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Original article

Role of Balloon Angioplasty in Non-mature Arteriovenous Fistula caused by Stenosis

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ABSTRACT

Background: Arteriovenous fistula (AVF) is a significant procedure for patients in need for hemodialysis. Failure of maturation due to stenosis is a challenge, which need further intervention.

Aim of the work: To present our experience in therapeutic intervention for non-mature arteriovenous fistula caused by stenosis using balloon angioplasty.

Patients and Methods: 25 patients who had stenosis of primary AVF were included. The mean age was 57.28±6.97 years and patients were 16 males and 9 females. Patients were Followed-up every three months up to 1 year. Collected data included patient demographics, cause of renal failure, characters of primary AVF, and variables of balloon angioplasty (e.g., clinical success and complications), primary patency and recurrence of stenosis.

Results: AVF type was radiocephalic (60.0%), brachiobasilic (24.0%) and brachiocephalic (16.0%). The fistula segment was juxta-anastomotic (44%), anastomosis (36.0%) and efferent in 20.0%. Technical success was 100%; the patency rate at 6 months was 80.0%, at 9 months was 64.0% and at 12 months was 56.0%. There was puncture site hematoma in 2 patients (8.0%) that were treated conservatively. The recurrence was reported in 9 patients (36.0%) (8 cases due to re-occlusion and one patient due to thrombus formation). Recurrence was significantly associated with older age and high coronary artery disease.

Conclusions: Balloon angioplasty is effective and safe procedure for treatment of AVF non-maturation due to stenosis.

Keywords: Arteriovenous fistula; Balloon angioplasty; Non-mature; Stenosis.

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INTRODUCTION

Patients with end-stage renal disease (ESRD) are in need for renal replacement therapy. Autologous arteriovenous fistulae (AVF) are the primary and best vascular access method for hemodialysis[1].

In comparison to synthetic grafts and central vein catheters, the AVF are associated with low rate of complications mainly thrombosis and infection; had low revision rate, costs[2], and low mortality rate[3]. On the other side, AVF had the disadvantage of being associated with a relatively high rate of early thrombosis and failure of maturation. Main causes for AVF maturation failure are arterial or venous problems and presence of accessory vein. AVF failure of maturation could be early or late; early failure refers to fistula never develop to a degree to be used in dialysis or fail within 3 months of its first use[4]**.** Late failure refers to failure after 3 months of successful use[5].

Reported rate extending between 24 and 60% rate of failure to mature in studies from European and American hemodialysis patients respectively[6-9].

Thus, autologous arteriovenous fistulae (AVF) failure of maturation is a challenging matter in the establishment of functioning hemodialysis vascular access. Current recommendation is to monitor newly created fistula closely to discover maturation; and if happened, early intervention is recommend. However, there was no consensus on the ideal intervention to enhance AVF maturation[10].

AIM OF THE WORK

Here, we presented our experience in management of stenosis of Non-mature arteriovenous fistula using balloon angioplasty.

PATIENTS AND METHODS

A total of 25 patients with end-stage renal disease, who had dysfunction (stenosis) of primary AVF were included in the present study. The mean age was 57.28±6.97 years and patients were 16 males and 9 females. The study was conducted during the period from June 2016 to June 2018. Patients were Followed-up every three months up to 1 year according follow up protocol adopted by the vascular surgery department for such patients. Patients ***included*** if they had clinical and radiographic signs of stenosis. On the other side, patients with percutaneous transluminal angioplasty (PTA) with stenting, previous PTA for the same AVF or previous thrombectomy were ***excluded*** from the study. The study protocol was approved by the local research and ethics committee of Al-Azhar faculty of Medicine (Dameitta). All patients signed an informed consent after full explanation of the study protocol. Their data privacy and withdrawal right were ascertained. Collected data included patient demographics (age, gender), cause of renal failure, characters of primary AVF, and variables of balloon angioplasty (e.g., clinical success and complications), primary patency and recurrence of stenosis. Patients were examined by color Doppler Ultrasound before fistulography for diagnosis of AVF stenosis. Fistulography was carried out through brachial artery puncture with a 21G needle and injection of 10 mL of contrast substance under local anesthesia. Images were recorded for feeding artery, arteriovenous anastomosis, juxta-anastomotic segment of the efferent and draining veins up to the central veins. The stenosis was assessed by comparison between the stenotic and normal segments of the veins together with application of balloon angioplasty for the stenotic segments with a diameter of <50% of the normal segment. Balloon angioplasty was carried out through endo-venous approach. Access was done through the outflow vein with 5F vascular sheath insertion. Heparin was injected at a dose of 2500 IU (and an additional dose of 1250 IU was injected once every hour, if there is a need, with a maximum dose of 5000 IU).The determination of balloon size was done according to the measured diameter of the reference vessel. A standard balloon (Boston Scientific Inc., 300 Boston Scientific Way Marlborough, Massachusetts, USA) with a diameter of 1 mm larger than the normal size of the venous segment (range 4–8mm) were used. The insufflation of the balloon was sustained for 2 min, and the procedure was repeated if needed. If stenosis was become < 30% after balloon angioplasty, the technical success of the procedure was documented. Manual compression was used to achieve hemostasis after removal of sheath. Clinical success was recognized as adequate dialysis after the procedure. All patients were followed up for at least one year after balloon angioplasty. Angiography was performed if restenosis was suspected based on clinical examination or dialysis parameters. Primary patency was defined as the interval between the balloon angioplasty and the next thrombosis or repeated intervention, as defined by Gray et al.[11]

