# Native Arteriovenous Fistula Creation for Hemodialysis, Surgical Technique and Outcome in Taiz - Yemen: A Prospective Study

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**Abstract: Aim:** The present study investigates surgical outcomes post AVF creation by parachute vascular anastomosis technique (PVAT) in Taiz, Yemen. **Materials and Methods:** This prospective study of 196 patients who underwent a native AVF created by parachute anastomosis technique from October 2017 to September 2019 in Authority of Althawra hospital in Taiz- Yemen. AVF was performed under local anesthesia. Patients were followed up in outpatient clinic for six months. **Result**: Total of 231 AVF in 196 patients, 121 (61.7%) were male and 75 (38.3%) were female. The immediate patency rate (palpable thrill intra operative) was 218 (94.4%) with an overall functional rate (successful use of the AVF for six consecutive sessions of HD) of 198 (85.7%). The primary failure rate (within 3 months) was 33 (14.3%). Six months primary patency was 186 (80%). During study period, the most common complication was thrombosis 30 (13%).**Conclusion:** Based in our result and literature review we could report excellent functional rate (85.7%) of AVF created by parachute vascular anastomosis technique. For that, parachute technique may be suggested as one of optimal selection to create AVF especially in elderly, diabetic patients and smaller vascular caliber.



**Keywords: Keywords:** Hemodialysis access, arteriovenous fistula, Parachute anastomosis technique, primary failure

## 1 Introduction

AVF is generally recognized as the cornerstone of long-term dialysis treatment due to its superior patency and lower complication rates.[1]Over last 50 years, AVF still represents the favorite vascular access to provide HD in terms of access patency,[2] patient mortality,[3],[4] morbidity[5] and health cost[6] compared to other types. Kidney Disease Outcomes and Quality Initiative (KDOQI) guidelines recommend that 40% incident and 50% prevalent HD patients should undergo dialysis with an AVF.[7]

AVF is created by a surgical anastomosis between native artery and vein, to allow access to vascular system for HD.[8],[9] The preferred type of AVF is radiocephalic fistula which was the first AVF designed in 1966 by Brescia.[10] However, this access often fails to mature in the elderly patient with underlying vascular disease, particularly in diabetics.[11] Second preferred type is brachiocephalic fistula.[12],[13] This type of fistula is being placed with increased frequency because of the high failure rate of radiocephalic fistula, followed by a brachiobasilic transposition fistula.[14]

Failure of an AVF not only interrupts a functional access but also reduces the number of sites at which another access can be made. In addition, subjecting the patients to interventional procedures is required to salvage the failing AVFs. Therefore, it is important to evaluate risk factor that effect AVF patency and identify failure rate and post-operative complications that may occur after AVF placement.[15]

To date, no publication has been reported on creating and outcomes of AVF in our city. Thus, Present study was conducted to identify functional, primary failure rate and complication of native AVF creation by (PVAT) in Taiz, Yemen from October 2017 to September 2019.

## 2 Patient and Methods:

This prospectively study was conducted at Department of vascular surgery, Authority of Althawra Hospital in Taiz-Yemen, from 1st October 2017 to 30th September 2019. All patients with ESRD, who refer for creation AVF were include in this study. A total of 196 patients underwent 231 AVF operations were enrolled in the study. Details demographic, Clinical, and preoperative dialysis variables were obtained for every patient. Allen’s test and arterial pulses (i.e. axillary, brachial, radial, and ulnar) were examined. Patients with visible veins on the clinical examination were directly scheduled for AVF creation while patients with non-visible veins were undergo vein mapping by ultrasonography (US) before being scheduled for surgery.[16] The distal part of the non-dominant extremity was selected as priority anatomical site, whenever possible.[17] All operations were created by the researcher supervised by senior cardiovascular consultant.

