site were also done. The investigations for those involved included complete blood picture, coagulation profile, liver function tests, and duplex examination for the assessment of arterial and venous diameter and flow.

Patients

Patients were divided into two groups according to the clinical evaluation and duplex assessment. Group 1 was submitted to AVF. This group included 79 cases, according to the site; three cases were radiocephalic AVFs, 35 cases were brachiocephalic AVFs, and 41 cases were brachiobasilic AVFs. A magnifying loupe was used in all cases [a binocular loupe (USA, New York; Optical Technologies), Galilean TTL 3×0 Pro working distance 300–500]. According to the technique; 38 cases had end-to-side, eight cases had end to side one-stage brachiobasilic, 29 cases had end-to-side two-stage brachiobasilic, and four cases had side-to-side.

Group 2 underwent placement of a permanent CVC. This group included 41 cases (14 cases of right internal jugular vein, 14 cases of left internal jugular vein, six cases of right femoral vein, and seven cases of left femoral vein) (Figs 1–3). All procedures were done under sonographic and fluoroscopic guidance.

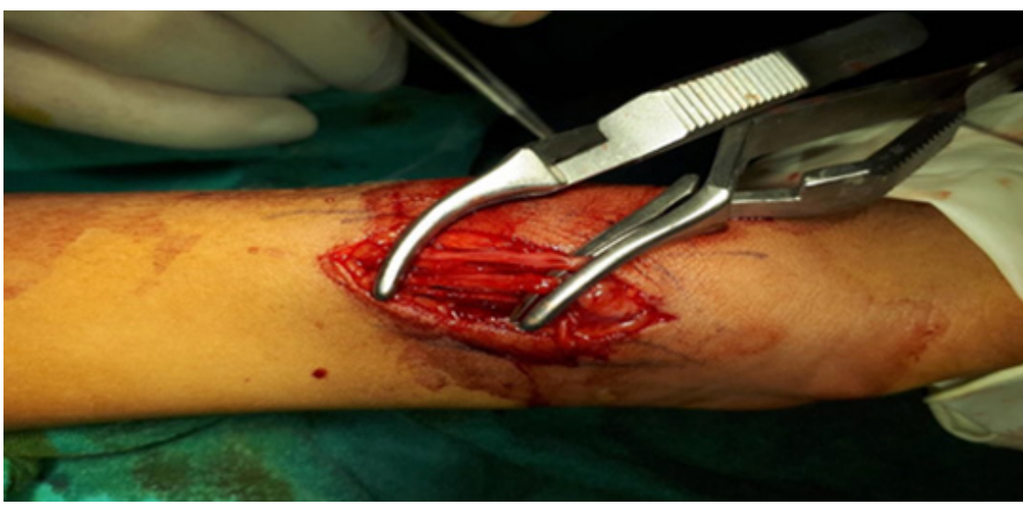

Fig. 1: Distal radiocephalic AVF, side-to-side anastomosis. AVF, arteriovenous fistula.

