

# Permanent Vascular Access (Arteriovenous Fistula) for Haemodialysis Three Years Experience at Sheikh Zayed Hospital, Lahore

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## SUMMARY

A prospective study of permanent arteriovenous (AV) fistula in 466 patients, 309 (66%) males and 157 (34%) females was performed at Sheikh Zayed Hospital over the period of three years. Most of the patients 455 (97.6%) had native AV fistula, 269 (57.7%) at wrist, 98 (21%) at mid forearm and 88 (18.8%) at elbow. Only 11 (2.4%) patients had A.V. fistula with synthetic grafts. Early failure was seen in 25 (5.4%) patients, infection in 18 (3.4%), late failure (thrombosis) in 18 (3.6%) and false aneurysm in 7 (1.5%). Early bleeding and distal ischemia occurred in 6 (1.3%) each and distal oedema was seen in only 1 (0.2%) patient. No cardiac failure or nerve injury was noted. We conclude that native permanent vascular access particularly (radio-cephalic) can be placed in most of the patients with end stage renal disease and is associated with few complications.

## INTRODUCTION

**H**emodialysis requires a reliable, repeated access to the circulation with minimal complications. Vascular access always has been an important challenge facing the nephrologists. Successful maintenance of vascular access is essential for the delivery of hemodialysis, the well being of ESRD patients, and the reduction of ESRD costs. Willem Kolff<sup>1</sup> developed dialysis to treat acute renal failure (ARF) in the 1940s' using rubber and later plastic catheters. Quinton-Scribner<sup>2</sup> shunt was first permanent access, Brescia-Cimino AV fistula<sup>3</sup> followed for hemodialysis. At present two types of vascular access are used, acute hemodialysis and chronic hemodialysis access. Acute hemodialysis access includes acute dialysis catheters and cuffed, tunneled dialysis. These devices provide immediate access to circulation but are associated with many immediate and late complications<sup>4</sup> and remain reserved only for emergency situations.

Currently permanent access is provided by primary (native) arteriovenous (AV) fistula, synthetic AV fistula (bridge grafts) and silastic double lumen cuffed tunneled catheters. These permanent arteriovenous (AV) accesses are of utmost importance for successful dialysis but are subjected to many early and late complications. One fourth of hospital admissions and stay for hemodialysis is attributed to vascular access complications. For optimal success of these AV fistulae, proper side & site selection, complete asepsis & refined surgical techniques are mandatory. Achievement of native permanent vascular access is vital and gained well in advance from the start of first hemodialysis to reduce these complications, to obtain virgin vessels for construction of AV fistula and sufficient time for its maturation. So far near ideal is native AV fistula, which is simple to perform, provide ample blood flow, has least complications and long surveillance time. We analyzed our early experience at Sheikh Zayed Hospital, in

permanent vascular access with primary and synthetic graft AV fistulas in regard to their complications and success rate.

## PATIENTS AND METHODS

During three years period from February 1998 to January 2001, 466 patients 309 (66%) males and 157 (34%) females with age range between 10 and 80 years, referred from the department of Nephrology, Sheikh Zayed Hospital, Lahore were included in the study. All these patients had AV fistulae constructed. Other than above two patients were refused as they had severe myocardial ischemia causing angina at rest even on maximum medication. Acute severe systemic illnesses and particularly infections were controlled before making the fistulae. Surgery was performed on an out patient basis except for patients who were already admitted in nephrology ward.

### Technique

In spite of all efforts to select and prepare the patients well before (preferably 4–6 month) the expected time of dialysis, most of these patients were referred for AV fistula when there was already indications to start dialysis therapy. Patient's cardiovascular status was assessed & stabilized when needed. Acute systemic infections were treated promptly. Local swelling, oedema, phlebitis and cellulitis were treated with antibiotics, proper elevation and rest. Patients were explained properly and educated for the care, exercises and use of AV fistula. Non dominant arm was preferred. Site was selected carefully and assessment of collateral venous circulation was done. Radio-cephalic at wrist was always first choice, mid fore arm was 2<sup>nd</sup> and elbow was the last choice for primary (native) AV fistula. Allen's test was performed in all patients for assessment of arterial blood flow. If the patient had previous central catheter insertion, opposite side was used for construction of AV fistula (because of risk of subclavian vein stenosis).

