

Research

## Native Versus Synthetic A-V Fistula for Hemodialysis Access in Obese Patients

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### Abstract

#### Background

The success of chronic hemodialysis in obese patients with end – stage renal failure depends upon the presence of functional arteriovenous fistula to facilitate venipuncture and get adequate blood flow.

#### Aim of the Work

The aim of this work is to compare between native and synthetic fistula in the arm in obese patients referred for haemodialysis access placement regarding safety and effectiveness.

#### Patients and Methods

This retrospective comparative experimental study was carried out on 52 patients with chronic renal failure, who divided into two groups (A&B). In group A, 26 cases were submitted for brachiobasilic fistula, and in group B, the other 26 cases were submitted for brachiosubclavian graft. All patients were examined clinically and the required investigations including; blood picture, PT and INR, in addition to Doppler ultrasonography for some cases. The two groups were compared as regard to patency rate, maturation period and complications.

#### Results

Brachiobasilic fistulas are technically feasible and show good patency rate when compared to prosthetic grafts. Fewer surgery-related complications were seen compared to upper arm prosthetic grafts, and most of them were treated without loss of the fistula. We suggest that this procedure should be considered before placement of a prosthetic graft whenever feasible, Cannulation of the brachiobasilic fistula began at an average of 30 days after surgery. Delays in cannulation were mainly due to prolonged arm swelling and obesity. Brachiosubclavian graft should not routinely be used until 14 days after placement. The incidence of complication was less with Brachiobasilic fistulas especially as regard wound infection, early thrombosis and steal syndrome can be improved by gaining more experience in selecting the suitable candidate and in performing this anastomosis. The Brachiobasilic fistula has some advantages that a native

vein fistula provides better resistance to infection than a prosthetic graft, and it can be performed in obese candidates.

#### Conclusion

For those obese patients with forearm dialysis fistula dysfunction without an adequate superficial vein, a brachiobasilic fistula should be considered as an alternative to prosthetic graft insertion. Regional anesthesia combined with axillary or interscalene nerve block can be a good choice to decrease the need for general anesthesia in hemodialysis patients if available.

**Key Words:** Vascular Access; Arm; Hemodialysis; Arteriovenous Fistula; Arteriovenous Access

#### Introduction

Creating an arteriovenous (AV) fistula for long term hemodialysis is always challenging for surgeons [1].

Patients suffering from obesity undergoing long-term hemodialysis either lack adequate veins for construction or display development of an unsalvageable thrombosis in such a fistula [2].

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The choice is frequently between the use of a prosthetic graft or an autologous vein. Upper-extremity access with the use of polytetrafluoroethylene (PTFE) has proven valuable [3].

For patients suffering from prior forearm AV fistula dysfunction without an adequate superficial vein, we believe that a brachio basilic fistula should be done [4,5].

For long-term hemodialysis obese patients lacking adequate superficial veins, the choices are generally between an autologous vein and placement of prosthetic grafts [6].

Dialysis is the process of separating elements in a solution by diffusion across a semi-permeable membrane (diffuse solute transport) down a concentration gradient [7].

Dialysis is the treatment of choice for removal of sodium in acute hyponatremia in infants due to accidental ingestion of toxic amounts of sodium chloride. Hyponatremia is a rare indication for dialysis. Hypercalcemic crises of various etiologies may be rapidly corrected by dialysis [8].

The selection of the mode of dialysis (peritoneal dialysis or hemodialysis) depends upon several mechanical and medical factors. The mechanical factors include; the development and maintenance of an adequate vascular access required for chronic hemodialysis. Likewise, the abdominal cavity must be capable of receiving indwelling peritoneal dialysis catheter. The peritoneal cavity must also be relatively free of adhesions and able to contain the large volumes of the fluid instilled during dialysis. The medical factors include; the rates of fluid removal with the various forms of dialysis especially in patients with limited cardiovascular responsiveness. The effects of anticoagulants administered during hemodialysis should be considered in patients with bleeding complications [9].