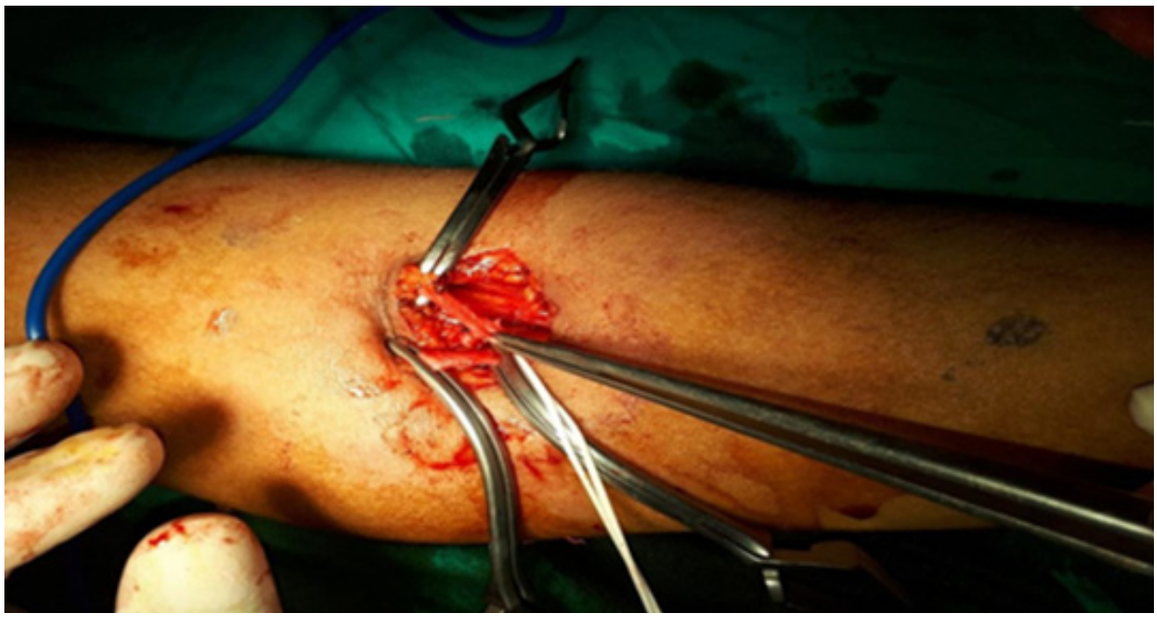

Fig. 2: Brachiocephalic AVF, end-to-side anastomosis. AVF, arteriovenous fistula.

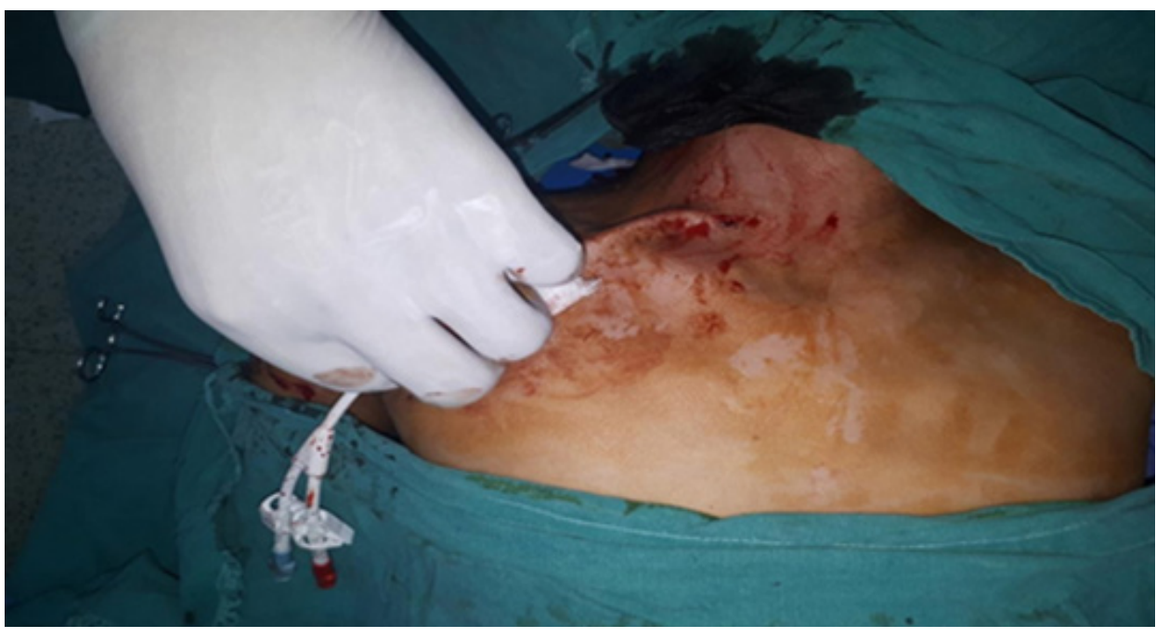

Fig. 3: Right internal jugular vein permanent catheter.

Definitions

Kaplan–Meier life table analysis

A variant on the life table mode to measure interval-reliant clinical results can be recorded as vascular survival or infection-free patency rates.

Primary patency

The time from vascular access formation to the initial reinterference (interference to clear vascular access patency) due to vascular access thrombosis or dysfunction, the duration of survival, or until its abdication.

Assisted primary patency

The time from vascular access formation to the first closure (thrombosis clear vascular access patency) or estimation of survival including interferences to preserve the vascular access.

Secondary patency

The time from vascular access formation to the abdication of the vascular access (thrombosis) after single or multiple interferences or the interval of estimation of survival together with the attainment of censored events.

Maturation of vascular access

Modifications that arise in the vascular access after formation (increase in AVF diameter and vascular access flow, wall configuration modifications, AVG tissue to graft integration) make it appropriate over time for the insertion of dialysis needles.

Mature vascular access

Vascular access that is predictable to be appropriate for hemodialysis and is suitable for insertion of dialysis needles and predictable to provide a satisfactory flow of blood during hemodialysis.