**Outcome Parameter**

Maturation (Functional) of AVF was defined as the successful use of the AVF for six consecutive sessions of HD. This definition for the evaluation of AVF maturation has been validated in the literature in several previous studies.[18]–[20] Primary failure defined as an AVF that has never been usable for dialysis or that fails within three months of use.[21], [22] In our study, primary patency of AVF at immediate, one, three, and six months had been measured. [2]

**Procedural detail**

AVF was routinely created under local anesthesia (2% xylocaine\ 3 mg\ kg) or regional anesthesia and sedation for brachiobasilic transposition anesthesia. Antibiotic was not given before the procedure. After cleansing and sterilizing the site of operation. A longitudinal incision (3 cm) made for the wrist or forearm region and a horizontal incision for the elbow antecubital region, the artery and vein were dissected and freed. Exposure of the vein was performed in a way to prevent its angulation and bending. At this stage, the distal part of the vein ligated. Heparinized isotonic saline was pushed by syringe 20 cc with a feeding infant tube 6 *fr* for the proximal part of the vein then occluded via bulldog to block retrograde flow. After confirming vein suitability, the suitable artery was suspended and arterial flow was controlled with bulldog, small arterial branches were preserved. A longitudinal arteriotomy about 5-8 mm was performed in the forearm while a 4-6 mm was performed in arm with surgical blade number 11 and Pott's scissors. The side which was underwent arteriotomy was suspended from both sides and an adequate view was achieved. End-to-side anastomosis by parachute vascular anastomosis techniques using 6/0 or 7/0 propylene sutures.[23]–[26] Thrill over fistula was confirmed, followed by adequate hemostasis before closure. The wound was closed in one layer using 3/0 absorbable mattress sutures for the skin with gentle antiseptic dressing was made. (Fig. 1).

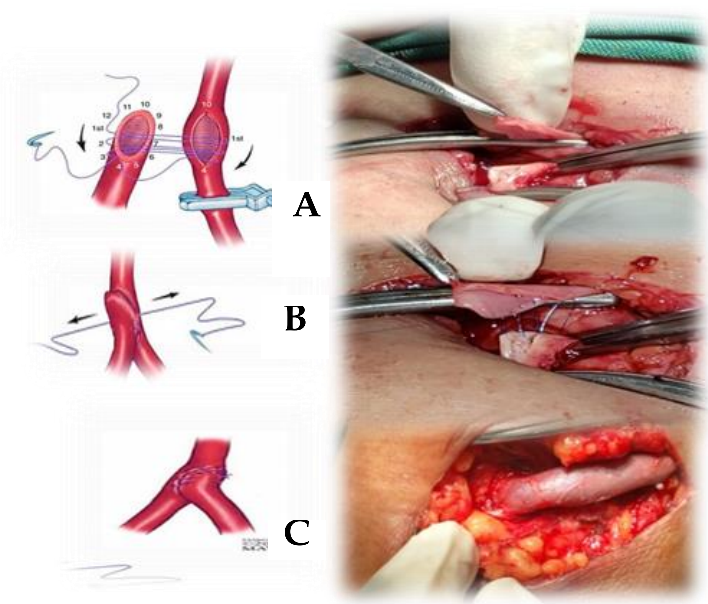


**Figure 1:-** **Parachute suture technique" it involves:** (**A**) The first bite is Out-In suture was made beginning 3 mm ahead of the middle of the posterior walls of vein and In-Out of the artery. This process will be repeated along the posterior vessel wall until the posterior walls of both artery and vein are securing and orienting with a continuous suture. (B) The sutures will be then rinsed with heparinized saline and gentle traction is applied to both ends along the suture and will allow the vessel walls to "parachute" together. Then the anterior vessel wall will be brought together with a continuation of the running suture. (C) Finally, the anastomosis is finished at the same point at the beginning. After the last suture, both ends of the suture material are pulling gently, but putting the knot will be delayed until the unclamping of the radial or brachial artery. This permits the anastomosis site to become expanded to its widest size and prevents a purse-string effect at the anastomosis site. [23]–[26]

**Follow-Up Schedule**

All patient were discharges on operation day with oral All patient discharges on operation day with oral antibiotics and analgesics for three days. Patients were instructed to start hand exercise on the second postoperative day with ball. The follow up was performed on an outpatient basis, at 7th and 14th days then at 4 and 6 weeks post-operative, where fistula was released to puncture for HD. Periodic follow up was performed for at least 6 months (average 6 to 24 months)

**Study analysis**

Data collection and analysis conducted using SPSS (IBM SPSS Statistics 24.0). Initially, descriptive analysis of outcome and variables predominantly was analyzed as frequencies, tables and percentages for categorical variable and mean and SD for continuous variable. The association between variable and outcome or complication were analyzed by the Chi-square (x2) or fisher test for the categorical variable and unpaired Student's t-test for the continuous variable with the corresponding 95% confidence interval (CI). P-values $\leq 0.05$ were considered statistically significant.

