Sometimes endovascular salvage of failing hemodialysis access is indispensable as you may not get another

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Purposes
This study aimed at salvaging fistulas using percutaneous transluminal balloon angioplasty (PTA) and evaluated the feasibility and safety of this PTA.
Patients and methods
A retrospective study was conducted on 15 patients to evaluate the results of endovascular intervention for the treatment of failing arteriovenous fistula from August 2015 until March 2016; these patients included eight (53.3%) men and seven (46.7%) women; most patients were aged between 40 and 60 years.
Results
Immediate success rate was 66.4% in anastomotic stenosis, 75% in juxta-anastomotic stenosis, and 100% in cases of central venous and arterial stenosis. Success rate after 6 months was mostly 50%, which necessitated re-PTA, except in central stenosis cases, which showed a success of 100%. Failed procedure was observed in three cases; two were due to puncture site hematoma and vein or anastomotic site rupture; these were treated with open surgery and ligation of the artery and vein proximal and distal to the anastomosis. Thrombosis was the cause of failure in the third case.
Conclusion
From this study we conclude that saving access can save life. Failing arteriovenous fistulas can be salvaged with PTA safely and effectively. Results are obtained with less trauma to the patient, preservation of access sites, and less postprocedural pain and wound edema. Centrally located stenoses are accessible. Re-PTA is needed in half of the patients.

Keywords:
endovascular salvage, failing hemodialysis access, outcomes

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Introduction

Hemodialysis, which is the main modality of renal replacement therapy, depends on the ability to maintain good vascular access capable of sustaining high blood flow rates. The native arteriovenous fistula (AVF) is recommended as the first choice because of its superior patency and lower complication rates over grafts and catheters. Vascular access dysfunction is a major cause of morbidity and hospitalization in the hemodialysis population [1].

Autogenous AVFs and prosthetic arteriovenous grafts (AVG) are necessary for chronic end-stage renal failure patients on hemodialysis. AVFs are the preferred initial hemodialysis access because of their longer patency compared with AVGs. AVGs, however, remain clinically important in patients in whom AVFs are not feasible, and possibly in special populations such as the elderly [2,3].

In the past when confronted with such failing fistulas, the usual response was to forget this access completely, insert a temporary catheter, and plan for a new access. However, on the basis of the limited number of access sites available for each patient and the increasing life expectancy of patients on regular hemodialysis, the DOQI guidelines recommend early detection and treatment of all hemodynamically significant fistula stenoses, both to extend the life span of each access as long as possible and to avoid the need to use a temporary hemodialysis catheter [4,5].

Hemodialysis accesses are prone to failure due to thrombosis, usually concomitant with stenosis over the anastomosis or outflow vein. Access thrombosis frequently requires semiemergent salvage intervention, but outcomes are generally unfavorable. Patients may eventually require multiple salvage procedures to restore functionality or for creation of a new access. Some patients require placement of central venous catheters in the interim while the hemodialysis access becomes fully functional.

Alternatively, to prevent access failure, clinicians can monitor the performance of these accesses and prophylactically provide interventions to rectify the hemodynamic problems and prolong their patency [6–8].

Hemodialysis vascular access dysfunction (which mounts to failure) is classified into early and late failures. At a clinical level, early failure has been defined as an AVF that never develops adequately for dialysis (failure to mature), or which fails within 3 months of starting dialysis. Late failure is defined as failure that occurs more than 3 months from fistula construction or use [9].

A variety of endovascular interventions have been used, including a combination of venous angioplasty, arterial angioplasty, and accessory vein obliteration. Successful fistula maturation can be achieved in up to 92% of patients. Treatment of discrete stenotic lesions with percutaneous angioplasty is the most readily apparent intervention that would be expected to enhance fistula flow and contribute to successful maturation [10].

This study aimed to review the effectiveness of endovascular intervention for preservation of failing accesses.

Patients and methods

The current study was conducted at the General Surgery Department, Benha University, from August 2015 until March 2016. Follow-up data over 6 months were collected from the hospital archives. This retrospective study was conducted on 15 patients to evaluate the results of endovascular intervention for the treatment of failing AVF. These patients had been operated upon from March 2014 until February 2015 and included eight (53.3%) men and seven (46.7%) women; most patients were aged between 40 and 60 years.