Statistical analysis of data: the collected data were organized, coded and analyzed by statistical package for social science for windows, Version 20.0 (IBM Corp., Armonk, NY, USA). For categorical variables, Fisher's exact test, Pearson Chi-square tests were used, independent samples (t) and Mann–Whitney U test were used for numerical data. Data were presented as mean ± standard deviation (SD), minimum–maximum values, number (n) and percentage (%) according to type of data. A value of $p < 0.05$ was considered statistically significant.

RESULTS

In the present work, patient age ranged from 37 to 65 years; the mean age was 57.28±6.97 years; 64.0% of patients were males. Risk factors were in the form of smoking (44.0%), diabetes mellitus (72.0%), hypertension (84.0%) and coronary artery disease (32.0%). The primary AVF type was radiocephalic in 60.0%, brachiobasilic in 24.0% and brachiocephalic in 16.0%. The fistula segment was juxta-anastomotic in 44%, anastomosis at 36.0% and efferent in 20.0% (table 1).

Regarding outcome of balloon angioplasty, technical success was 100%; the patency rate at 6 months was 80.0%, at 9 months was 64.0% and at 12 months was 56.0%. The procedure complications were in the form of puncture site hematoma in 2 patients (8.0%) that were treated conservatively. The recurrence during follow up period was reported in 9 patients (36.0%) (8 cases due to re-occlusion and one patient due to thrombus formation). The time to recurrence ranged from 105 to 210 days with a mean duration of 167.14±34.13 days (table 1).

In the present work, recurrence was significantly associated with older age (as patients with recurrence were significantly older than those without recurrence (62.44±1.87 vs 54.37±7.13 years respectively)) and increased coronary artery disease (CAD was reported in 55.6% of patients with recurrence compared to 18.8% of patients without recurrence). Otherwise, no significant association was found between recurrence and patient gender, other risk factors, AVF type or fistula segment (table 2). Examples of studied cases were presented in Figures (1-3)

Table (1): Results among studied populations.

Variable		Statistics
Age		57.28±6.97;37-65
Sex (N, %)	Male	16(64.0%)
	Female	9(36.0%)
Risk factors	Smoking	11(44.0%)
	Diabetes mellitus	18(72.0%)
	Hypertension	21(84.0%)
	Coronary artery disease	8(32.0%)
Primary AVF type	Radiocephalic	15(60.0%)
	Brachiobasilic	6(24.0%)
	Brachiocephalic	4(16.0%)
Fistula segment	Juxta-anastomotic	11(44.0%)
	Anastomosis	9(36.0%)
	Efferent	5(20.0%)
Technical Success		25(100.0%)
Primary patency rate	At 6 months	20(80.0%0
	At 9 months	16(64.0%0
	At 12 months	14(56.0%)
Procedure complications	None	23(92.0%)
	Puncture site hematoma	2(8.0%)
Recurrence		9(36.0%)
Cause of recurrence	Re-occlusion	8(32.0%)
	Thrombus	1(4.0%)
Time to recurrence (days)		167.14±34.13; 105-210

Table (2): Factors associated with recurrence

Variable		Recurrence	No recurrence	Test	P value
Age		62.44±1.87	54.37±7.13	***3.30***	***0.003****
Sex	Male	7(77.8%)	9(56.3%)	1.15	0.28
	Female	2(22.2%)	7(43.8%)		
Risk factors	Smoking	4(44.4%)	7(43.8%)	0.01	0.97
	DM	6(66.7%)	12(75.0%)	0.19	0.65
	HTN	6(66.7%)	15(93.8%)	3.14	0.08
	CAD	5(55.6%)	3(18.8%)	***3.60***	***0.049****
AVF type	Radiocephalic	5(55.6%)	10(62.5%)	0.67	0.68
	Brachiocbasilic	3(33.3%)	3(18.8%)		
	Brachiocephalic	1(11.1%)	3(18.8%)		
Fistula segment	Juxta-anastomotic	4(44.4%)	7(43.8%)	0.06	0.96
	Anastomosis	3(33.3%)	6(37.5%)		
	Efferent	2(22.2%)	3(18.8%)		

