

## Endovascular Salvage of Dysfunctional Autogenous Vascular Access

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### ABSTRACT

Chronic kidney disease is a major public health problem. Hemodialysis is still the most commonly used form of renal replacement therapy. Arteriovenous fistulae are the preferred mode of vascular access worldwide due to its ability to provide high blood flow rates with superior patency and low rate of complications. Vascular access failure is a major source of morbidity, mortality and expense for patients undergoing hemodialysis. Every effort should be spent to preserve them as their value can only become more precious the longer the patient remains on hemodialysis. Several techniques have been described to maintain a hemodialysis access site; varying from open surgical ones to percutaneous endovascular approaches and sometimes hybrid procedures. **Patients and Methods:** This study included 20 patients who were referred from the dialysis unit to vascular surgery department of Kasr Alainy hospitals in the period between March 2012 to March 2014 with dysfunctional arteriovenous fistula. All of the patients underwent fistulography followed by angioplasty and they were followed up for 6 months. **Results:** The age of patients ranged from 27 to 79 years. The study included 14 males and 6 females. Our study included 10 radiocephalic AVF, 4 brachiocephalic AVF, and 6 brachiocephalic AVF with superficialization. Transradial approach was used in 16 patients of which cutdown technique was applied in 6 cases due to very distal AV fistula. Transvenous approach was used in 4 cases. Juxta-anastomotic venous stenosis was detected in the 16 cases. Multiple stenoses in the draining vein were detected in 4 cases. Associated Arterial stenosis was detected in 4 cases. Angioplasty was performed in all patients. Technical success was 18/20 cases. One vein ruptured and resulted in a hematoma and the fistula was surgically ligated and the other there was failure of angioplasty. One radial access hematoma occurred and was managed conservatively. **Conclusion:** PTA is an effective therapy in restoring the function of failing AVFs. Compared to surgery, PTA has several advantages, including the fact that it is relatively simple, less invasive, shorter procedure, causes less stress to the patient, enables immediate dialysis without the need for central venous catheter, reduces the risk of infection, and saves the patient's veins.

**Keywords :** Salvage of AV fistula, fistula angioplasty

### INTRODUCTION

Because autogenous AV fistulae have better long term patency and less liable to infection and much less expensive than AV grafts, The National Kidney Foundation- Dialysis Outcomes Quality Initiative recommends a "fistula first approach to ESRD patients. Dialysis access patency remains crucial for patients with end stage renal disease (ESRD). Malfunctioning dialysis access is a major problem usually caused by venous stenosis or less commonly arterial stenoses and sometimes both. Large accessory veins can also delay maturation of AV fistula. The National Kidney Foundation- Dialysis Outcomes Quality Initiative 2006 clinical guidelines recommend intervention on a fistula with hemodynamically significant venous stenosis and/or inadequate flow.

The purpose of this study is to describe the percutaneous interventions required to and

maintain patency of dysfunctional autogenous AV fistulas.

### PATIENTS AND METHODS

This study included 20 patients who were referred from the dialysis unit to vascular surgery department of Kasr Alainy hospitals in the period between March 2012 to March 2014 with dysfunctional arteriovenous fistula.

Patients presenting with dysfunctioning arteriovenous fistula manifested by fistula with weak thrill or pulse with no thrill or insufficient flow during dialysis were included in the study while patients with Thrombosed arteriovenous fistula (which means there is no even pulse palpable by physical examination.) or physical evidence of arteriovenous fistula related infection or Patient with history of major allergic reaction

to IV radiocontrast agents were excluded from the study.

Patient demographics, type of AV access and number and location of lesions, were recorded.

Duplex ultrasound was done to all patients to categorize the patient to either

- a) Juxtaanastomotic venous stenosis.
- b) Multiple venous stenoses.
- c) Arterial inflow stenosis
- d) Combined arterial and venous stenoses.

#### **Technique:**

In cases with only juxtaanastomotic venous stenosis, a 6 French 11 cm long vascular introducer sheath was inserted percutaneous retrograde into the venous limb of the AVF while the radial artery access was chosen in cases with multiple venous stenoses or in cases with both arterial and venous stenoses. Cutdown on the radial artery in the anatomical snuff box was used in patients with very distal radiocephalic AVF to gain more working distance and only 2-3 cm of radial sheath were inserted. Two thousand and five hundred units of heparin were administered through the side port of the introducer sheath into the AVF.