After selection of the appropriate site, full aseptic techniques were adopted. The site was prepared with 10% pyodine iodine. Local anesthesia (lignocaine 2% without adrenaline) was used. A longitudinal incision 3–4 cm was made over the

wrist and midforearm and a transverse skin crease incision was used at the elbow. The radial-cephalic end to side anastomosis was made at wrist and forearm. At the elbow the brachial-median cubital or brachial-cephalic end to side anastomosis performed. The arteriotomy at the wrist and the midforearm was always more than double the diameter of the vessel, for ample blood flow, and equal or less than the diameter of the brachial artery at the elbow to avoid the steal syndrome. General anaesthesia was used for synthetic PTFE (ringed / non-ringed) grafts and were bridged between radial artery-basilic vein at forearm in two patients only and rest of all were bridged between brachial artery-axillary vein in gentle loop at arm. These patients were hospitalized for one to three days. All the patients received three doses of antibiotics one at the time of surgery followed by two doses, except synthetic grafts AV fistulae who received three days course of antibiotics. Patients were instructed to elevate the arm on pillow, exercise, not to use tight clothing, avoid sleeping on operated side and needle pricking.

Fistulae were labeled as successful if they were mature by six weeks and gave a blood flow greater than 250ml/minute on dialysis machine. Complications such as bleeding, early failure (thrombosis), infections, pseudo aneurysm formation, late failure, median nerve injury, distal oedema, ischemia & heart failure were looked for and recorded in each patient.

All outdoor patients were sent home two to six hours after surgery. They were seen after two days, two weeks and four weeks in cardiothoracic outpatient and then seen in dialysis unit periodically. All complications were dealt with according to their urgency and causes.

## RESULTS

A total of 466 AV fistulae were constructed in 309 (66%) males and 157 (34%) females.

Majority of these 58% (269 out of 466) fistulae were performed on the wrist and remaining on other sites. Only in 11(2%) patients synthetic (PTFE) grafts were used as shown in Table 1.

Early failure (thrombosis) was recorded in 25 (5.4%) patients in primary fistulae. Thrombectomy



was carried out successfully in all these cases. Infection was seen in 18(3.9%) and it was more common at elbow and successfully treated with oral or intravenous antibiotics. Late failure was documented in 17 (3.6%) patients and was slightly more common at wrist and dealt with by construction of new AV fistula at new site. Bleeding was seen only at wrist in 6 (1.3%) patients. Distal ischemia noted in 6(1.3%) patients and was significantly higher at elbow. All were treated successfully, by decreasing the anastomosis length or vein diameter to reduce fistula flow. Distal oedema was only seen at elbow in one patient (0.2%), settled with proper elevation and arm exercises. There was no true aneurysm, cardiac failure or nerve injury noted. Frequency of various complications according to site and type of AV fistula is depicted in Table 2.

**Table 1: Site of AV fistulae construction.**

Site	Frequency	Percentage
Right Wrist	74	15.9
Left Wrist	195	41.8
<b>Total at Wrist</b>	<b>269</b>	<b>57.7</b>
Right Mid Forearm	34	7.3
Left Mid Forearm	64	13.7
<b>Total at Mid Forearm</b>	<b>98</b>	<b>21</b>
Right Elbow	37	7.9
Left Elbow	51	10.9
<b>Total at Elbow</b>	<b>88</b>	<b>18.8</b>
<b>PTFE Graft</b>	<b>11</b>	<b>2.4</b>

### DISCUSSION

Successful chronic hemodialysis requires permanent vascular access<sup>5</sup>. AV fistulae constructed from endogenous vessels remain the first choice for its simplicity to construct, easy access, efficiency for hemodialysis, avoidance of foreign materials, superior long term survival, least complications, lower morbidity and improved performance over the time<sup>6</sup>. AV fistulas are typically constructed with an end-to-side vein-to-artery anastomosis between an artery and vein. The most commonly used fistulas are created by anastomosing the radial artery and

cephalic vein (radiocephalic or wrist fistula) or by anastomosing the brachial artery and cephalic vein (brachiocephalic or upper arm fistula). Native fistulas can also be created between the brachial artery and basilic vein. During creation of a brachio basilic fistula, the basilic vein is usually mobilized and tunneled laterally and superficially to allow easier cannulation (transposed brachio basilic fistula)<sup>7</sup>. The K/DOQI guidelines has recommend that fistulas be used for access in 40 percent of prevalent patients and 50 percent of incident patients in the United States. Catheters should be used in less than 10 percent of prevalent patients. But these recommendations are not followed as such<sup>8,9</sup>. One report from the DOPPS study has shown that fistulas were used only in 24 and 15 percent of prevalent and incident patients, respectively<sup>8</sup>. In another study from the Clinical Performance Measures Project, 28, 49, and 23 percent of prevalent patients were dialyzed via a fistula, graft, and catheter, respectively<sup>9</sup>. The incidence of fistulas in hemodialysis patients is reported to be 51, 55, 66, and 84 percent in Canada, Australia, Sweden and Japan, respectively<sup>10</sup>. We constructed 97.6% native A.V. fistula. We cannot explain these disparities by case-mix. Practice patterns are likely to play a role. The disadvantages of primary fistulae includes long maturity time(one to four months), non availability of adequate vessels because of vascular disease or frequent phlebotomy and its failure to develop even after careful screening. All these can be significantly reduced by early referral of renal patients to nephrologists and construction of native AV fistula at least 6 months prior to the 1<sup>st</sup> expected dialysis. Early failure in primary AV fistula according to Kinnaert and Vereerstraeten is 7.7 – 12%<sup>11</sup>. Our study revealed it to be 5.4% and is almost equally distributed at wrist and elbow.