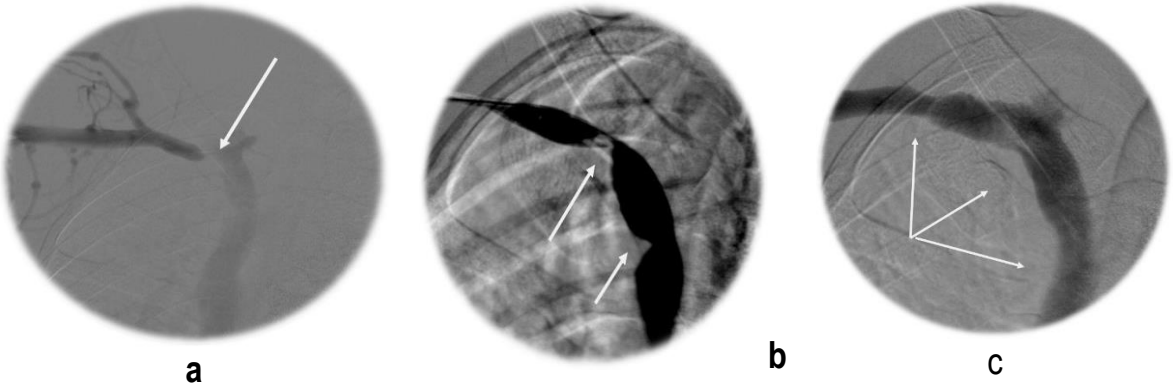

Figure (1): Venography of the right subclavian and innominate vein showing stenosis of innominate vein (a), wasting of the balloon (b), and dilatation of the stenosis after balloon angioplasty (technical success) (c).

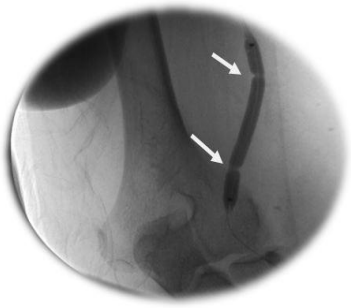

Figure (2): Wasting of balloon with angioplasty of the left cephalic vein

Figure (3): Angioplasty of stenosed anastomosis of right brachiocephalic fistula

Figure (4): stenosed right cephalic vein at juxta-anastomosis

DISCUSSION

Creation of patent arteriovenous fistula remains the gold standard for initiation of hemodialysis with is the main stay in treatment of end stage renal disease (ESRD) (who waiting or unsuitable for renal transplantation). The prevalence of end-stage renal disease is increasing with increased life expectancy of patients with ESRD. Thus, maintaining patency of AVF is crucial for those patients[12]. AVF maturation includes remodeling of the vessel wall, feeding artery enlargement and arterialization of the vein due to increased blood flow and pressure[13]. Non- maturation of the fistula may occurred and recognized by 'insufficient AVF flow to maintain hemodialysis (HD)

after a maturation period of 6 weeks' and the incidence rate is up to 60 %[7].

Here, we presented our clinical experience with treatment of stenosed, non-mature AVF with balloon angioplasty. Results of the present work showed that, balloon angioplasty is effective (technical success was 100% with patency rate of 80.0% at 6 months, 64.0% at 9 months and 56.0% at 12 months after procedure, and safe (complication rate was 8.0%). The associated factors with recurrence were patient age and coronary artery disease.

Ascher et al.[14], Gallagher et al. [15], DerDerian et al. [16] and Rizvi et al.[17] reported that, balloon angioplasty to assist maturation is usually used for treat stenotic non-matured AVF under angiography or ultrasound guidance. They reported a success rate ranged between 55% to 89%.DerDerian et al.[18] reported that, the most common complications were hematoma (40%), extravasation (9%), formation of puncture site hematoma (4%), and thrombosis (2%). In the present work, only puncture site hematoma was reported in 8.0% of patients.

In an observational prospective trial, Beathard et al. [4] included one hundred patients with early non-mature AVF were included with stenosis in 78 %, with 48% of these lesions found to be close to the anastomosis (Juxta-anastomotic). Percutaneous balloon angioplasty was performed with 98.0% success rate. Upon follow up, 84% of the AVF were functioning at 3 months, 72 % at 6 months, and 68 % at 12 months. The overall rate of complications was 4%. Only one patient (1%) had a vein rupture (major complication) with an expanding hematoma and subsequent loss of the access. The other complications were low-grade hematomas needing no specific treatment and no sequelae.

Shah and Agarwal[19] advocated assessment of newly created AVF at 4-6 weeks after creation to discover candidates with early AVF non-maturation (failure). Clinical examination is a simple but effective technique to discover such patients with AVF failure and should be confirmed by Duplex ultrasound. Once discovered, these patients should underwent appropriate intervention use of the percutaneous endovascular techniques such as balloon angioplasty and vein obliteration. They added that, majority of early fistula non-maturation can be salvaged.

In conclusion, balloon angioplasty is an effective and relatively safe interventional procedure for treating stenosis associated with non-matured AVF fistula.

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