## 3 Results

Total of 231 AVF procedures in 196 patients, 121 (61.7%) were male and 77 (38.3%) were female with male to female ratio of (1.5:1). The mean age was 48.5± 16.8 (range 9-85) years, majority (48.5%) of the patients belonged to age group 41 – 63 years; followed by (25.1%) patients belonging to 19–40 years of age.

Functional rate of the fistula was highest 42/47(89%) in the age group equal and more than 64 years followed by 97/112 (86.6%) in the age grouped 41–63 years. Function rates in other age groups were 48/58 (82.6%) in 19–40 years and 11/14 (78.6%) in <18 years. The function rates in male were 121/140(86.4%) and 77/91(84.6%) in female patients, while the failure rates of AVF were 19/121(13.6%) and 14/91(15.4%) in male and female patients, respectively. However, this difference was statistically insignificant (p = 0.7).

Medical history of chronic disease included hypertension in 146 (74%), diabetes in 53 (27%), CHD in 31(15.8%) and PAD in 19 (9.7%) patients. In addition, patients with history of smoking and chewing Qat were 41(20.9), 15(7.7) respectively.

**Table 1.** AVF procedure (intra-operation) characteristics.(n= 231)

| *Baseline characteristics* | **Patient, μ (%)** | **Failure, μ (%)** | **Total, μ (%)** | **P-value** |
|---|---|---|---|---|
| **Access Side** | | | | |
| Left | 157 (68) | 26 (11.3) | 183(79.3) | |
| Right | 41 (17.7) | 7 (3) | 48(20.8) | **0.9** |
| **FistulaConfiguration** | | | | |
| Radiocephalic AVF | 55(23.8) | 19(8.3) | 74(32) | |
| Brachiocephalic AVF | 99 (42.9) | 13 (5.6) | 112(48.5) | |
| Brachiobasilic AVF | 42 (18.2) | 1 (0.4) | 43 (18.6) | **0.01** |
| Ulniobasalic AVF | 1 (0.4) | 0 | 1 (0.4) | |
| Brachiobrachial AVF | 1 (0.4) | 0 | 1 (0.4) | |
| TOTAL | 198 (85.7) | 33 (14.3) | 231 (100) | |
| **Good Intraoperative thrill** | | | | |
| YES | 189 (81.8) | 18 (7.8) | 207 (89.6) | |
| NO | 9 (3.9) | 15 (6.6) | 24 (10.5) | **0.00** |
| TOTAL | 198 (85.7) | 33 (14.3) | 231 (100) | |
| **When using post operation (weeks)** | | | | |
| < 4 wks | 43(18.6) | | | |
| 4 - 6 wks | 134(58) | | | |
| > 6 wk | 28(12.1) | | | |

Regarding the time of dialysis initiation majority of patients 180 (91.8%), were referred late (after initiation or within 1 month). As in our finding, 144(73.5%) patients had non-tunneled catheter at time of AVF creation. Furthermore, 175(89.3%) patients have already had other forms of vascular access before AVF creation; one or more non-tunneled catheters were used.

In this study, all the patients had native AVFs with end-to-side anastomotic (parachute) technique. No grafts were used. Majority of patients 183 (79.2%) had left non-dominant arm. The most common AVF was the brachiocephalic 112 (48.5%), then radiocephalic 74 (32%), Brachiobasilic 43(18.6%), one ulniobasalic AVF and one brachiobrachial AVF (Table 1). The first time cannulation were achieved after four, four to six and more than six weeks in 43(18.6%), 134 (58%) and 28 (12.1%) patients respectively.