Haemodialysis is the most common treatment for end stage renal failure. The blood passes through an extracorporeal circulation where it is separated from the dialysis fluid by an artificial semi-permeable membrane. Solutes move across the membrane only by diffusion [10].

The actual dialyzer may be of a parallel plate, coil, or hollow fiber type. Body solutes and excessive body fluids can be easily cleared by using dialysate fluids of known chemical composition. Newer high-efficiency membranes (high/flux) are serving to reduce dialysis treatment time. Treatment is intermittent usually 3-5 hours 3 times weekly [11].

The aim of this retrospective study is to compare between native and synthetic fistulae in obese patients; defined as having a BMI  $\geq$  30 kg/m<sup>2</sup>, which were referred for haemodialysis access placement regarding safety and effectiveness.

## Patients and Methods

Fifty two patients with established chronic renal failure, who were candidates for angio access for hemodialysis were recruited. The patients provided written informed consent before the start of the study, which was approved by the Institutional Ethics Committee in accordance with the Declaration of Helsinki of 1996.

### Patients Fell Into 2 Groups

- Group A: who underwent native brachio basilic fistula then superficialization of basilic vein; (26) cases?
- Group B: who underwent prosthetic graft between brachial artery and subclavian vein; (26) cases.

### Inclusion Criteria

1. Patients more than 13 years old and less than 75 years old.
2. End stage renal diseases.
3. Primary forearm A-V fistula dysfunction without an adequate superficial vein.
4. Adequate basilic vein sized  $\geq$  3 mm in diameter.
5. Body mass index (BMI)  $\geq$  30 kg/m<sup>2</sup>.
6. No upper arm A-V graft having previously been performed.

### Exclusion Criteria

1. Arteries smaller than 3 mm in diameter.
2. Veins smaller than 2.5 mm in diameter.

### Methods

This study is retrospective comparative experimental studies that were started by:

- 1) Personal data including

Name, age, sex and occupation.

- 2) Detailed information about the operation (technique):

Demarcation of the site of the brachial artery, the basilic vein and the subclavian vein is done before the operation.

For the native brachio basilic fistula:

Under local anaesthesia, the brachial artery and basilic vein were exposed using the same incision in the antecubital fossa. The vein was anastomosed to the artery in end to side fashion using 6/0 polypropylene vascular suture.

Approximately 3 weeks later, the patient underwent a second operation for "superficialization" of the fistula. Under local anaesthesia or regional nerve block, the basilic vein of the upper arm was exposed through a

medial longitudinal incision with a mean length of 16 cm. Notably, the medial brachial cutaneous nerve is in close proximity to the basilic vein and need to be carefully separated from the vein during dissection. The branches of the vein were ligated. The basilic vein was mobilized up to its junction with the brachial vein. The anterior surface of the vein was marked to avoid axial rotation. A subcutaneous tunnel was created on the anterior aspect of the arm, maintaining its axial orientation, and the vein was passed through the tunnel. Additional care was taken to ensure hemostasis at the end of the procedure.

For the prosthetic brachiosubclavian graft:

Under general anaesthesia, the brachial artery was exposed via an antecubital small incision and the subclavian vein was exposed via a transverse small incision one finger breadth below the middle one third of the clavicle. Six millimeter diameter, standard wall polytetrafluoroethylene (PTFE) graft was tanned and anastomosed to the brachial artery and the subclavian vein in end to side fashion by using 6/0 polypropylene vascular suture.

A palpable thrill must be palpated after closure of the skin and a low frequency murmur with systolic crescendo is auscultated to signify success of the procedure.

3) Follow up (for 6 months):

The fistulae are studied weekly post-operatively by clinical examination as follows:

- A) Age of maturation.
- B) Distal circulation.
- C) Frequency of usage.
- D) Complications.
  1. Thrombosis.
  2. Aneurysmal formation.
  3. Failure of veins to develop.
  4. Infection.
  5. Arterial insufficiency.
  6. Haemorrhage.
  7. Edema of the hand.