The primary failure rates of grafts are much less than that associated with fistulas, but it varies by site. Primary failure rates of 0 to 13 and 0 to 3 percent have been reported for forearm and upper arm grafts, respectively<sup>12,13</sup>. We did not have any primary failure in our 11 PTFE grafts.

Infection is a complication which results 20% of early failure, pseudo aneurysm formation and bleeding<sup>14,15</sup>. In our study, the rate of infection

**Table 2 Complication Frequency**

Complications	No. of Patients	Percent	At wrist 269	At forearm 98	At elbow 88	PTFE grafts 11
Early failure	25	5.4	15	5	5	0
Infection	18	3.9	9	3	6	0
Late failure (thrombosis)	17	3.6	12	2	3	0
False aneurysm	7	1.5	5	1	1	0
Early bleeding	6	1.3	6	0	0	0
Distal ischemia	6	1.3	2	0	4	0
Distal Oedema	1	0.2	0	0	1	0
Late bleeding	0	0	0	0	0	0
Cardiac failure	0	0	0	0	0	0
Nerve injury	0	0	0	0	0	0

happened to be 3.9%, while at elbow it was significantly higher (5.4%). Aneurysm formation and bleeding was observed 1.5% and 1.3% respectively. Vascular access-related cardiac decompensation is a rare complication, even in patients with underlying cardiac dysfunction. However, patients with cardiomyopathy can develop high-output heart failure if fistula flow exceeds 20 percent of the cardiac output<sup>16</sup>.

According to Anderson<sup>17</sup> heart failure is rare and is seen only in cardiac patients if fistula blood flow exceeds 20% of cardiac output and cardiomyopathy may develop. Heart failure was not seen in our study because of careful pre-operation assessment. Thrombosis accounts for 80% of fistula losses and remains the main cause of late failure. Thrombosis<sup>18-20</sup> is common at venous side, which was confirmed in our study and late failure is seen 3.6% and distributed equally to all the sites. Preliminary data from the Dialysis Outcomes and Practice Patterns Study (DOPPS) have shown that grafts are 3.8 times more likely to require a thrombectomy and 3.0 times more likely to require access intervention than native fistula<sup>21</sup>.

Distal hypoperfusion of the extremity can occur due to placement of an AV access in patients with severe peripheral vascular disease due to diversion of arterial blood flow into the fistula. This complication may be more common among diabetics and the elderly<sup>22</sup>. Distal ischemia (1.3% in

our study) was kept low by making the brachial arteriotomy smaller than its diameter and confirming the blood flow by Allen's Test. Distal oedema (0.2%) appearing at elbow only, was negligible because religiously using end to side anastomosis technique at wrist and forearm.

Arteriovenous fistulae with synthetic bridge grafts are usually made with PTFE (ringed or non-ringd) prosthesis<sup>23</sup>. Their advantages are that they can be constructed when no superficial vessels are available and they mature early<sup>24</sup> (two weeks time). They have much lower long term survival (if early failure is excluded) than primary AV fistulae and require many more interventions<sup>25</sup> to maintain patency. This is confirmed in our study as well. Corethen<sup>26</sup> and hybrid PTFE grafts<sup>27</sup> are also being used for better endothelialization morphologic substrate, but these are not used in our institution though heparin coated ringed PTFE grafts are used more recently with better early results.

## CONCLUSION

We conclude that for permanent vascular access primary (native) arteriovenous fistula at wrist and mid-forearm are the best choice, especially when it is made six months to a year earlier before the start of first hemodialysis. At wrist AV fistula is simple to create, excellent patency, lower complications, less steal syndrome and more



proximal site available for construction of AV fistula in case of failure. Disadvantage of lower flow rate is not seen in our study. Practice of early AV fistula construction enhances the availability of virgin vessels, gives long maturation time and avoidance of early thrombosis, infection and other complications. To increase the complication free survival time and long surveillance of the AV fistula, patients and dialysis technicians education is of utmost importance. Rotating cannulation in grafts AV fistula and buttonhole techniques of cannulation in native AV fistula does help its long surveillance.

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