Follow-up

All patients were followed up to assess the first dialysis session after the creation of AVF or CVC, to assess the primary patency of the access and secondary patency, and to assess vein maturation (blood flow at least 400 ml/min). Complications assessment included failure, thrombosis, infection, steal syndrome, venous hypertension, hematoma and pseudoaneurysm, access malfunction, and wound complications of any procedure.

Follow up protocol

Duplex examination will be done every week in the first month and then every 2 weeks.

Ethical consideration

The study protocol was submitted for approval by the Medical Research Ethics Committee (Institutional Research Board) and Faculty of Medicine, Mansoura University, Egypt (code number: MD/17.01.81). Informed written consent was obtained from each participant in the study.

Statistical analysis

Data entry and analysis were done using the Statistical Package for the Social Sciences (Statistical analysis was done using IBM SPSS statistics for windows, Version 23.0. Armonk, NY: IBM Corp), version 20 under Windows. Qualitative data were described as numbers and percentages. χ^2 test was used to compare qualitative variables, as appropriate. Quantitative data were described as mean and SD for normal distributed data and medians for non-normally distributed data. Survival analysis and Kaplan–Meier curves display the cumulative probability of an individual remaining free of the endpoint 'nonpatency'. The log-rank test compares events at all time points on the survival curve according to certain factors. *P value* less than or equal to 0.05 was considered to be statistically significant.

RESULTS:

This prospective study was conducted on 120 patients: 66 (55%) males and 54 (45%) females in the age range from 2 to 19 years and suffering from chronic renal failure with a mean age of 11.5+3.6. Fourteen (11.7%) cases were of idiopathic (unknown) etiology, 24 (20%) cases due to renal atrophy, 10 (8.3%) cases due to chronic proliferative glomerulonephritis, 11 (9.2%) cases due to lupus nephritis, 10 (8.3%) cases due to ureteric stenosis or obstruction, seven (5.8%) cases due to nephrotic syndrome, 10 (8.3%) cases due to PUV and VUR, and other causes of ESRD in the pediatric age group are listed in (Table 1). As regards associated comorbidities, 11 (9.2%) cases were associated with SLE, six (5.0%) cases with hypertension, five (4.2%) cases are associated with anemia, four (3.3%) cases are associated with proteinuria, four (3.3%) cases are associated with deafness, two (1.7%) cases are associated with cardiomegaly and LVH, two (1.7%) cases are associated with dilated cardiomyopathy, and pulmonary edema, and two (1.7%) cases are associated with stunted growth (Table 1).

Table 1: Demographic data of studied chronic renal failure patients

	Studied patients (*N*=120) [*n* (%)]
Age	
Mean (SD)	11.5 (3.6)
Minimum–maximum	2–19
Sex	
Male	66 (55)
Female	54 (45)
Cause of renal failure	
Idiopathic (unknown)	14 (11.7)
Renal atrophy	24 (20)
Chronic proliferative glomerulonephritis	10 (8.3)

Lupus nephritis	11 (9.2)
Ureteric stenosis or obstruction	10 (8.3)
Nephrotic syndrome	7 (5.8)
PUV and VUR	10 (8.3)
Cystic kidney disease	7 (5.8)
Nephrocalcinosis	7 (5.8)
Neurogenic bladder	6 (5.0)
Urinary regurgitation and irritable bladder	3 (2.5)
Recurrent UTI	2 (1.7)
Hemolytic uremic syndrome	1 (0.8)
Glomerulosclerosis and tubular atrophy	1 (0.8)
Urinary retention	1 (0.8)
Persistent vomiting and oliguria	1 (0.8)
Nephromegaly	1 (0.8)
Alport syndrome	1 (0.8)
Cornelia de Lange syndrome	1 (0.8)
Familial hyperlipidemia (not renal failure)	1 (0.8)
Renal tubular acidosis	1 (0.8)
Comorbidities associated with studied patients	
SLE	11 (9.2)
Hypertension	6 (5.0)
Anemia	5 (4.2)
Proteinuria	4 (3.3)
Deafness	4 (3.3)
Cardiomegaly and LVH	2 (1.7)
Dilated cardiomyopathy and pulmonary	2 (1.7)
Edema	1 (0.8)
Liver cirrhosis	1 (0.8)
Familial hyperlipidemia and HCV	1 (0.8)
Thalassemia	1 (0.8)
DM	1 (0.8)
Meningocele	1 (0.8)
Polydactyly	1 (0.8)
Lower limb deformity	2 (1.7)
Stunted growth	1 (0.8)
Bronchial asthma	1 (0.8)
HCV and osteodystrophy	1 (0.8)
Epilepsy	1 (0.8)
Cataract	1 (0.8)
Congenital hypoplasia of the pelvis and LL	1 (0.8)
Valvular heart disease and pleural, pericardial effusion, glycogen storage disease, and hepatomegaly	1 (0.8)

DM, diabetes mellitus; HCV, hepatitis C virus; LL, lower limb.

