

Factors affecting arteriovenous fistula maturation in patients with end stage renal disease

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Abstract

Background: Failure of arteriovenous fistula to mature is a devastating problem in patients requiring regular haemodialysis. Many factors might be incriminated in such dilemma.

Aim: to evaluate different factors that might affect arteriovenous fistula maturation in a prospective study.

Methods: Fifty patients (31 males & 19 females) with end stage renal disease and requiring regular haemodialysis underwent their suitable fistulas. Successful fistulas were categorized into early matured or delayed one, where by mature fistulas were those matured in 6 weeks. Fistulas' maturation was evaluated in respect to the association of certain risk factors such as gender, age, smoking, diabetes, hypertension, obesity & hepatitis-C virus or the type of fistula selected.

Results: Female gender and the association of diabetes adversely affect the maturation of fistulas. Fistula early maturation was lower in females (28.6 vs 59.1, $P < 0.05$) Also, fistula early maturation was lower in diabetics versus non-diabetics (28.6 vs. 63.6, $P < 0.05$). Similarly; proximal fistulas matured early than distal one (71.4 vs 28.6, $P < 0.05$).

Conclusion: Arteriovenous fistula patency & maturation is worse in women & diabetic patients. Proximal AVF may be selected as a first choice. Duplex ultrasonography is a useful aid in choosing the proper fistula.

Introduction:

End-stage renal disease (ESRD) and the need for dialysis remain one of the most challenging problems facing both nephrologists and surgeons. Even with renal replacement therapy, ESRD patients have a significantly shorter life expectancy across quartiles of age. Successful construction and maturation of a dialysis fistula are necessary prerequisites for these patients to survive their diminished life span.¹

Satisfactory blood flow through an arteriovenous fistula (AVF) is essential for adequate haemodialysis in patients with ESRD. Three components of a well-functioning fistula included: inflow artery, needle-stick segment and native outflow vein. All of these components contribute to the maturation and proper functioning of a fistula.²

The most frequent problems with fistulas are weak flow after construction. Failure of a fistula to mature can usually be anticipated

within 1 month following its creation. However; the National Kidney Foundation Dialysis Outcomes Quality Initiative guidelines³ consider the fistula non-mature after 4 months of its creation if it does not satisfy the requirements for regular haemodialysis.

Preoperative non-invasive assessment by duplex sonography is very helpful in locating veins that are not clinically visible and also provides information about the functional characteristics of veins, including venous outflow. Duplex sonography is the method of choice for evaluation of arteries (wall, haemodynamics & calcification).⁴

The aim of the present study is to evaluate different factors that might affect AVF maturation in a sample of Egyptian patients with end stage renal disease.

Patients and methods:

Fifty patients with ESRD on regular haemodialysis or preparing for regular

haemodialysis were included in the study. Patients included in the study were essentially recruited from the vascular out-patient clinic at Menoufia University Hospitals, Shebin El-Kom, or directly referred from the Department of Nephrology. The study was conducted over 12 months duration starting from first of March 2010.

Inclusion criteria: All patients 18 years old of either gender with ESRD requiring maintenance haemodialysis, first time to do A-V fistula in upper limb were included into the study.

Exclusion criteria: Patients with peripheral vascular disease in the target limb, patients with current cardiac problem affecting the fistula flow (ejection fraction <40%), patients with known outflow venous obstruction (thrombosis, cervical rib, ... etc), patients with vascular malformation in the target limb & patients with ESRD requiring synthetic grafts.

Patients' assessment:

Pre-operative assessment:

All the patients underwent full history & clinical examination. Allen's test was done whenever distal fistula is planned. Also; duplex study is made in order to select a suitable artery with its suitable superficial vein. Furthermore; vein distensibility was checked using proximal compression by the application of sphygmomanometer cuff. We intended to choose the artery and vein minimum diameters (6 mm for the artery and 2.5 mm for the vein).

Incorporation of the clinical assessment & duplex findings was made by independent consultant vascular surgeon in selecting fistula of choice for every patient. The necessary preoperative precautions & tests were made e.g. controlling systemic blood pressure, .. ect.

Intra-operative evaluation:

The intra-operative evaluation was essentially based on assessing the condition of the selected vessels compared to the finding expected by clinical and duplex evaluation.

Post-operative evaluation & care:

Immediate postoperative evaluation of the patency of fistula was made either by palpating a thrill along the course of the outflow vein,

auscultating machinery murmur whenever the outflow vein is impalpable and/or Doppler examination especially in obese patients.

All patients were followed up weekly for 16 weeks post-operatively for patency or arise of complications. Duplex examination was performed at 4, 6 & 16 weeks post-operatively measuring blood flow & diameter of the outflow vein. At the first session of haemodialysis; the adequacy of the flow in the fistula was reported.

Results:

Patients' demography:

Fifty patients (31 males & 19 females) participated in the study. Mean age was 49.96 ± 15.63 varying from 19-80 years. 19 patients were smokers. 21 were diabetics (Type II). 41 have systemic hypertension & 26 were hepatitis C +ve. The dominant right upper limb was in 44 patients.