Diagnostic angiography was performed through the sheath. When the venous access was used upstream compression was done to while injecting to visualize the anastomosis and the inflow artery. number and location of lesions were recorded

A hydrophilic coated 0.035 "Terumo guidewire (Terumo, Tokyo, Japan) 150 cm was used to cross the lesion. Balloon size was determined based on the findings of fistulography usually 6 or 7 mm semicompliant balloon with length 2-4 cm catheter was then passed over the guidewire and advanced to the lesion assisted by fluoroscopy.

The balloon was then fully inflated (i.e. until no residual balloon waist is present). Inflation was sustained for 30-60 seconds. Multiple inflations were used for resistant lesions. If there was still residual stenosis, a non compliant balloon was used.

After PTA, a set of arteriovenous fistulograms were again performed in different angulations to document the result of angioplasty.

#### **Assessment:**

The result of PTA was considered technically successful if the degree of residual stenosis was less than 30% as visualized using the fistulogram.

A clinically successful PTA procedure was defined as the ability to dialyze 3 consecutive times.

Primary patency was defined as patency during the interval between primary intervention and repeated radiologic intervention because of dysfunction.

All patients were followed up for 6 months after the intervention. Complications and interventions were recorded for this period.

## **RESULTS**

This study included 20 patients presented with dysfunctional arteriovenous fistula. They had peripheral endovascular intervention in the form of percutaneous transluminal angioplasty.

The age of patients ranged from 27 to 79 years. The study included 14 males and 6 females. only 6 patients had diabetes mellitus and 14 patients had hypertension. Our study included 4 brachiocephalic AVF, 10 radiocephalic AVF and 6 brachiocephalic AVF with superficialization.

Trans-radial approach was used in 16 cases where open technique was applied in 6 cases due to very distal AV fistula. Transvenous approach was used in 4 cases.

Juxta-anastomotic venous stenosis only was detected in the 16 cases. Multiple venous stenoses in the draining vein was detected in 4 cases. Associated arterial stenosis was detected in 4 cases.

Angioplasty was performed in all patients.. There were no cases of central vein stenosis or accessory vein ligation.

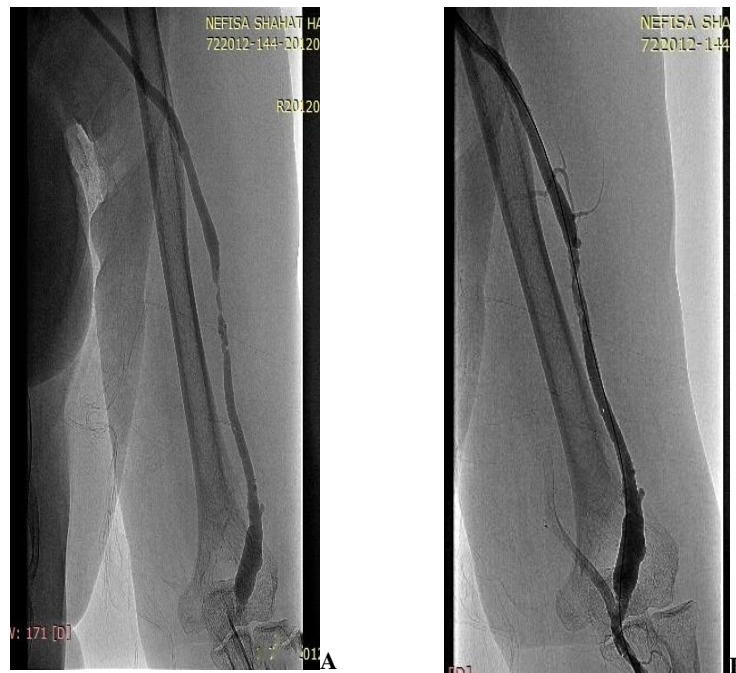
High pressure balloons were used in 5 cases (after failure of semicompliant balloons to fully dilate the lesion).