In this study, there were two (1.7%) cases with previous peritoneal dialysis, 49 (40.8%) patients with previous access creation, and 83 (69.2%) with previous catheter insertion. Preoperative duplex assessment was done in all cases. Magnifying loupe was used in 79 (100%) of the AVF group. Death was in 23 (19.2%) cases [10 cases in AVFs and 13 cases in the permanent CVC group, and two (1.4%) patients were lost to follow-up]. Access thrombosis and infection were seen in 43 (35.8%) cases (18 cases in AVFs and 25 cases in permanent catheters) (Table 2).

Table 2: Baseline data for the studied chronic renal failure patients

	Studied patients (*N*=120) [*n* (%)]
Previous PD	2 (1.7)
Previous access	49 (40.8)
Previous catheter insertion	83 (69.2%)
AVF, CVC Duplex data	120 (100)
Loupe	79 (100% of AVFs)
Death	23 (19.2)
AVFs	10 (12.7)
Permanent catheters	13 (31.7)
Lost follow-up	2 (1.4)
Thrombosis and infection	43 (35.8)
AVFs	18 (22.8)
Permanent catheters	25 (60.98)

AVF, arteriovenous fistula; CVC, central venous catheter.

In this study, the minimal arterial diameter was 2.0 mm and the maximum diameter was 4.6 mm with a mean diameter of 3.2 mm. The minimal venous diameter was 2.2 mm and the maximum diameter was 5.5 mm with a mean diameter of 3.4 mm. Patients were followed up for a period that ranged from 2 years (Tables 3, 4).

The primary patency rate for autogenous AVFs was 88.6, 82.3, 79.7, 78.5, 62, and 54.5% at 3, 6, 9, 12, 18, and 24 months, respectively. The secondary patency rate for AVFs was 92.4, 84.8, 83.5, 81.01, 67.09, and 60.8% at 3, 6, 9, 12, 18, and 24 months, respectively.

Table 3: Survival analysis for primary patency duration among the studied groups for arteriovenous fistulas

	AVF (*N*=79) (mean (SD)]
Duration of patency	17.5 (0.9)
	Cumulative proportion
3 months	0.84
6 months	0.79
12 months	0.75
18 months	0.59
24 months	0.54

AVF, arteriovenous fistula.
Log-rank test.

Table 4: Survival analysis for secondary patency duration among the studied groups for arteriovenous fistulas

	AVF (*N*=79) [mean (SD)]
Duration of patency	18.4 (0.9)
	Cumulative proportion
	0.87
3 months	0.83
6 months	0.81
12 months	0.77
18 months	0.60
24 months	

AVF, arteriovenous fistula.

The cumulative patency rate among studied groups was 88.6% for primary patency of AVFs and 92.4% for the secondary patency of AVFs at 3 months (*P=0.4*). At 6 months: primary patency was 82.3% and secondary patency was 84.8% (*P=0.6*). At 9 months, primary patency was 79.7% and secondary patency was 83.5% (*P=0.5*). At 12 months, primary patency was 78.5% and secondary patency was 81.01% (*P=0.6*). At 18 months, primary patency was 62% and secondary patency was 67.09% (*P=0.5*). At 24 months, primary patency was 54.4% and secondary patency was 60.8% (*P=0.4*) (Table 5).

Table 5: Primary and secondary patency of the arteriovenous fistula group

Primary patency		Secondary patency	*P* value
3 months	70 (88.6)	73 (92.4)	0.4
6 months	65 (82.3)	67 (84.8)	0.6
9 months	63 (79.7)	66 (83.5)	0.5
12 months	62 (78.5)	64 (81.01)	0.6
18 months	49 (62)	53 (67.09)	0.5
24 months	43 (54.4)	48 (60.8)	0.4

The primary patency rate according to the site of autogenous AVFs; radiocepahlic AVFs: 100, 100, 100, 100, 66.7, and 66.7% at 3, 6, 9, 12, 18, and 24 months, respectively. Brachiocephalic AVFs: 88.6, 85.7, 80, 80, 62.9, and 54.3% at 3, 6, 9, 12, 18, and 24 months, respectively. Brachiobasalic AVFs' primary patency was 87.8, 78, 78, 75.6, 60.98, and 53.7% at 3, 6, 9, 12, 18, and 24 months, respectively. *P value* was 0.8, 0.5, 0.6, 0.6, 0.9, and 0.9 at 3, 6, 9, 12, 18, and 24 months, respectively (Table 6). In our study, vein maturation in AVFs was 72 (98.6%) and non-maturation was one (1.4%) and the median duration of vein maturation was 45 days (35–65 days) and the median flow rate was 735 ml/min (400–1500 ml/min) (Table 6).

