Experience with Arteriovenous Fistulas for Chronic Hemodialysis in Pediatric Age Group

Nehad Zaid

Vascular Surgery Unit, General Surgery Department, Menoufiya University Hospitals
nehadzaid@yahoo.com

Abstract: Aim of the work: The aim of this work is to estimate the 2-year cumulative patency of upper arm A-V fistulae in children on regular haemodialysis. **Methods:** All children who are referred to our surgical unit from January 2007 to January 2011 with inadequate forearm veins underwent upper arm A-V fistulae both brachio-basilic & brachi-cephalic A-V fistulae (Kaplar-Meier Analysis) and long rank tests are done. **Results:** 14 children (8 males & 6 females) with inadequate forearm veins created 14 A-V fistulae (10 B.B. & 4 B.C.). Median age was (12.0±3.6 years), mean (±SE) operative time for BB was (2.2±0.3 hrs) & for BC was (1.5±0.0 hrs). The overall 2-years qualitative patency was (60%) (BB 60% & BC 50%). Three fistulae failed & 3 censored (2 unrelated deaths and one lost follow up, three underwent surgical thrombectomies & regained function). There was no significant difference in survival times based on fistula type, age, sex or operative time. **Conclusion:** BBF & BCF are a reliable angio-access for maintained regular haemodialysis for children not suitable for distal forearm fistula due to inadequate forearm vein.

[Nehad Zaid. **Experience with Arteriovenous Fistulas for Chronic Hemodialysis in Pediatric Age Group.** *J Am Sci* 2012;8(12):961-967]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 132

Keywords: Arteriovenous, Fistulas, Hemodialysis

1. Introduction

In the last few years, we have encountered with a large number of children with end stage renal disease planned for chronic regular hemodialysis. Safe and effective vascular access for hemodilysis was indicated for all these children. Vascular access is the basis for chronic hemodialysis and persists as a surgical challenge, especially for pediatric patients. As a first choice, external central venous catheters are usually utilized, but they restrict the child's physical activity and usually do not last for a long time because of complications due to infection (1).

In 1966, arteriovenous fistulas (AVFs) were introduced by Breschia and Cimino as a standard procedure for chronic hemodialysis in adult patients[1]. In pediatric population ,adequate access creation is difficult and is complicated by the additional responsibility to preserve future access sites in children who may require chronic haemodialysis (2) .

Following the early experience in adult patients, the first successful creation of AVFs in children was reported in 1970 (3). Three years later, Broyer *et al.* reported that 54% of distal fistulas in children who weighed less than 20 kg had good results(4). In 1981 the utilization of microsurgical techniques for the creation of AVFs in children who weighed less than 10 kg was first reported (5). After these studies, the importance of microsurgery began to be stressed on account of the high patency rate of the AVFs in children (6).

In patients with inadequate forearm veins, upper arm fistulae can be attempted (7). The brachiocephalic and basilic vein transposition fistulae are the most common upper arm fistulae across all ages (8). Similarly, several authors recommend an attempt to create a transposed basilic vein arteriovenous fistula before choosing a prosthetic graft for haemodialysis access (9). However.most of the studies on upper arm arteriovenous fistulae have been done in adults,and the paediatric vascular access survival data are still limited (10) .

Aim of the Work:

The aim of this study is to present our experience with creation of arteriovenous fistula in children with end stage renal disease indicated for chronic haemodialysis and to estimate the patency rates of brachiocephalic fistulae and basilic vein transposition in children with inadequate forearm veins.

2. Patients and Methods:

This is a retrospective study included children with end stage renal disease indicated for hemodialysis referred to our vascular surgical unit, Menoufia University Hospital, between January 2007 and January 2011. The median age of children was (11.5 years), the range of age was 9-16 and the males to females ratio was (4-3). The median weight of children was 31.5 Kg; the range of weight was 28-55.

The candidates of this study were examined clinically for presence of adequate forearm veins and none of them had suitable forearm veins. All of these patients were endorsed for upper arm arteriovenous fistulas either brachiobasilic or brachiocephalic.