### Statistical Analysis

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for

the Social Sciences) software for analysis.

According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean  $\pm$  SD, the following tests were used to test differences for significance.

Differences between frequencies (qualitative variables) and percentages in groups were compared by Chi-square test. Differences between parametric quantitative independent groups by t test. Survival function by Kaplan meier and life table.

P value was set at  $<0.05$  for significant results &  $<0.001$  for high significant result. Data were collected and submitted to statistical analysis. The following statistical tests and parameters were used.

### Results

In this retrospective comparative experimental study, Fifty two patients suffering from established chronic renal failure were candidate for angio access and they constituted the material of this work, the age of the patients ranged between 18 years and 75 years. The mean age of (26) cases of brachiobasilic fistula was  $46.57 \pm 9.93$  year and the mean age of (26) cases of brachiosubclavian graft was  $44.11 \pm 10.43$  year.

Of the (26) cases of the brachiobasilic fistula, 12 cases were male (46.2%) and 14 cases were female (53.8%). In the brachiosubclavian graft cases, male represented (38.5%) of cases and female represented (61.5%) of cases.

The mean time of maturation of vein in brachiobasilic fistula was  $31.92 \pm 1.67$  day and it was  $13.85 \pm 0.78$  day in brachiosubclavian graft.

There was no significant association between sex and groups, also there was no significant difference between groups and age ( $P=0.38$ ) but native was significantly higher than synthetic regarding maturation time.

Complications distribution among studied groups revealed 21 and 16 not complicated cases among native and synthetic group respectively, and revealed 5 and 10 complicated cases among native and synthetic group respectively.

There was no significant association between groups and complications ( $P= 0.12$ ).

Early thrombosis not occurred in any of brachiobasilic fistula but occurred in 5 cases of brachiosubclavian graft (19.2%) after episodes of hypotension which required a surgical thrombectomy.

Late thrombosis developed in 2 cases of brachiobasilic fistula (7.7%) and also 2 cases of brachiosubclavian graft (7.7%). Late thrombosis is mostly due to progressive stenosis over the anastomosis and venous outlet, secondary to intimal hyperplasia. Treatments include a thrombectomy or thrombectomy plus balloon angioplasty.

Wound infection was noted in a female patient aged 45 years with brachiobasilic fistula 7 days post-operatively (3.8%), and 2 cases of brachiosubclavian graft (7.7%) which needed empirical treatment with antibiotics.

Aneurysmal dilatation developed in one case of brachiobasilic fistula and one case of brachiosubclavian graft. This dilatation developed at the site of repeated needle punctures of the arterialized vein and required no treatment.

Symptomatic steal not occurred in any of brachiosubclavian graft and occurred in one case of brachiobasilic fistula (3.8%) and ended by ligation of the shunt.

There was no significant association between groups and different complications ( $P=0.22$ ).

In brachiobasilic fistula, there were 38.5% of cases with no previous dialysis, and 61.5% of cases with previous hemodialysis. While in brachiosubclavian graft, there were 53.8 % of cases with no previous dialysis, and 46.2% of cases with previous hemodialysis. So, there was no significant association between groups and previous dialysis ( $P=0.26$ ).

Primary functional patency rate in brachiobasilic fistula was 80.8%, and in brachiosubclavian graft, it was 57.7%. Of the five complicated cases of brachiobasilic fistula, one case was male aged 39 years and the other four cases were females aged 59,45,49,35 years. Eleven non functional cases of brachiosubclavian graft; nine females aged 56, 39, 75, 44, 30, 53, 42, 43, 47 years and two males aged 48,50 years. So, there was no significant association between primary patency rate and groups ( $P=0.07$ ).