Technical success was 18/20 cases. There was one case of failed angioplasty which showed arterial and juxta-anastomotic venous stenosis where even the high pressure balloon was not successful). One vein ruptured due to usage of a 7 mm balloon instead of a high pressure balloon, resulted in a hematoma and the procedure was aborted and the fistula was surgically ligated. One radial access hematoma occurred and was managed conservatively.

There were 16 fistulas patent for 6 months. Two had recurrence in 3 months.



**Fig. 1:** 53 years old male patient with CKD 2 years ago on regular hemodialysis with right radiocephalic AVF 1.5 years ago followed by weak blood flow and pulse over the fistula. A. Percutaneous transradial approach showed anastomotic arterial stenosis and juxta anastomotic stenosis with a small nipple of the vein visualized. B The patient was managed by endovascular angioplasty for the stenosis in the artery and flow rerouting of the vein from cephalic to basilica



**Fig. 2:** Sixty three years old female patient with CKD 1.5 years ago on regular hemodialysis Sessions) underwent right brachiocephalic AVF 4 months ago followed by insufficient flow during hemodialysis. Transradial open access was performed. A. Fistulography showed anastomotic and other mid arm stenosis of the cephalic vein. B The patient was managed by endovascular venous angioplasty.

## DISCUSSION

Vascular access complications are one of the main causes associated with an increase in morbidity and mortality in stage 5 chronic kidney disease patients on regular hemodialysis (HD). To improve quality of life (QOL) and overall outcomes for HD patients, 2 primary goals were originally put forth in the vascular access guidelines to emphasize placement of a functioning fistula. First, increase the placement of native fistulae and second, detect access dysfunction before access thrombosis<sup>[1]</sup>.

The AVF is regarded as the vascular access of choice for hemodialysis because of its superior patency and lower complication rates compared to AV grafts (AVG)<sup>[2]</sup>. Juxta-anastomotic stenosis is considered the major cause of AVF dysfunction<sup>[3]</sup>. The National Kidney Foundation/Kidney Disease Outcomes Quality Initiative has suggested percutaneous transluminal angioplasty (PTA) as a preferred treatment for vascular access stenosis  $\geq 50\%$  with clinical or hemodynamic abnormalities<sup>[1]</sup>. Other causes include preexisting or de novo inflow stenoses, accessory veins and long outflow vein stenosis<sup>[3]</sup>. In this study juxta-anastomotic stenosis was detected in 16 cases. Stenosis in the draining vein was detected in 4 cases. Associated arterial stenosis was detected in 4 cases combined with venous stenoses.

Results of PTA after vascular access thrombosis are generally worse, with a reported six-month patency rate of only 19% in one study done by Lilly et al, 2001<sup>[4]</sup>. This finding suggests that the outcome of PTA of less severe stenosis is superior to the outcome of PTA of more severe stenosis that lead to thrombosis, emphasizing the importance of effective surveillance of access stenosis and preemptive PTA. In our study all patients exhibited insufficient flow on hemodialysis which is a strong predictor of imminent thrombosis which is associated with higher risk of subsequent failure of the vascular access. All patients underwent fistulography. All patients exhibited baseline stenosis  $\geq 50\%$  with clinical abnormalities.

The transradial approach was used in the 16 cases either percutaneous (n=10) or open (n=6) and proved to be better than the transvenous approach regarding the ability to treat multiple lesions (juxta-anastomotic and venous outflow stenoses) and post puncture compression without

the flow within the fistula being compromised and without the risk of hematoma on the access puncture site which may delay the use of the access<sup>[5]</sup>. A limitation to the TRA is the inability to accommodate large sheath sizes when managing central venous stenoses. There was no cases with central venous stenoses in this study.

High pressure balloons were mandatory in 5 cases due to failure of conventional balloons to fully dilate the stenosis. In a study done by Aftab et al in 2014 in which he compared cutting balloon angioplasty versus high pressure balloon angioplasty in cases with failed conventional balloon angioplasty and he has shown in this randomized prospective study that cutting balloon angioplasty has higher 6 month and 1 year patency rates<sup>[6]</sup>. This is very similar to the findings in our study, the 2 failed cases of angioplasty were due to failure of high pressure balloons, the 2 cases that lost patency were those of the patients who presented with tight lesions that required high pressure balloons. This also demonstrates that stenoses that do not respond well to conventional semi compliant balloons are more prone to early restenosis and thrombosis.