The patients included in this study had been operated upon for AVF and had been followed up weekly for 1 month for early detection of failing AVF. A failing AVF was characterized by one or more of the following: (a) reduced thrill of vascular access assessed by clinical palpation by a vascular surgeon; (b) documented decreased dialysis flow rate defined by KDOQI guidelines (access flow less than 600 ml/min, or less than 1000 ml/min with more than 25% decrease over a 4-month period); (c) stenosis detected by duplex ultrasound; (d) nonmaturation of an AVF 6 weeks after creation [11].

Patients suffering from thrombosed AVF (primary failure), patients with infected fistula, those with a huge aneurysmal dilatation with impending rupture (skin changes), those who developed hypotension when they started dialysis (low cardiac output state), and those who showed sensitivity to the dye used in angioplasty were excluded from the study. Patients lost to follow-up (not coming or died), those with contrast allergy, and those who refused to participate were also excluded.

All patients were submitted to detailed history taking, including history of present illness, detailed cardiac and chest problems, history of previous vascular operations, risk factors, allergy, and history of medical disease, examinations that included palpable and/or audible thrill, the length of the dilated segment, the presence of a competing vein, blood pressure, chest and heart examinations, investigations that included routine laboratory investigations (complete blood count, coagulation profile, ECG, serum creatinine, and blood sugar), duplex that measured the lesions (if present) to determine the size of the balloon and/or stent to be used in each lesion, and finally computed tomography venography to assess central vein stenosis.

Endovascular intervention

The procedure was carried out in the operating room or angiosuite. Patients were prepared for surgical intervention to manage any possible complications. The field was sterilized and the patients were monitored clinically by pulse oximetry in the contralateral limb. The procedure was performed under local anesthesia of the puncture site (2% lidocaine hydrochloride) and light sedation during balloon inflation. All patients were approached percutaneously with an appropriately sized sheath (either radial sheath or standard sheath; usually 6 Fr), which was advanced over a guidewire into either the venous or arterial limb of the fistula. The affected site was evaluated before and after treatment. Fistulograms were offered to all patients with one or more of the above-mentioned features of vascular access failure. The degree of stenosis in the perianastomotic region, fistula, and outflow vein and central veins were assessed during fistulography. Endovascular intervention in the form of balloon angioplasty was performed in the same setting if a stenosis of 50% or more of the vessel diameter is detected on angiography using a standard guidewire. Usually, a 260 cm 0.035″ angled hydrophilic guidewire is inserted in the sheath over a 5- or 4-Fr selective Bern or vertebral catheter under angiographic guidance, which is passed upward into the vein across the lesion supported by the catheter until secured in the central vein. The catheter is advanced passing the lesion; then the wire is removed and the central vein imaged for any stenosis or occlusion. The wire is then readvanced through the catheter until the central vein and exchanged for the balloon. Angioplasty balloon, generally 4×60, is inserted in the perianastomotic region and a 12×40 is inserted for central veins. The balloon is inflated with only enough pressure to obtain full dilatation. A completion fistulogram is performed immediately after angioplasty to determine the success of the procedure. In cases with failed balloon angioplasty a venous stent (wall stent) of compatible size is inserted. All patients were observed in the day surgery ward for 2–3 h and discharged if no acute complications (bleeding or thrombosis) were detected. AVFs, which were functional for dialysis before intervention, were used for dialysis the day after angioplasty [12].

Outcome items

Postintervention outcomes included immediate success rate (identified by clinical success: ability to carry out three successful hemodialysis sessions using a pump at 300 ml/min or more through the treated fistula; angiographic success: defined as restoration of luminal diameter with less than a 30% residual diameter stenosis; and technical success: restoration of a good propagating thrill), success rate after 6 months, and complications including hematoma, thrombosis, infection, and rupture of the AVF wall during the first 3 h and follow-up for the first 3 months.

Statistical analysis

The means of all continuous variables were compared by appropriate parametric or nonparametric tests. Categorical variables and proportions were compared using the χ^2-test or the Fisher exact test. Results are expressed as medians, percentages, and means±SD.

Results

During the study period, follow-up data over 6 months were collected from hospital archives; 15 patients with hemodialysis access [eight (53.3%) men and seven (46.7%) women] had failing access confirmed by a fistulogram and subsequently underwent balloon angioplasty for regaining access; most patients were aged between 40 and 60 years. The site of failing AVF was brachiocephalic [nine (60%)] and brachiobasilic [six (40%)]. The associated morbidity was diabetes in 10 cases (66.7%), hypertension in nine cases (60%), and smoking in three cases (20%) (Table 1 and Fig. 1).