Secondary patency rate in brachiobasilic fistula was 92.3%, and in brachiosubclavian graft, it was 76.9%. Also there was no significant association between secondary patency rate and groups ( $P=0.12$ ).

Of the 5 non functioning cases of brachiobasilic fistula 3 cases became functioning after a surgical or angioplasty intervention, and of the 11 non functioning cases of synthetic graft 5 cases became functioning after intervention.

The primary patency rate at the end of interval was 81% and 58% in native and synthetic group respectively.

The secondary patency rate at the end of interval was 92% and 77% in native and synthetic group respectively.

Of the fifty two arteriovenous fistulae performed in this study, failure of maturation, venous hypertension, vascular access neuropathy and heart failure have not occurred.

Patients who had undergone a BBAVF had a better survival rate than patients who only had an access graft inserted.



**Fig. (1): Incision for brachiobasilic anastomosis.**



**Fig. (2): Incision for basilic vein superficialization.**



**Fig. (3): Isolation of basilic vein.**

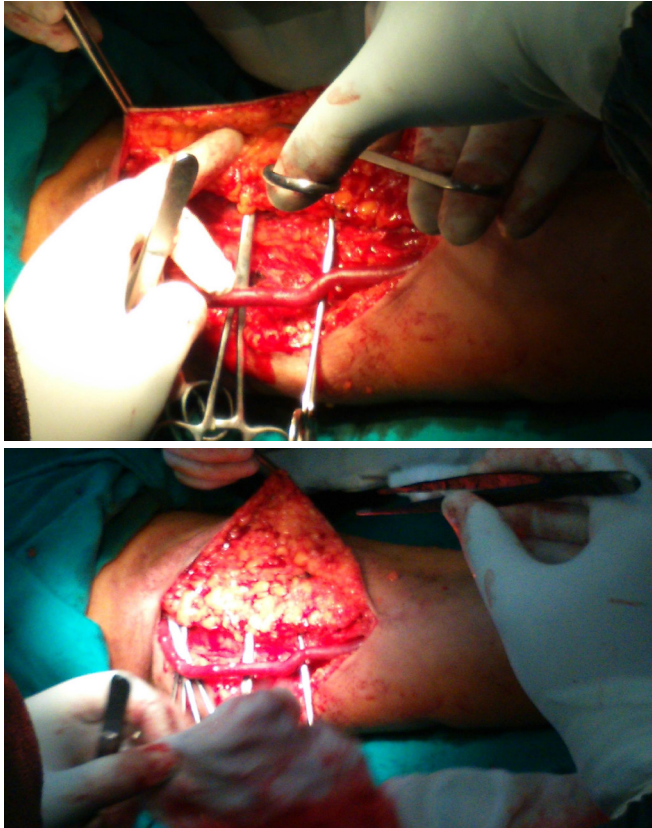


Fig. (4): Basilic vein superficialization and tunneling under the skin.



Fig. (6): Incision for brachiosubclavian graft.



Fig. (5): Closure of the wound with and without drain.