In 2015 Swinnen et al has performed 68 juxta-anastomotic stenting with bare metal nitinol stents, has shown excellent technical success of 97% and 2 year primary patency of 90% and 80% at 4 years<sup>[7]</sup>. At the time of our study we were not aware of this possibility and it was not used in any case.

The society for cardiovascular interventional radiology (SCVIR) Technology Assessment Committee recommended reporting both angiographic and functional data as efficacy parameters for PTA<sup>[8]</sup>. A successful PTA procedure should lead to an increase in access flow of 250-300 mL/min<sup>[9]</sup>.

Schwab et al 2001 defined failure of PTA as an increase in access flow less than 20% [10]. This lack of effect in a minority of patients may be caused by rapid recoil of stenotic lesion, occurring in the period between PTA and the first access flow measurement. Ultrasound after PTA showed that immediate elastic recoil occurred in 50% of the stenotic lesions<sup>[11]</sup>. Access flow measurements, during or immediately after PTA, made in the intervention room, could be helpful to optimize procedure results<sup>[10]</sup>.

Initial technical success rates of PTA i.e. post PTA residual stenosis less than 30%, range from

80 to 94%<sup>[12], [13]</sup>. The highest rate of technical failure is associated with central lesions. This was similar to our technical success rate of 18/20 (90%). Functional success which means ability to dialyze 3 consecutive times was achieved in 90% of cases with good flow on hemodialysis.

Primary patency rates at six months after PTA range from 43 to 77% in AVG<sup>[12], [13]</sup> and<sup>[14]</sup>, and a six-month patency of more than 95% for PTA of AVF<sup>[14]</sup>, with poorest long term success in central lesions (ranging from nearly 25% to 42% at 6 months). PTA seems to be more successful in AVF than in AVG. Also, the mean time interval for re-PTA is longer for AVF than AVG indicating a slower development of restenosis in AVF<sup>[14]</sup>. In this study 20 cases were subjected to angioplasty 16 cases showed 6 month patency rate (80%), which may be explained by intervention prior to thrombosis which is associated with more favourable outcome and there was no central lesions which are associated with lower patency rate. This remarkable primary patency in our study may be explained by early referral of cases prior to thrombosis, no cases with central lesions subjected to PTA which is associated with poor outcome and finally the study included cases with AVF only with no AVG as it shows better patency and slower development of restenosis.

PTA results in substantial vascular injury, which may trigger development of restenosis. However, several authors found similar success rates after first, second or third PTA<sup>[13] [14]</sup>.

In our study none of the subjects was subjected to re-PTA, so results after re-PTA couldn't be evaluated. However substantial vascular injury may have occurred in the form of clinically insignificant stenosis.

In our study complications occurred in only one patient in the form of hematoma from balloon oversizing and the procedure was aborted and the tear could not be tamponaded with balloon so surgical ligation was done and alternative access done for the patient. So PTA can be considered a safe procedure, many others like Beathard et al in 1992<sup>[13]</sup> who experienced only 1 complication in 149 cases of transvenous PTA and there was only 1 access related hematoma that was managed conservatively. Le et al in 2015 reported 55 cases of transradial approach to PTA of AVF stenosis and there was no transradial punctures resulted in perioperative radial artery thrombosis or postoperative clinical hand ischemia and five

technical failures were due to an inability to cross the stenosis and required another access site to complete the intervention. One technical failure was due to a pseudoaneurysm rupture and required immediate ligation of the fistula i.e only 1 major complication in 55 cases<sup>[5]</sup>.

The limitations of the current study was that it was conducted in a relatively small number of patients. Therefore, further randomized, large-scale studies are required.

In conclusion, PTA is an effective therapy in restoring the function of failing AVFs. Compared to surgery, PTA has several advantages, including the fact that it is relatively simple, less invasive, shorter procedure, causes less stress to the patient, enables immediate dialysis without the need for central venous catheter, reduces the risk of infection, and saves the patient's veins. However, the open surgical and endovascular treatment should be viewed as alternative or complementary approaches rather than competitive ones (NKF-K/DOQI Clinical practice guidelines for vascular access, 2006)<sup>[1]</sup>.

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