Table 6: Primary patency according to the site in autogenous arteriovenous fistula

Patency at follow-up visits	Radiocepahlic AVFs (*N*=3) [*n* (%)]	Brachiocephalic AVFs (*N*=35) [*n* (%)]	Brachiobasilic AVFs (*N*=41) [*n* (%)]	*P* value
3 months				0.8
Patent (*N*=70)	3 (100)	31 (88.6)	36 (87.8)	
6 months				0.5
Patent (*N*=65)	3 (100)	30 (85.7)	32 (78)	
9 months				0.6
Patent (*N*=63)	3 (100)	28 (80)	32 (78)	
12 months				0.6
Patent (*N*=62)	3 (100)	28 (80)	31 (75.6)	
18 months				0.9
Patent (*N*=49)	2 (66.7)	22 (62.9)	25 (60.98)	
24 months				0.9
Patent (*N*=43)	2 (66.7)	19 (54.3)	22 (53.7)	

Row percent is considered.

In CVC patients, 41 catheters were inserted and all catheters were inserted under sonographic and fluoroscopic guidance. The primary patency for the permanent catheter was 92.7, 85.4, 70.7, 51.2, 24.4, and 4.9% at 3, 6, 9, 12, 18, and 24 months, respectively. According to the site of CVC insertion; primary patency was as follows: right internal jugular catheter was 100, 92.9, 78.6, 64.3, 50.0, and 14.3% at 3, 6, 9, 12, 18, and 24 months, respectively. For the left internal jugular catheter primary patency was 92.9, 85.7, 64.3, 42.9, 14.3, and 0% at 3, 6, 9, 12, 18, and 24 months, respectively. For femoral catheter primary patency was 84.6, 76.9, 69.2, 46.2,(7.69, and 0% at 3, 6, 9, 12, 18, and 24 months respectively. *P value* was 0.4, 0.6, 0.7, 0.4, 0.02, and 0.13 at 3, 6, 9, 12, 18, and 24, months, respectively (Table 7).

Table 7 Primary patency according to the site in permanent catheters

Patency at follow-up visits	Rt internal jugular (*N*=14) [*n* (%)]	Lt internal jugular (*N*=14) [*n* (%)]	Femoral (*N*=13) [*n* (%)]	*P* value
3 months				0.4
Patent (*N*=38)	14 (100)	13 (92.9)	11 (84.6)	
6 months				0.6
Patent (*N*=35)	13 (92.9)	12 (85.7)	10 (76.9)	
9 months				0.7
Patent (*N*=29)	11 (78.6)	9 (64.3)	9 (69.2)	
12 months				0.4
Patent (*N*=21)	9 (64.3)	6 (42.9)	6 (46.2)	
18 months				0.02*
Patent (*N*=10)	7 (50)	2 (14.3)	1 (7.69)	
24 months				0.13
Patent (*N*=2)	2 (14.3)	0	0	

Row percent is considered.

Primary patency among the studied groups was 88.6% for AVFs and 92.7%for permanent catheter at 3 months (*P=0.4*). At 6 months, the patent rates were 82.3% for AVFs and 85.4% for permanent catheters (*P=0.6*). At 9 months, the patent rates were 79.7% for AVFs and 70.7% permanent catheters (*P=0.2*). At 12 months, patent rates were 78.5% for AVFs and 51.2% for permanent catheters (*P=0.002*). At 18 months, patent rates were 62% for AVFs and 24.4% for permanent catheters (*P<0.001*). At 24 months, patent rates for AVFs were 54.4% and 4.9% for permanent catheters (*P<0.001*) (Table 8).