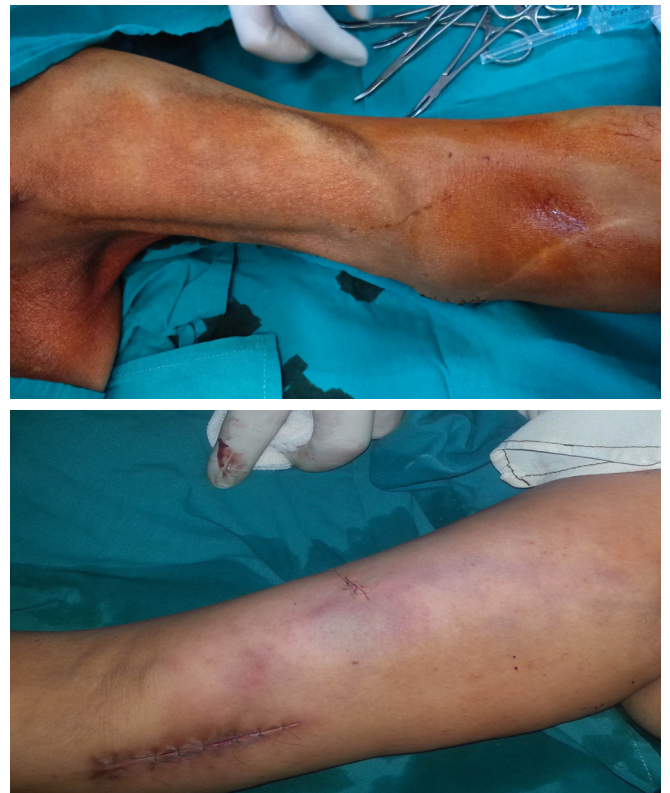


Fig. (7): Closure of the wound.



Fig. (8): Postoperative swelling of the limb



Fig. (9): Wound infection.



Fig. (10): Aneurysm formation.

## Discussion

In cases with end stage renal disease, renal transplantation is the curative and most reasonable treatment, but due to long waiting list, long term hemodialysis is the main resort for end stage renal disease (ESRD) patients [12].

To initiate hemodialysis, the first step is the creation of the arteriovenous fistula. The arteriovenous fistulae are recommended by several guidelines committees as the vascular access of choice for routine outpatient hemodialysis [13].

Unfortunately, AV fistulae had many complications, ranging from infection, aneurysm formation, stenosis or thrombosis and ultimately the formation of intimal hyperplasia [14].

Constant care to maintain vascular access patency of great importance. However, Failure of AV access is a major cause of morbidity, rising the need for advanced intervention to regain AV access patency [15].

In this study of 52 patients with chronic renal failure, there were 26 patients submitted for brachio basilic fistula, and the other 26 patients were submitted for brachiosubclavian graft.

The primary survival patency rate of the brachio basilic fistula in this study was 81%, while it was 69% in Weale et al [16]. The primary survival patency rate of brachiosubclavian graft in this study was 65%, while it was 67% in Rabbani et al [17] study. The mean age of brachio basilic fistula was  $46.57 \pm 9.93$  year and of brachiosubclavian graft was  $44.11 \pm 10.43$  year. Rabbani et al.(17) studied 37 patients and the mean ages of fistula group and graft group were 54 (13 to 75) and 53 (22 to 73) respectively.

The male to female ratio was 1 : 1.3 in this study. In a study of 59 patients Tellis et al. [18] had a male to female ratio of 1.5 : 1, while in Chazan et al. [19] study, it was 0.55 : 1.

The effect of age and sex is most probably due to their effect on the vasculature of the patients, as young and male patients usually have better artery and vein suitable for anastomosis, than old and female patients but in our study there was no significant association between sex and groups, also there was no significant difference between groups and age ( $P=0.38$ ).

The importance of selecting a good vein for creation of the arteriovenous fistula is stressed upon in many studies, furthermore, some authors advise performing a preoperative venogram to evaluate the availability of the distal veins, and to rule out proximal venous stenosis and obstruction [20].

In this study, the mean time of maturation of vein in brachio basilic fistula was  $31.92 \pm 1.67$  day and it was  $13.85 \pm 0.78$  day in brachiosubclavian graft, while in Chieh-Hung Lee et al. [21] study, cannulation of the brachio basilic fistulae began at an average of 33 days.

The maturation period was affected by the condition of the vein at

operation, and it was found that the maturation period was shorter in case of a good vein. Although Murphy et al. [22] mentioned that the time needed for maturation is in the average of eight days, Nicholas(23) advised to wait for 4 – 6 weeks to allow arterialized veins and venous collaterals to develop.