On assessing the patency of 231 AVFs, (n=198, 85.7%) fistulas were patent. Among these 198 patent AVFs, brachiocephalic fistula was 43%, followed by radiocephalic (23.8%) and Brachiobasilic f AVFs (18.2%). We found that, the proximal fistula site (arm) and the present of good thrill intraoperative of AVF were significantly associated with a more favorable outcome of AVF Primary patency (P = 0.016), (P = 0.000) respectively. In our study, the primary patency rate was 203 (87.9%) at 1st month, 193 (83.9%) at 3 months and 184 (80.0%) at 6 months. Thirty-three (14.3%) fistulae failed within the first 3 months, Failing AVFs were managed by new fistula in our series.

The most common complication was thrombosis 30 (13%) followed by noninfectious fluid collections (hematoma /seroma/lymphocele) 24 (10.4%), wound infection 17 (7.4%), bleeding 9 (3.9%) and Postoperative edema 10 (4.3%). Aneurysm, venous hypertension and steal syndrome were found in 9 (3.9%), 4 (1.7%) and 3 (1.3%) cases respectively.

## 4 Discussion

Effective formation and sufficient function of AVF in patients with ESRD need a multidisciplinary approach in determining and resolving the leading causes of primary failure. The process of AVF maturation is multifaceted and leftovers poorly understood, in spite of numerous studies describing the pathophysiology of the procedure and biomechanical issues associated with maturation. [27]

The rate of primary failure of AV fistulas is highly variable and has ranged from 47 to 60 percent in randomized trials, but the published rates depend heavily on the definition of failure.[28],[29] Mc Lafferty at al., 2007 described adequate AVF maturation of 82% and a primary failure rate of 18% in patients with AVF.[30] Monroy-Cuadros et al. noticed AVF failure in 81 patients out of 831 studied cases (rate = 10%)[31], and Sari et al. reported 15.3% for incidence rates of primary AVF failure and never using AVF after operation. [32]

Unsurprisingly, in a meta-analysis on 46 articles (7,393 AVFs), the generally risk of primary failure was 23%, but it enlarged in the elderly to 37%,[33], [34] and primary fistula patency was established in 26 of 43 patients (60%), meaning that AVF failure rate was equal to 40%.[35] In the previous years, a worse condition has been reported showing that from 101 AVFs only 47 AVFs (46.5%) established sufficiently to be used for HD, on behalf of the AVF failure rate of 53.5%.[36] Gjorgjievski et al., 2019 reported sufficient functioning was accomplished in 83.71%, and primary failure noticed in 16.29% of the created fistulae.[37] In our study, adequate maturation was achieved in 85.7%, and primary failure occurred in 14.3% of the created fistulae. As discuses above, the rate of primary AVF failure in this study was similar or better compared to the average reported AVF failure rates in other parts of the world.

The mean age of patients with ESRD undergoing AVF in our series was 48.3 years which was similar or close to other studies.[38],[39] The influence of age on the patency of AVF is still controversial. Al-Jaishi et al[34] and Gibson et al[40] found that age had no effect on primary patency. The results in our study confirm that patient age is not a factor in the success of procedure and AVF should not be suspended from patients based on age similar observation was also found by other study.[38],

[39], [41], [42]

We did not find a significant effect of gender on AVF patency in our study. In a literature review of 2012, Smith et al[43] also found the same result. On the other hand, there're studies found significant differences in outcomes of AV fistula creation when comparing males and females.[44], [45]

In contrast to previous studies[46],[47],[48],[31] in which there is significant difference noticed between patients with diabetes and risk of loss of primary patency, our study also indicated that patients with diabetes had no effect on AVF patency rates. Our results are similar to those of Maharaj et al[47] and Olsha et al[51] and suggest that diabetes as an isolated variable should not greatly affect access decision.In our study, HTN 164 (74.5%) was most common comorbidity. Similar finding, was report by Susan J. et al[52] (73.7%) from India, while lower percentage had reported in other studies.[53],[54] HTN had no effect on AVF patency in our study (p value = 0.182).

Timely placement of native AVF is the cornerstone of preoperative management for patients.[55], [56] Early referral strategy significantly decrease morbidity,[57]mortality,[58], [59]CVC insertion,[60] urgent HD[61] and length of hospital stay.[62] However, as has been alluded in many studies delayed presentation of ESRD patients to the hospital in developing countries and referral for AVF creation have provided the need for temporary vascular access to have HD.[63]–[65] In our study, Majority of patients 180 (91.8%) were referred late. We found that nine out of ten patients in our series had a previous central venous access for emergency HD before referral for AVF creation.