Table 8: Primary patency among studied groups at follow-up visits

Patency at follow-up visits	AVF (*N*=79) [*n* (%)]	Permanent catheter (*N*=41) [*n* (%)]	*P* value
3 months			0.4
Patent	70 (88.6)	38 (92.7)	
6 months			0.6
Patent	65 (82.3)	35 (85.4)	
9 months			0.20
Patent	63 (79.7)	29 (70.7)	
12 months			0.002*
Patent	62 (78.5)	21 (51.2)	
11 months			<0.001*
Patent	49 (62)	10 (24.4)	
22 months			<0.001*
Patent	43 (54.4)	2 (4.9)	

AVF, arteriovenous fistula.
P value less than 0.05 is considered statistically significant.

Vascular access complications included primary failure in 7.6 and 2.4% as regards autogenous AVF and permanent catheters, respectively. *P value* was 0.4. Thrombosis occurred in 22.8% and 0% had infection in autogenous and 34.15% thrombosis and 26.83% had infection in permanent catheters. *P value* was less than 0.001. Steal syndrome was seen in 1.3 and 0% as regards autogenous AVF and permanent catheters, respectively. *P value* was 1.00. Hematoma was in 10.1) and 0% as regards autogenous AVF and permanent catheters, respectively. The *P value* was 0.05. Renal transplantation was in 15.2% cases of s AVFs and follow-up for patency was continued. And 9.8% of cases with permanent catheters underwent removal of one catheter at 3 months and the other three catheters were continued for follow-up for patency till thrombosis at 9, 18, and 19 months.

Death occurred in 12.7 and 31.7% of cases as regards autogenous AVF and permanent catheters, respectively. The *P value* was 0.01 (Tables 9 and 10).

Table 9: Complications among studied groups at follow-up visits

Complications	Autogenous AVF (*N*=79) [*n* (%)]	Permanent catheter (*N*=41) [*n* (%)]	*P* value
Primary failure	6 (7.6)	1 (2.4)	0.4
Thrombosis	18 (22.8)	14 (34.15)	<0.001
Infection	0	11 (26.83)	
Withdrawn	12 (15.2)	13 (31.7)	–
Steal	1 (1.3)	0	1.00
Venous hypertension	0	0	–
Hematoma	8 (10.1)	0	0.05
Renal transplantation	12 (15.2)	4 (9.8)	0.4
Death	10 (12.7)	13 (31.7)	0.01*

AVF, arteriovenous fistula.
*Fisher's exact test.

Table 10: Size of permanent catheters (French) and body weight (kilograms) of patients

	Permanent catheter patients (*N*=41) [*n* (%)]
Size of catheter	
8 Fr (10–20 kg)	6 (14.6)
10 Fr (20–40 kg)	16 (39.1)
12 Fr (≥40 kg)	19 (46.3)

The choice of permanent catheter in patients was based on their body weight. For patients with a body weight ranging from 10 to 20 kg, a 6 Fr diameter catheter [six patients (14.6%)] was used, while for a body weight from 20 to 40 kg a 10 Fr catheter [16 patients (39.1%)] was used and in those more than 40 kg a 12 Fr catheter [19 patients (46.3%)] was used.

Length of catheters according to site: jugular site length ranged from 18 to 28 cm while femoral from 32 to 40 cm.

DISCUSSION

Mandel-Shorer *et al*.[9] reported that the establishment of a treatment strategy in pediatric ESRD patients is a lifetime affair. Although fruitful transplantation is attainable even in younger patients, graft durability is restricted, and several patients of transplantation might return to hemodialysis through their ESRD treatment. The establishment of hemodialysis in pediatrics is influenced by the challenge of starting suitable vascular access and the identification that upcoming hemodialysis might be restricted due to loss of vascular access locations early in life. Borzych-Duzalka *et al*.[10] reported that data concerning vascular access in children's hemodialysis are inadequate due to the limited number of cases that are looked after in specific centers. Therefore, the intensity of the multicenter results of the International Pediatric Hemodialysis Network has been used to afford the biggest hemodialysis research in children up to now concerning vascular access selection, efficiency, and the result. Only a fourth part of the 404 patients starting hemodialysis established AVFs as primary vascular access, 73% of patients received CVCs, and 1% received AVGs. Despite the predilection of a CVC in young patients being clarified partially by the procedural troubles related to AVF creation in pediatrics, CVCs were the principal vascular access selection as well in 65% of cases over 10 years.