Aneurysm formation was a complication encountered in this study, and it occurred in one case of brachio basilic fistulae and one case of brachiosubclavian graft and required no treatment. This is however, is not related to the type of the fistula, and most probably due to repeated needle venipuncture at the same site and subsequent obliteration of the upper venous segment. Two factors – as stated by Bonalumi et al. [24], seem to lead to this complication : preference for inserting needles in distal areas by dialysis personnel, and the pressing desire of the patient always to be punctured at the same venous site because of skin insensibility.

Early postoperative swelling is a common finding following brachio basilic fistula or upper arm bridge prosthetic graft creation. It results from venous hypertension, and as collaterals develop and outflow improves, it rapidly disappears. Arm elevation and patient reassurance are usually sufficient.

Persistence of severe swelling suggests obstruction of the major outflow vein (the axillary-subclavian-innominate vein). A venogram can document this clinical impression. This condition can be managed by balloon angioplasty, balloon angioplasty plus stenting, extension of the graft over the obstruction, or ligation of the fistula in severe cases. In Chieh-Hung Lee et al. [21], it was one case of brachio basilic fistula and twenty cases of the graft,

Late swelling is usually due to central vein (axillary, subclavian, or innominate vein) stenosis or obstruction. In this particular situation, the causative factor was intima hyperplasia that resulted from turbulent flow draining of the AV fistula or trauma to the vascular wall induced by previous indwelling catheter placement. A diagnosis is supported by the presence of venous collaterals around the shoulder and is documented by fistula angiography. Treatment modalities consist of balloon angioplasty alone or with stenting, extension of a graft to the unobstructed vein, or access ligation [25].

Steal syndrome tends to be more prevalent with brachio basilic fistulae, most likely because of the larger diameter of the basilic vein. In addition, more severe atherosclerotic arterial disease in these patients, which may have resulted in multiple prior failures of the access procedure such that they now must undergo brachio basilic fistula placement, also may be a contributing factor to steal syndrome and occurred in one case (3.8%) with brachio basilic fistula in our study and ended by ligation of the shunt. In the Chieh-Hung Lee et al. [21] series, there was one case of arterial insufficiency.

Thrombosis was the most-common complication of AV fistulae, and early thrombosis (within 1 month after surgery) was mainly due to technical or judgmental errors. Common causes were kinking of the vein over the anastomosis, an inadequate anastomotic technique, and undetected venous outflow occlusion. In addition, inadequate arterial inflow due to atherosclerotic arterial disease can also produce early failure. Late thrombosis is mostly due to progressive stenosis over the anastomosis and venous outlet, secondary to intimal hyperplasia. Treatments include a thrombectomy, thrombectomy plus balloon angioplasty, or graft bypass beyond the diseased vein.

Early thrombosis not occurred in any of brachio basilic fistula but occurred in 5 cases of brachiosubclavian graft (19.2%) after episodes of hypotension which required a surgical thrombectomy.

The incidence of late thrombosis was 7.7% for brachio basilic fistula and 7.7% in brachiosubclavian graft in this study and treated by thrombectomy or thrombectomy plus balloon angioplasty. In Thompson et al. [26], it was 23%.

Wound infection was noted in our study in one case with brachio basilic fistula 7 days post-operatively, and two cases of brachiosubclavian graft which needed empirical treatment with antibiotics, while in Rabbani et al. [27] study, Infection occurred in one case of graft group with no infection was found in the native cases.

In this manner, we tried to maximize future options, increase the patency of hemodialysis access and minimize the complications and costs.

## Conclusion

- For those obese patients with forearm dialysis fistula dysfunction without an adequate superficial vein, a brachio basilic fistula should be considered as an alternative to prosthetic graft insertion. Regional anesthesia combined with axillary or interscalene nerve block can be a good choice to decrease the need for general anesthesia in hemodialysis patients if available.

- Furthermore, a failed brachio basilic fistula does not prohibit subsequent use of a prosthetic conduit at the same site in the future. We believe that a brachio basilic fistula should precede the placement of upper arm prosthetic grafts in most patients for upper arm dialysis access whenever feasible.

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