Failing access was characterized by decreased access dialysis flow rate in seven patients (46.6%) or stenosis detected by duplex ultrasound in four cases (26.7%); other cases were suspected to be due to reduced thrill of vascular access in two cases (13.3%), lack of fistula maturation in one case (6.7%), and difficulty in access for cannulation in one case (6.7%) (Table 2 and Fig. 2).

The median time from access creation to the time of first intervention was 10 months (range=2–18 months) for brachiocephalic AVFs but 13 months (range=3–23 months) for brachiobasilic AVFs, as brachiobasilic AVFs sometimes had delayed maturation (Table 3).

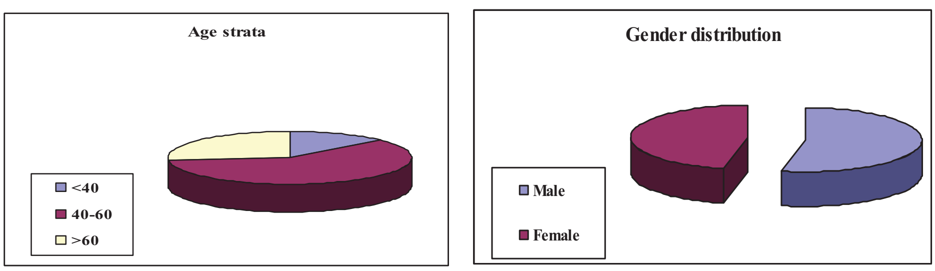
The majority of stenoses were anastomotic [six (40%)]; all six (100%) underwent successful balloon dilatation

Table 1 Preoperative data

Age [*n* (%)] (years)	
Strata	
<40	2 (13.3)
40–60	9 (60)
>60	4 (26.7)
Sex [*n* (%)]	
Males	8 (53.3)
Females	7 (46.7)
Diabetes [*n* (%)]	10 (66.7)
Hypertension [*n* (%)]	9 (60)
Smoking (active) [*n* (%)]	3 (20)
Location of AV fistula [*n* (%)]	
Brachiocephalic	9 (60)
Brachiobasilic	6 (40)

AV, arteriovenous.

Figure 1



a.Age strata b.Gender distribution

Preoperative data: (a) age strata; (b) sex distribution.

and there was no need for stenting; in cases with juxta-anastomotic stenosis [four (26.7%)] successful balloon dilatation was achieved in three (75%) cases and one case (25%) needed stenting; all patients with central venous stenosis [three (20%)] needed stenting (100%) because of failed balloon dilatation but there was no need for stenting in patients with arterial stenosis [two (13.3%)] (Table 4 and Fig. 3).

The immediate success rate was 66.4% in anastomotic stenosis (4/6 cases); one of the two failed cases was due to hematoma and the other due to rupture. The success rate was 75% in juxta-anastomotic stenosis (3/4 cases); the failed case was due to complete thrombosis. Immediate success rate was 100% in cases of central venous and arterial stenosis. The success rate after 6 months was 50% in all cases except in central stenosis, in which success was 100% (Table 5 and Fig. 4).

In the current study puncture site hematoma were observed in four cases; three of them were small and were treated conservatively but the other one case was treated with open surgery and ligation of the artery and vein proximal and distal to the anastomosis. Vein or anastomotic site rupture occurred in one case and was treated by ligation of the access, whereas infection was observed in two cases, which were treated conservatively with massive antibiotics. Thrombosis was observed in two accesses; one of them was lost and the other was treated conservatively for 2 weeks and saved (Table 6 and Fig. 5).

Table 2 Indications for endovascular salvage

Evidence of failing AV fistula	Number of cases [*n* (%)]
Decreases dialysis flow rate	7 (46.6)
Stenosis detected by duplex ultrasound	4 (26.7)
Reduced thrill of vascular access	2 (13.3)
Lack of fistula maturation	1 (6.7)
Difficulty in access cannulation	1 (6.7)

AV, arteriovenous.

Table 3 Time from access creation to first endovascular intervention

Location of the fistula	Median	Range (months)
Brachiocephalic (*N*=9)	10	2–18
Brachiobasilic (*N*=6)	13	3–23

Discussion

Vascular access for hemodialysis (AVF, AVG, or catheters) should be easy to access, safe, effective, and durable.