The files of all patients were reviewed regarding the preoperative investigations concerning the radiological investigations of non dominant upper

arm veins. The operative technique, operative time, operative complications, immediate patency rate, early follow up, and late follow up regarding the efficacy of hemodialysis and the patency rate.

Operative technique

a. Brachiobasilic arteriovenous fistula with immediate superficialization

The basilica vein was identified through a longitudinal incision made posterior to the biceps groove on the medial side of the arm. The lower end of the incision just above the elbow was dissected further to identify the brachial artery (Figs. 1a, b, c).

The basilic vein was mobilized longitudinally to the maximum extent through a step ladder incision or through a single longitudinal incision. Systemic heparinization was done before distally ligating the basilica veins. In all patients, the mobilized basilica vein was tunneled along the medial part of the upper arm (Figs. 2a, b, c). A longitudinal arteriotomy was made and the vein was spatulated to perform an end –to-side anastomosis using6/0 or 7/0 prolene running sutures according to the caliber of the vein (Figs. 3a, b). A palpable thrill and radial pulse were confirmed before continuation of the procedure. The wound is then closed in layers (Fig. 4) and patients received aspirin in the immediate postoperative period.

b. Brachiocephalic arteriovenous fistula

A transverse skin incision was made just above the crease of the elbow, and further dissection was carried out to identify the cephalic vein and brachial artery. The vein was dissected free the subcutaneous tissue an adequate length mobilized to allow it reach the brachial artery. Systemic heparinization was done before distally ligating the cephalic vein. A longitudinal arteriotomy was made and the vein was spatulated to perform an end –to-side anastomosis using6/0 or 7/0 prolene running sutures according to the caliber of the vein. A palpable thrill and radial pulse were confirmed before continuation of the procedure. The wound is then closed in layers and patients received aspirin in the immediate postoperative period.