Preservation of peripheral veins and the venous circuit back to the heart is an important component of vascular access planning. It is important to avoid iatrogenic trauma to the venous circulation due to phlebotomy or intravenous access in patients who are at risk for developing ESRD or who are already receiving renal replacement therapy of any type. Unfortunately in our practice, many patients notice to have venous lesion of upper limbs due to repeated venous access and phlebotomy. This, adversely affect the available peripheral and central venous routes so that, more proximal vein was used for AVF creation. This issue had recognized clearly in our study, as about forty-five present (105 patients) of our series had their first native AVF creation in proximal forearm or arm. Most experts agree that education regarding vein preservation should begin in individuals with stage *IV/V* CKD and strategies should be implemented to avoid unnecessary trauma to the venous circulation. These studies stress the need for early referral and education for predialysis patients to prevent the use of peripheral (upper limb vein preservation strategy) and central venous catheters and their subsequent complications.[66], [38]

The left upper limb being the nondominant limb in most of the patients was used for the creation of AVF in the majority (79.3%) of our patients. Similar preference for the nondominant upper limb was also reported; 88.1% by *Salako et al*[38] in South-Western Nigeria 2018, by *Susan et al*[52] in India 2018, 95% by *Shahnawaz et al*[67] in Pakistan 2012, and 82.4% by *GH. et al*[53] in Iran 2012. The preference for the nondominant limb is as a result of the need to carry out minimal work or activities with the limb to preserve the delicate AVF, especially in the first two weeks following surgery.

The preferred type of AVF is radiocephalic fistula. Because creation of this fistula preserves and may dilate the proximal veins for later access attempts, requires less frequent superficialization and lower rate of steal syndrome compare to upper arm AVF.[68],[69] In contrast to previous studies,[37],[53],[67],[20],[38],[52] in which radiocephalic fistula was most common type. The present study revealed that, brachiocephalic (48.5%) was the most common type AVF in our patients, followed by radiocephalic type (32%). Similar observation was also noted by *Yabanoglu et al*[26] in Turkey, and *Shan et al*[70] from Nepal and *Chan et al*[46] in USA. These observed differences may be related to multiples factors include destruction of veins by repeated venipuncture before fistula creation, poor technique, inadequate information available to patients and health worker on pre dialysis care.

AVF takes a number of weeks to mature, on average perhaps 4–6 weeks.[71], [72] In our study, the first time cannulation were achieved after four, four to six and more than six weeks postoperative in 43 (18.6%), 134 (58%) and 28 (12.1%) patients respectively.

Surgical techniques are important factor that affect AVF patency.[73] Despite being variable in clinical applications, the end-to-side anastomosis technique is applied with 4 quadrant, 2-quadrant, oval, diamond-shaped or parachute techniques. There are reports of the common use of the standard parachute end-to-side anastomosis technique not only in Cardio vascular surgery, but also in many surgical fields including hepatobiliary surgery and gastrointestinal surgery.[36], [26], [24], [25]The parachute technique may be an optimal selection in distal AVF where vascular structures are of lesser caliber, especially in DM, elderly patients, and diffuse vessel calcification.[24], [25], [74], [75] In our study, all patients underwent end-to-side anastomosis (parachute) technique for AVF creation. With an immediate patency (palpable thrill intra operative)[41] was 218 (94.4%). In other study, immediate patency was 78-90%.[41], [76], [77]

Thrombus is the most common complication of AVF operations with a rate of 3-14.5%.[10],[39] In our study, thrombosis was 13% of our patient. These figures were in agreement with the literature data. The most common cause of vascular access thrombosis is venous neointimal proliferation.[78] Similar finding was noted in other study.[39]

## 5 Conclusion

Functional AVF is the gold standard for vascular access for hemodialysis. We report, excellent functional rate (85.7%) of AVF created by parachute vascular anastomosis technique with primary failure rate (14.3%) compare to other study. The parachute shaped technique may be an optimal selection in distal AVF where vascular structures are of lesser caliber, especially in elderly and diabetic patients.

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