Table 4 Distribution of stenosis among the study patients

Location of the stenosis	Number of cases [*n* (%)]	Successful balloon dilatation [*n* (%)]	Stenting [*n* (%)]
Anastomotic stenosis	6 (40)	6 (100)	0 (0)
Juxta anastomotic stenosis	4 (26.7)	3 (75)	1 (25)
Central stenosis	3 (20)	0 (0)	3 (100)
Arterial stenosis	2 (13.3)	2 (100)	0 (0)

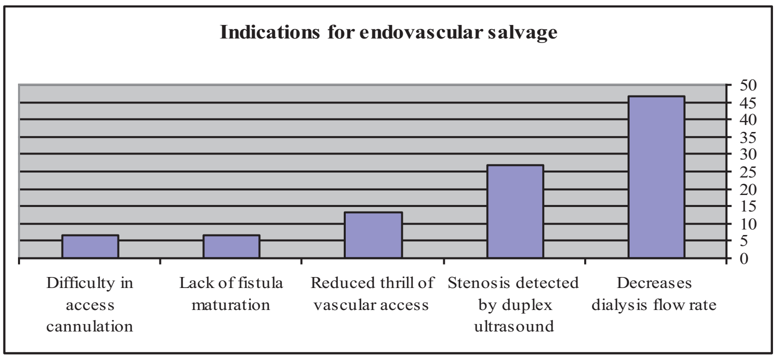
Table 5 Immediate success rate and success rate after 6 months

Location of the stenosis	Immediate success rate number [*n* (%)]	Success rate after 6 months number [*n* (%)]
Anastomotic stenosis	4/6 (66.4)	3 (50)
Juxta-anastomotic stenosis	3/4 (75)	2 (50)
Central stenosis	3 (100)	3 (100)
Arterial stenosis	2 (100)	1 (50)

Table 6 Postintervention complications

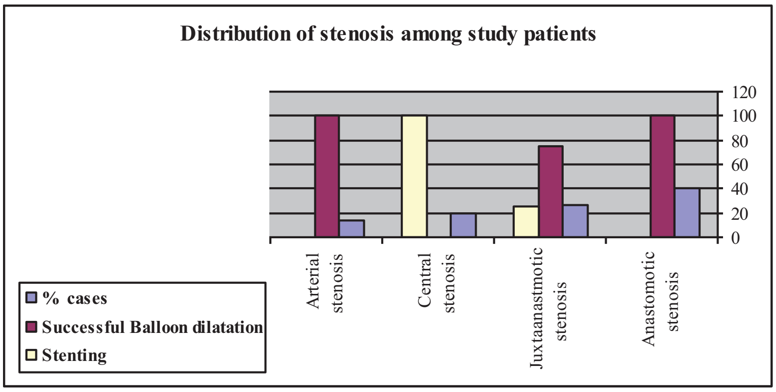
Complications	*n* (%)
Hematoma	4 (26.7)
Thrombosis	2 (6.7)
Infection	2 (13.3)
Rupture	1 (6.7)

Figure 2



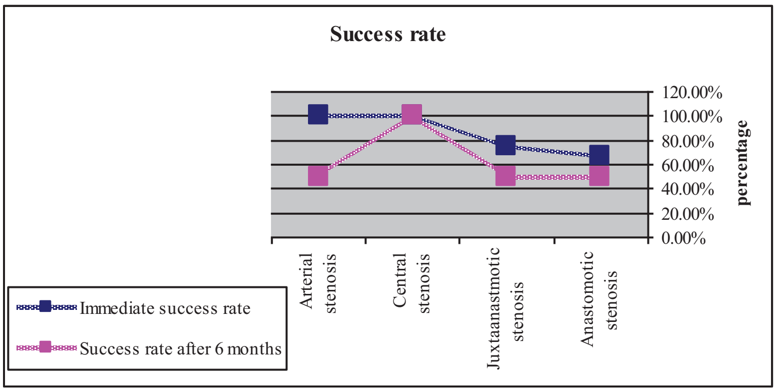
Indications for endovascular salvage.

Figure 3



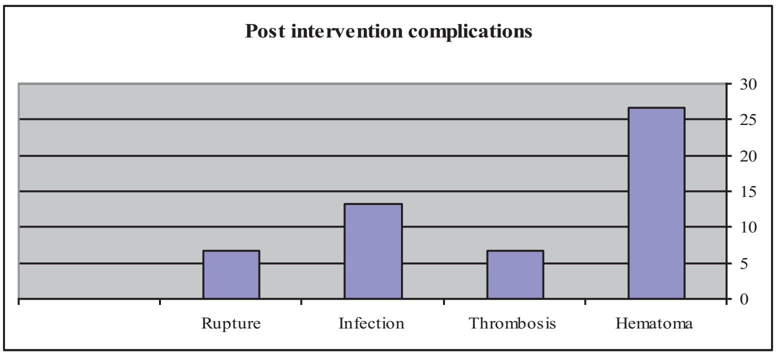
Distribution of stenosis among the study patients.