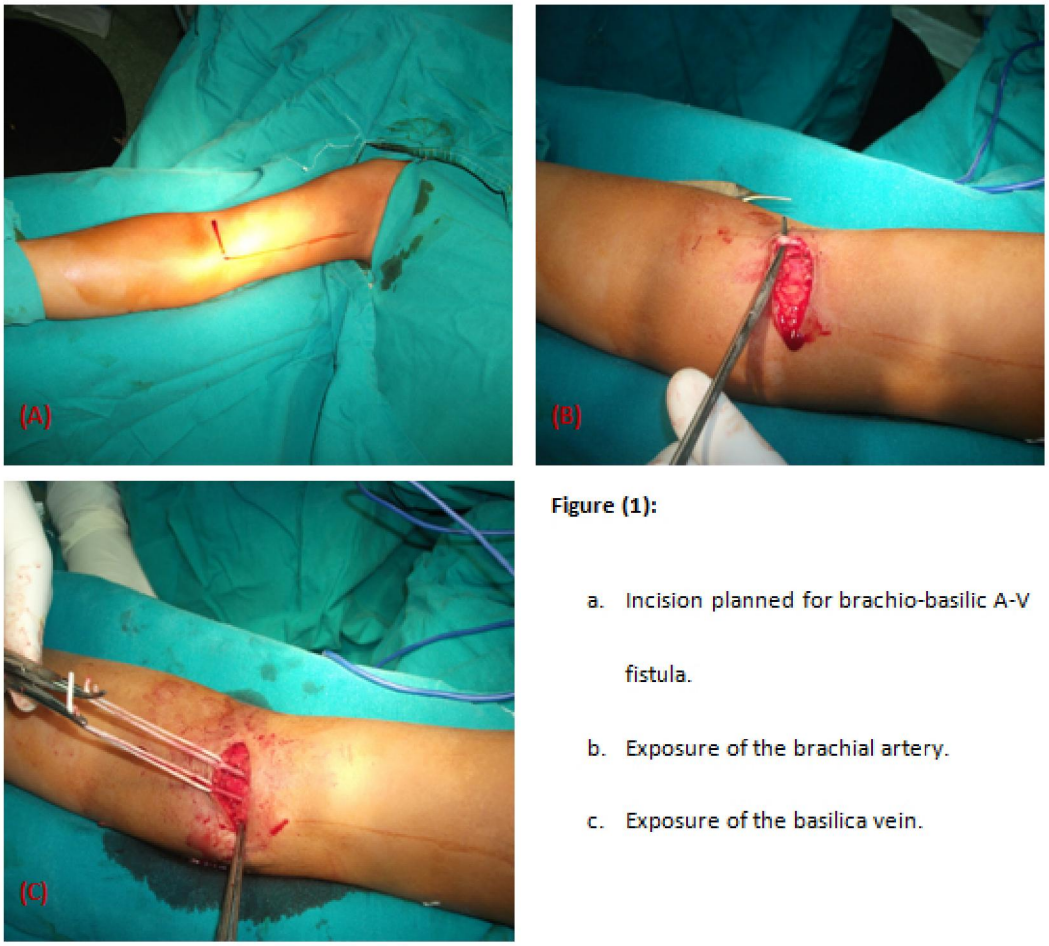


Figure (1):

a. Incision planned for brachio-basilic A-V fistula.

b. Exposure of the brachial artery.

c. Exposure of the basilica vein.

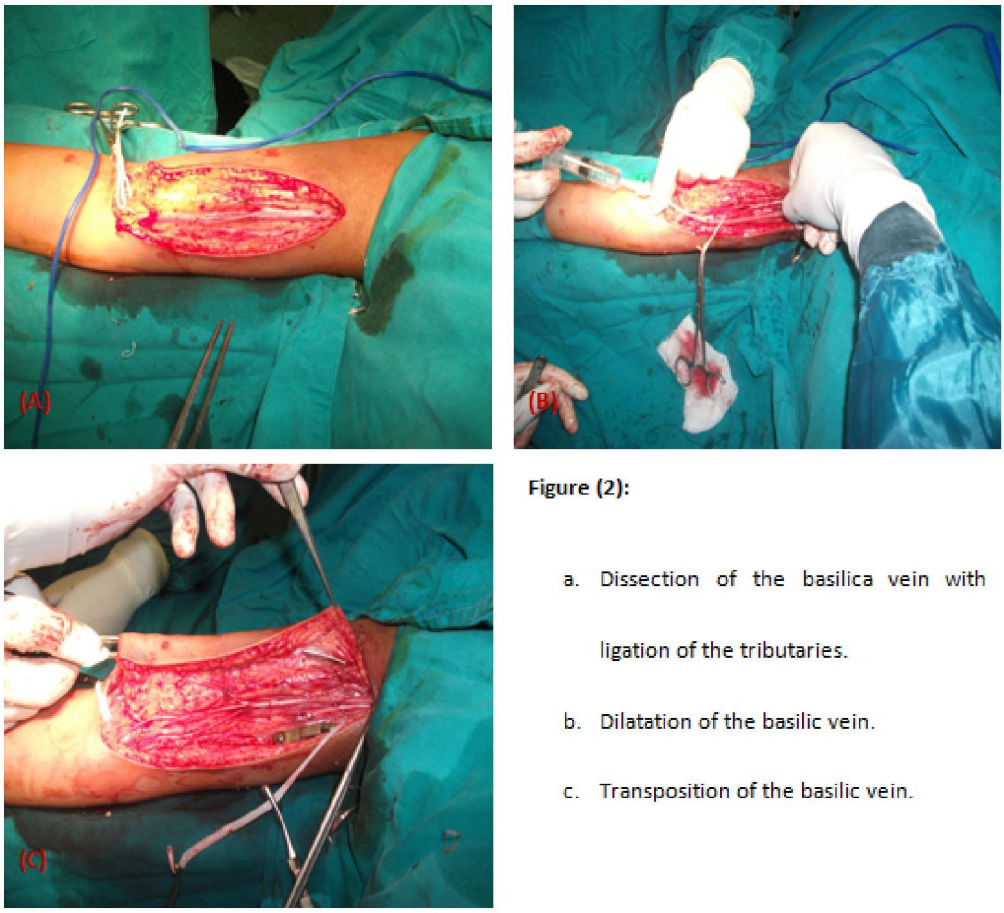


Figure (2):

a. Dissection of the basilica vein with ligation of the tributaries.

b. Dilatation of the basilic vein.

c. Transposition of the basilic vein.