Onder *et al*.[11] reported that an ideal vascular access permitting sufficient blood flow is necessary for effective and maintained hemodialysis. The most frequently used vascular access procedure in pediatrics in North America and Europe is a tunneled cuffed long-term catheter. The benefits of this catheter include immediate usage once inserted, needle-free hemodialysis, and no waiting after dialysis to stop bleeding. In our study, we conducted our search on 120 patients including 66 (55%) males and 54 (45%) females ranging in age from 2 to 19 years, all suffering from chronic renal failure with a mean age of 11.5±3.6 years. Two (1.7%) cases had previous peritoneal dialysis, 49 (40.8%) patients had previous access creation, 83 (69.2%) patients had previous catheter insertion, 79 (65.8%) patients had received AVFs, and 41 (34.2%) patients had received permanent CVCs.

Borzych-Duzalka *et al*.[10] reported that over 10 years, global consensus recommendations advised use of autogenous AVFs as a vascular access in pediatrics or adults that receive maintained hemodialysis, built on higher result records in elderly and patient sequences in minor cohort studies of pediatric population. Kidney Disease Outcomes Quality Initiative recommendations advised AVF creation in children weighing over 20 kg and who are unlikely to obtain transplantation within 1 year. Despite several pediatric patients requiring hemodialysis come meeting these measures, most pediatric patients continue to receive dialysis through a CVC.

Chand *et al*.[12] reported that with the International Pediatric Fistula First Initiative advising AVFs as a principal choice in pediatric patients, it is broadly known that AVF construction provides numerous benefits over CVCs or synthetic AVGs. These consist of higher patencies, lower infection rates, and fewer long-term complications.

Also, they reported that possible explanations for that practice contain fears around pain and worry due to repeated AVF cannulation and the absence of a devoted vascular access facility, and Borzych-Duzalka *et al*.[10] reported that pediatric surgical knowledge, even though advances in operative procedure have improved primary survival outcomes of AVF from 50 to 90%.

In our study, we conducted 79 autogenous AVFs. Patients were selected for fistula creation when duplex criteria showed a minimal venous diameter of 2.2 mm and minimal arterial diameter of 2 mm and blood pressure of at least 100/60 mmHg. Onder *et al*.[11] reported that arteriovenous end-to-side anastomosis remained the most shared operative procedure for the construction of AVF, used in 84.4% (87/103) of cases. Forty-five permanent vascular accesses have been created on the forearm, and 60 permanent vascular accesses have been located on the upper extremity. Radiocephalic stayed the most frequently used anatomical site below the elbow (38.4%) and brachiocephalic stayed the most frequent upper arm permanent vascular access (29.6%). Only nine permanent vascular accesses have been placed using the femoral artery vein.

In our study, 38 cases received end-to-side distal and brachiocephalic AVFs, eight cases received end-to-side one-stage brachiobasilic AVFs, 29 cases received end-to-side two-stage brachiobasilic AVFs, and four cases received side-to-side AVFs (one distal, one brachiocephalic, and two brachiobasilic AVFs). Akturk *et al*.[13] reported that a significant question to discuss is whether one would favor a microsurgical technique for AVF creation at the distal or at the proximal site in children. Moreover, distal AVFs have a less frequency of steal syndrome. Distal AVFs when formed by microsurgical procedures have survival outcomes equivalent to formerly described survival outcomes of proximal AVFs.

In our study, magnifying loupe was used in all 79 (100%) cases of AVF cases [a binocular loupe (Univet, Optical Technologies), Galilean TTL 3×0 Pro working distance 300–500]. Bylsma *et al*.[14] reported that the

mean time to maturation for AVF was reported in text in 34 studies and was calculated from the Kaplan–Meier curve in two studies. The overall mean time to maturation was 3.49 months.

In our research, vein maturation in AVFs occurred in 72 (98.6%) cases and nonmaturation was observed in one (1.4%) case with a median duration of vein maturation of 45 days. The median duration of vein maturation is 45 days (35–65 days) with a median flow rate of 735 ml/min (400–1500 ml/min). Murea *et al*.[15] reported that outcomes of vascular access were also assessed by the order in which arteriovenous accesses were located and used. With the order of the AVF located, primary fistula failure happened in 26.8% of the initial AVFs located, 36.0% of the next AVFs located, and 50.0% of the third AVFs located. In comparison, primary AVG failure happened in 20.0% of the initial AVGs located, and 14.3% in the next AVGs located. Of the AVFs located, 72.6% were effectively working, 71.4% of AVFs and 81.2% of AVGs. That corresponds to a primary AVF failure of 27.8% across all primary vascular access located, 29.1% of AVFs, and 18.8% of AVGs.