Figure 4



Immediate success rate and success rate after 6 months.

Figure 5



Postintervention complications.

However, there is no vascular access that satisfies all these requirements all the time and such cases usually require multiple procedures and or interventions. This is because the arteriovenous access is exposed to many factors that could contribute to its failure, which may be early (within the first 3 months) or late (after 3 months). These factors may be arterial (inflow) or venous (outflow) and may be either pre-existing in the patient or related to intraoperative technical errors or postoperative complications [13].

Stenosis is a common problem for AVFs and AVGs and represents the main cause of dysfunction and thrombosis. The choice of the best method for repair depends on the location of the lesion. Access stenosis has been classified on the basis of its location: juxta-anastomotic (type I), in the cannulable segment (type II), and at the outflow into the deep venous system (type III). There are two additional categories of stenoses not involving the access itself: those of the central veins caused by longstanding catheters and those of the arterial inflow [14].

All accesses should be evaluated immediately after their creation and routinely examined during their life span. After creation of an AVF or AVG, there should be a palpable thrill or a bruit; the presence of a strong pulse in the draining vein without a thrill or bruit indicates a proximal venous stenosis. Monitoring AVF by physical examination by trained physicians represents an accurate method for diagnosis of malfunction [15].

Patency of AVFs can be maintained with both open and endovascular revisions [16]. Many investigators feel that the durability of percutaneous transluminal balloon angioplasty (PTA) is too short despite the fact that results of traditional open surgical patch plasty are scarcely reported [17]. Most papers suggest fewer reinterventions after open surgery but there are no randomized prospective studies comparing open versus endovascular surgery in stenoses of native AVFs or prosthetic grafts [18]. According to the National Kidney Foundation (NKF) clinical practice guidelines [19] the choice of open versus endovascular repair should take into account the local expertise of a center. A primary patency of 50% at 6 months seems to be a reasonable goal for endovascular revision.

Endovascular treatment is tempting as it is a rapid procedure with no surgical wound and shorter hospitalization. Furthermore, the fistula can be used for dialysis immediately after PTA, whereas a temporary central dialysis catheter is often required after open repair. For these reasons, PTA is considered a better treatment for failing fistulas [18].

In the USA, endovascular intervention has now replaced surgical therapy as the standard management of vascular access dysfunction because of ease, efficiency, and minimal invasiveness, and data from 2009 show that angioplasties to treat AVF dysfunction have increased three-fold from 1998 to 2007 [20].

Although the transradial approach was the one used and preferred in the current study, other accesses (transvenous, transbrachial, combined, and transulnar) were also used. The transradial access is effective in visualizing and treating both arterial and venous limbs through a retrograde brachial angiogram via one access and permits the operator to stand further away from the image intensifier, thereby reducing radiation exposure. It can also be used diagnostically to map out venous anatomy for surgical revision of an AVF [21].

In the current study use of stents in central lesions was the treatment of choice to improve long-term patency but balloon angioplasty gave accepted results in other peripheral arterial or venous lesions except in one case (25%) of juxta-anastomotic stenosis, which required a wall stent.

The successful salvage rate in the present study was about 83%, which is greater than that of Miquelin *et al.* [22], who showed a salvage rate of 55%. Bhat *et al.* [23] showed a slightly higher salvage rate of 88%. A close but slightly lower rate was reported by Falk [2](74%).

Finally, it is important to set strategy to increase the longevity of AVFs as this dialysis access might be the last resort for dialysis. This strategy must incorporate the efforts of the nephrologists, the dialysis nurse, the vascular surgeon, and the interventionalist. At a minimum, this strategy should be directed toward ensuring that every fistula that is newly created has an opportunity to mature and become a functional access and ensure that every functioning fistula has the best opportunity for longevity.

Conclusion

Saving access saves life. Failing AVFs can be salvaged with PTA as it is a safe and effective treatment method. Results are obtained with less trauma to the patient. It preserves access sites, causes less postprocedural pain and wound edema, and centrally located stenoses are accessible. Re-PTA is needed in half of the patients.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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