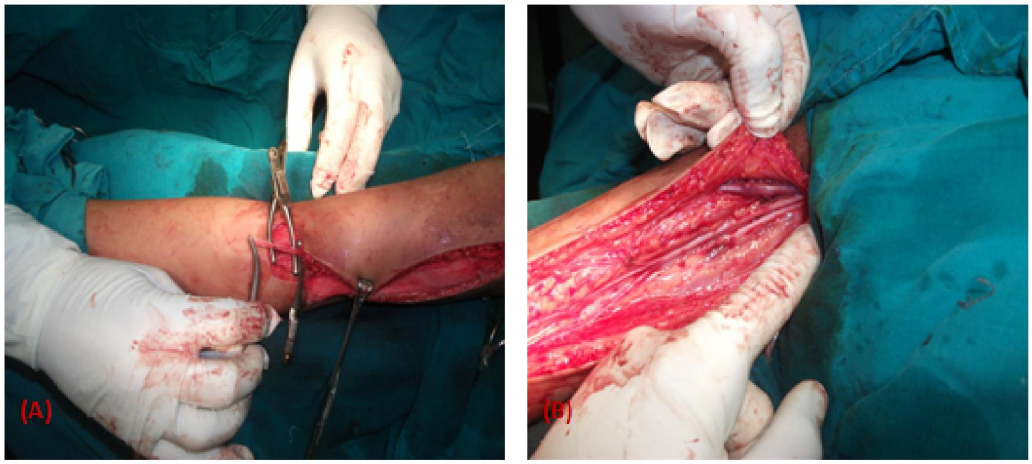


Figure (3):

a. End-to-end anastomosis of the vein to the artery.

b. Infiltration of the basilica vein after removal of the bulldog clamps.

Figure (4): Closure of the wound in layers.

3. Results:

There were 14 fistulae created in 14 patients. The demographic details and operative times are shown in (Table1 & Fig. 5).

The factors associated with renal failure in these children were acute glomerulonephritis, focal segmental glomerulosclerosis and other causes such as systemic lupus erythromatosus, reflux nephropathy and nephritic syndrome.

Thrombosis occurred in 6 patients out of 14(42.9%), all of them underwent surgical thrombectomies, three of them failed (21.4%) and the other three succeeded (21.4%) and completed the study (Table 2).

Three patients were censored in our study, two of them due to unrelated death and the third is lost to follow up.

There was no significant difference regarding the 2-year thrombosis-free survival rates based on the type of fistula (basilic transposition vs brachiocephalic), age, intraoperative weight, sex, or the side of the fistula (Table 3).

A Kaplan –Meier curve for cumulative patency is shown in (Figure 6). The two year cumulative thrombosis-free survival of all fistulae was 57.1%. The two year survival rates were 60% for brachio-basilic vein transposition and 50% for brachio-cephalic fistulae (Table 4).

Table 1: Demographic details of the studied groups

	Groups				Total (n=14)		Mann-Whitney test	*P* value
	BC (n=4)		BB (n=10)					
	Mean ± SD		Mean ± SD					
Age (Y) Median Range	12.0 ± 3.6 11.5 9-16		12.4 ±1.6 12.0 10-15		12.3 ± 2.2 12 9-16		0.29	0.775
Weight Median Range	36.5 ± 12.4 31.5 28-55		42.8 ±9.8 42.0 29-57		41.0 ± 10.6 39.5 28-57		0.99	0.322
Operative time	1.5 ± 0.0		2.2 ±0.3		1.9 ±0.4		2.69	0.007
	no	%	no	%	no	%	FE	P value
Sex Male Female	 2 2	 50.0 50.0	 6 4	 60.0 40.0	 8 6	 57.1 42.9	0.12	1.0
Side of shunt Left Right	 4 0	 100.0 0.0	 6 4	 60.0 40.0	 10 4	 71.4 28.6	2.40	0.251