Borzych-Duzalka *et al*.[10] reported an access patency of 70, 64, 62, and 60% with CVCs and 92, 90, 86, and 83% with AVFs after 1, 2, 3, and 4 years of hemodialysis. In the cases who received hemodialysis through a CVC, not any case converted to AVF or AVG in 6 months of hemodialysis, 2% in 12 months, 3% in 18 months, 12% in 24 months, and only 27% in 36 months of hemodialysis.

In our study, the primary patency rate for autogenous AVFs was 88.6, 82.3, 79.7, 78.5, 62, and 54.5% at 3, 6, 9, 12, 18, and 24 months, respectively. Secondary patency for AVFs was 92.4, 84.8, 83.5, 81.01, 67.09, and 60.8% at 3, 6, 9, 12, 18, and 24 months, respectively. Murea *et al*.[15] reported that previous research that assessed the outcome of primary AVF failure showed a wide range of primary access failure rates from 20 to 60%. In this research, the rate of primary AVF failure through VAs located was 19.9%; by vascular access type, the rate of primary vascular access failure was 21.2% of AVFs and 10.9% of AVGs.

In our study, failure was recorded in six (7.6%) as regards autogenous AVFs (*P=0.4*). Thrombosis and infection were (22.8%) (22.8% thrombosis and there was no infection) in autogenous and 60.98% (34.15% thrombosis and 26.83% infection) in permanent catheters. Mandel-Shorer *et al*.[9] reported that the prolonged CVC necessity in hemodialysis cases is accompanied by a higher frequency of vascular access dysfunction and obstruction, mostly due to CVC thrombosis or occlusion. Repeated CVC insertions are recurrently essential, causing a higher possibility of central venous stenosis or thrombosis.

Borzych-Duzalka *et al*.[10] reported that CVCs are the principal vascular access selection in pediatrics on hemodialysis inside the International Pediatric Hemodialysis Network. Age-associated structural restrictions and predictable initial linked renal transfers were accompanied by CVC use. CVCs were accompanied by inferior hemodialysis efficiency, more frequent complications, and a higher repeated necessity for vascular access exchange. These outcomes require a reassessment of CVC use in children.

In our study, primary patency for permanent catheters was 92.7, 85.4, 70.7, 51.2, 24.4, and 4.9 at 3, 6, 9, 12, 18, and 24 months, respectively. Primary patency rates according to the site of permanent catheter placement were as follows: for the right internal jugular catheter (100%), they were 92.9, 78.6, 64.3, 50.0, and 14.3% at 3, 6, 9, 12, 18, and 24 months, respectively. For the left internal jugular catheter primary patency was 92.9, 85.7, 64.3, 42.9, 14.3, and 0% at 3, 6, 9, 12, 18, and 24 months, respectively. For femoral catheters, primary patency was 84.6, 76.9, 69.2, 46.2, 7.69, and 0% at 3, 6, 9, 12, 18, and 24 months, respectively. *P value* was 0.4, 0.6, 0.7, 0.4, 0.02, and 0.13 at 3, 6, 9, 12, 18, and 24 months, respectively.

Aitken *et al*.[16] reported that the higher mortality rate in patients dialyzing through TCVCs is well described. The survival difference between the access modalities emerges early in the life of vascular access and is only partly attributable to infectious deaths. Recent United States Renal Data System data indicate that cardiovascular and all-cause mortality is higher in patients dialyzing through TCVC.

Borzych-Duzalka *et al*.[10] reported that the prevalence of CVCs is remarkable while reviewing the results due to the incidence of dysfunction and infection, which is significantly greater with CVCs causing nearly triple greater necessity for another vascular access employment at an altered location.

CONCLUSION

Vascular access in pediatric hemodialysis patients is challenging, but an essential aspect for healthcare practitioners. It calls for proper advanced planning to make sure that the best permanent vascular access is placed, involving communication among a multidisciplinary team of nephrologists, surgeons, and interventional radiologists, nurses, and ongoing monitoring to guarantee its long-term survival. The preference for CVCs is only partially explained by the technical challenge of AVF placement in young

patients. CVCs permit less effective hemodialysis and are accompanied by much higher complications and access failure rates in comparison to AVFs, resulting in earlier consumption of the vascular access reserve in patients facing years of renal replacement therapy. The detected high rate of transient uncuffed CVCs used temporarily in patients with AVF proposes frequent suboptimal vascular access planning in these patients.

ABBREVIATION

LVH: Left ventricular Hypertrophy

PUV: Posterior Urethral Valve

SLE: Systemic Lupus Erythematosus

VUR: Vesico-Ureteral reflux.

CONFLICT OF INTEREST

There are no conflicts of interest.

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