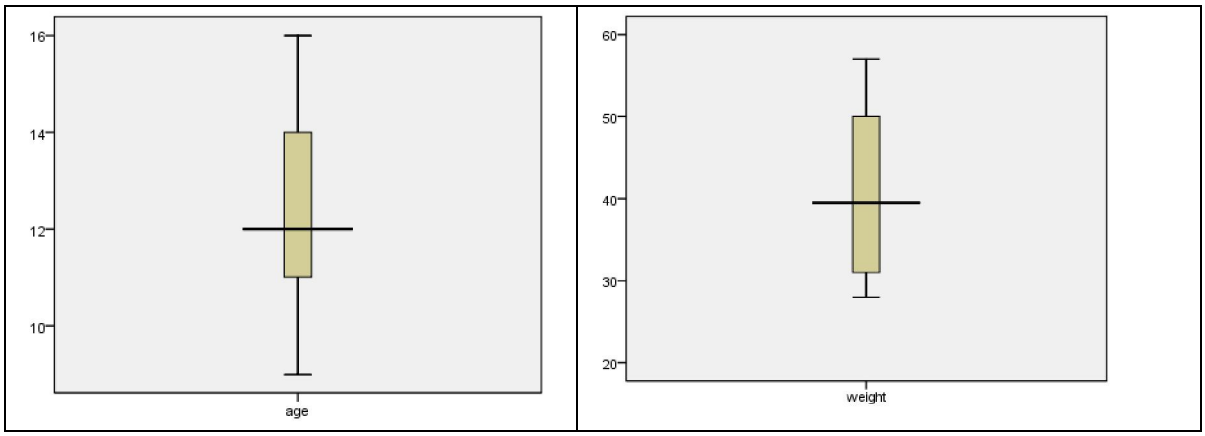


Figure (5):Operative times of the studied groups

Table 2: Patient's outcome analysis

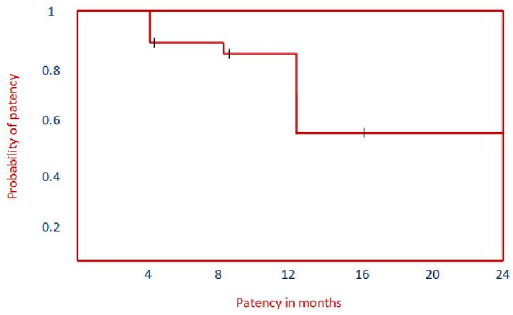
	4 M	8 M	12 M	16 M	20 M	24 M
Succeeded	13	11	9	6	7	8
Thrombosed	1	1	1			
Failed		1	2	3	4	4
Thrombectomy				2	1	
Unrelated death		1	1			
Lost				1		

Table 3: Kaplan-Meier survival analysis

Variables		Overall survival Mean (95% CI)	SE	Log rank	*P* value
Type of operation	BC BB	24 (24 – 24) 24 (24 - 24)	0.0 0.0	0.562	0.453
Sex	Male Female	24 (24 – 24) 24 (24 - 24)	0.0 0.0	0.0	1.0
Operation time	≤1.5 >1.5	24 (24 – 24) 24 (24 - 24)	0.0 0.0	0.562	0.453

Table 4: Free survival analysis

	Free Survival	
	No	%
BC	2	50%
BB	6	60%
Male	4	50%
Female	4	66.7
Left shunt	6	60%
Right shunt	2	50%
Total patients	8	57.1%



Kaplan-Meier survival curve for all patients

Figure 6: Kaplan-Meier curve for patency (thrombosis free survival)

4.Discussion:

Although the kidney transplant is the treatment of choice for patients with end stage renal disease, however in Egypt many factors make this solution difficult due to religious and financial factors. According to the recommendation of North American Pediatric Renal Transplant Cooperative Study registry 2008, the peritoneal dialysis is one of the treatment options. Long-term hemodialysis indicated for children with end stage renal disease

with peritoneal membrane failure, noncompliance with peritoneal dialysis, or difficult social situation (10-12). In these children requiring hemodialysis for extended periods, maintaining adequate vascular access is critical. The situation is complicated by the additional responsibility to preserve future access sites in children who may require lifelong hemodialysis (13, 14).

The vascular access group has recommended the use of arteriovenous fistula over types of access, based on various studies showing reduced mortality and morbidity, lower rate of thrombosis, fewer interventions, and a longer survival of access with the use of arteriovenous fistula when compared to grafts and catheters especially in the upper extremities (15). The group strongly endorses the creation of a native fistula over other types of access in both adults and children. Permenant vascular accesses using autologous veins in children have been shown to have survival rates better than central lines (13) and rates comparable to arteriovenous grafts (13,14). The current recommended sequence of placement of arteriovenous fistula for hemodialysis access is peripheral to central starting with the Brescia-Cimino fistula at wrist, followed by forearm cephalic fistula, before proceeding to elbow brachiocephalic fistula and basilic vein transposition arteriovenous fistula (15).

Our clinical practice closely follows the Vascular Access Group Guidelines for placing distal to proximal accesses and constructing native arteriovenous fistula before attempting a prosthetic graft.

Our study included 14 children; all of them had evidence of inadequate forearm veins, thus brachio-basilic fistulae were done for 10 patients and brachio-cephalic fistulae were done for 4 patients. 10 patients underwent brachio-basilic fistula and 4 patients underwent brachio-cephalic fistula. Male to female ratio was 4: 3; the median age was 12 years (6-9). The median weight of our patients was 39.5 kg (28-57). The operative time was 1.9±0.4 Hour. There was no significant difference between the results of the two methods regarding the patient's sex, weight, and the operative time. This suggests that upper arm fistulae may be constructed without negative effect on fistula survival even in young children (16).

Our 2-year cumulative thrombosis free survival estimate of 57.1% which is somewhat lower than the rates reported in the literature for upper arm fistulae in adults of 60% to 83% (7,8,17,18) and lower than the rate reported for children upper arm fistulae (16). This lower rate may be attributed to faulty technique of vein-puncture for hemodialysis or due to bad compliance of patients and poor health education.

The 2-year cumulative survival rate of 60% for brachio-basilic fistulae in our study were comparable to the 52% to 83% (9, 19) survival reported in the adult literature. Our brachio-cephalic fistula 2-year survival rate of 50% was little inferior to the 57% to 63 % (20,21) 2-years cumulative survival in adults.

Overall, there were 6 cases out of 14 patients (42.9%) of thrombosed arteriovenous fistulae in our study, four cases of thrombosed arteriovenous fistulae were after brachibasilic (40%) and the other 2 cases after brachiocephalic(50%), three of them underwent successful thrombectomies and completed the study and the other three failed to recanalise and to function, this result is comparable to the work of Ramanath *et al.* (16) whom reported 4 cases out of 15 patients of failure.

In our study 3 patients were censored, two of them died due to unrelated deaths and 1 patient was lost during the study with working fistula.

Our results show that arteriovenous fistulae in the upper arm whether brachiobasilic or brachiocephalic are amenable to be created in children with inadequate forearm veins for maintenance haemodialysis and must be attempted before placement of synthetic grafts.

Brachiocephalic and basilic vein transposition fistulae create reliable haemodialysis access for children who have inadequate forearm veins to allow construction of more distal fistulae. The 2-year cumulative thrombosis-free patency rates are comparable to those reported in adults.

Conclusion:

BBF & BCF are a reliable angio-access for maintained regular haemodialysis for children not suitable for distal forearm fistula due to inadequate forearm vein.

Corresponding author
Nehad Zaid
Vascular Surgery Unit, General Surgery Department, Menoufiya University Hospitals
nehadzaid@yahoo.com

References:

1. Uenis Tannuri, Ana Cristina Aoun Tannuri: Experience with arteriovenous fistulas for chronic hemodialysis in children: technical details and refinements. Clinics vol.60 no.(1): 37-40. São Paulo Jan./Feb. 2005
2. Brescia MJ, Cimino JE, Appel K, Hurwich BJ. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. New Eng J Med 1966;275:1089-92.

3. Wander JV, Moore ES, Jonasson O. Internal arteriovenous fistulae for dialysis in children. J Pediatr Surg 1970;5:533-8.
4. Broyer M, Loirat C, Gagnadoux MF, Cukier J, Beurton D, Vacant J. "By-pass" et fistule arterio-veneuse en vue de l'hemodialyse chronique chez lénfant. Arch Fr Pediatr 1973; 30: 145-61.
5. Bourquelot P, Wolfeler L, Lamy L. Microsurgery for hemodialysis distal arteriovenous fistula in children weighing less than 10 kg. Proc Eur Dial Transp Assoc 1981;18:537-40.
6. Yazbeck S, Oreagan S. Microsurgery for Brescia-Cimino fistula construction in pediatric patients. Nephron 1984;38:209-12.
7. Fitzgerald JT, Schanzer A, Chin AI, *et al.*: Outcomes of upper arm arteriovenous fistulas for maintenance hemodialysis access. Arch Surg 2004; 139:201-8.
8. Oliver MJ ,McCann RL, Indridason OS,*et al.* comparison of transposed brachiobasilic fistulas to upper arm grafts and brachiocephalic fistulas.Kidney Int 2001;60:1532-9.
9. Dix FP,Khan Y,Al-Khaffaf H. the brachial artery-basilic vein arteriovenous fistula in vascular access for heodialysis---a review paper.Eur J Vasc Endovasc Surg 2006;31:70-9.
10. Vascular Access Work Group. Clinical practice recommendation 8: vascular access in pediatric patients. Am J Kidney Dis 2006; 48(Suppl 1): S 274-6.
11. McDonald SP,Craig JC. Long-term survival of children with end stage renal disease. N Engl J Med 2004;350:2654-62.
12. Neu AM, Ho PL, Mcdonald RA, *et al.* Chronic dialysis in children and adolescents. The 2001 NAPRTCS Annual Report. Pediatr Nephrol 2002;17:656-63.
13. Ramage IJ, Bailie A, Tyerman KS, *et al.* Vascular access survival in children and young adults receiving long-term haemodialysis. Am J Kidney Dis 2005;45:708-14.
14. Sheth RD, Brandt ML ,Brewer ED, *et al.* Permanent haemodialysis vascular access survival in children and adolescents with end-stage renal disease. Kidney Int 2002;62:1864-9.
15. Vascular Access Work Group. Clinical practice guidelines for vascular access. Am J Kidney Dis 2006;48(Suppl 1):S176-S247.
16. Ramanath N. Haricharan, Charles J. Aprahamian,Traci L. Morgan, Carroll M. Harmon , Douglas C.Barnhart. Intermediate-term patency of upper arm arterovenous fistulae for haemodialysis access in children. J Pediatr Surg 2008;43:147-151.
17. Dixon BS, Novak L ,Fangman J. haemodialysis vascular access survival: upper –arm native arteriovenous fistula. Am J Kidney Dis 2002;39:92-101.
18. Hossny A. Brachiobasilic arteriovenous fistula:different surgical techniques and their effects on fistula patency and dialysis-related complications. J Vasc Surg 2003;37:821-6.
19. Murphy GJ, White SA, Knight AJ, *et al.* Long-term results of arteriovenous fistulas using transposed autologus basilic vein.Br J Surg 2000;87:819-23.
20. Dunlop MG,Mackinlay JY,Jenkins AM.Vascular access:experience with the brachiocephalic fistula.Ann R Coll Surg Engl 1986;68:203-6.
21. Murphy GJ, Saunders R, Metealfe M, *et al.* Elbow fistulas using autogenous vein:patency rates and results of revision. Postgrad Med J 2002;78:483-6.

8/12/2012