The majority of patients 43/50 showed fistula maturation. Complications were arisen in 7 patients; thrombosis in 3 patients, infection in one patient, haematoma and fistula disruption in 2 patients, and one has died. The successful fistulas comprised 25 proximal (brachio-cephalic) & 18 distal (radio-cephalic) one.

Consequently; patients who showed fistula maturation were divided into two groups. First group included patients in whom fistulas have been matured in ≤ 6 weeks. Second group included patients in whom fistulas have been matured in > 6 weeks. Statistical significance was made to classify fistula maturation in regards to that interval (6 weeks).

Risk factors that might affect fistula maturation:

Several factors were looked for its relationship with fistula maturation including: Gender, age, smoking, diabetes, hypertension, obesity & hepatitis-C virus. The association of all these factors was evaluated in its relationship to either early matured fistula or the delayed matured one. It was obvious that the female gender and the association of diabetes were the only significant factors that may be associated with delay in fistula maturation. These factors are presented by Table(1).

Table (1): Risk factors that might affect fistula maturation.

	Early matured fistula (n =21)	Delayed matured fistula (n =22)	Pvalue
Age (years)	49.5±14.07	48.64±16.38	>0.05
Females/Males ratio(%)	6/15 (28.6 /71.4)	13/9 (59.1 /40.9)	<0.05*
Diabetes mellitus	6 (28.6%)	14 (63.6%)	<0.05*
Hypertension	16 (76.2%)	20 (90.9%)	>0.05
Smoking	11 (52.4%)	6 (27.3%)	>0.05
Body mass index	26.24±4.49	26.8±6.6	>0.05
Hepatitis C virus (+ve)	15 (71.4%)	11 (50%)	>0.05

Type of fistula in relation to fistula maturation:

Proximal fistula matures earlier than distal one. This may be due to high blood flow in

proximal fistula that helped earlier maturation.

This difference was presented by Table(2).

Table (2): Relationship between type of fistula and fr.stula maturation.

Type of fistula	Early matured fistulas (n =21)	Delayed matured fistulas (n =22)	Pvalue
Proximal	15 (71.4%)	10 (45.5%)	<0.05*
Distal	6 (28.6%)	12 (54.5%)	

Discussion:

Non-maturation of native arteriovenous fistula for hemodialysis still is problematic in a large group of patients. The mechanisms of maturation and factors responsible for non-maturation are poorly understood as evidenced by high non-maturation rates up to 30%.⁵

There is marked variation in literature regarding the definition of a "successful" fistula. The definition has included the presence of a thrill or bruitability to use the fistula for at least one dialysis session or ability to use the fistula reproducibly for dialysis for at least one month with a dialysis blood flow 350 ml/min.⁶

The problem of fistula patency and maturation is distorted between lots of variants. Health service; whether Nephrologist' care, Vascular Surgeon' judgment and dialysis Nurse cannulation may have a role in timing, selection & successfulness of the AVF. Also; patients' age, gender and associated co-morbid risk factors can influence the outcome of fistula creation.?

In regards to age, the progressive increase in age of patients undergoing regular hemodialysis is responsible for the growing number of AVF complications & failure. Patients over 65 years old have a higher incidence of co-morbid factors as diabetes mellitus, atherosclerosis, neoplasms, and heart failure. Also; vascular changes (due to age atherosclerosis, vascular calcifications, stiffness of vessels) can make difficult creation and delayed maturation of the AVF.^{8,9}

In our study the advancement of age was not a significant factor influencing fistula maturation. This came in agreement with previous reports of Wolowczyk et al, 2000 to & Ridao-Cano, et al 2002.¹¹

Patient gender does seem to influence fistula maturation world-wide. The patency of distal forearm, wrist or snuffbox AVFs is poorer in women than in men.^{12,13} Since, this seems to apply also to more proximal AVFs

it may be unrelated to the larger vessels of men and may have a hormonal basis.¹⁰ Also possible explanation is that vessels are of smaller caliber in women than in men, and therefore less likely to dilate sufficiently thereby contributing to a 30% lower maturation rate.^{14,15} In our study also females exhibited a lower maturation rates than males.

In diabetic patients; little attention has been paid in literature to the special and demanding problem of vascular access. There is controversy regarding the influence of diabetes on fistula patency & maturation. Some authors claimed that diabetes has adverse effect on fistula flow rate and patency;^{16,13} whereas others have found no effect.^{17,18} In our study we have found that diabetes mellitus significantly delayed fistula maturation and proximal (arm) fistula is preferred in diabetic patients.

Obesity does seem to influence fistula maturation in other way because deeper veins are more difficult to cannulate, although this does not affect patency.^{19,16} In our study; we did not find a relationship between fistula maturation and obesity but this may be due to little discrepancy in weight among the studied group.

Similar irrelevant relationship between fistula maturation and smoking, hypertension or hepatitis-C virus was observed in our patients.

Vessel size seems to be an important factor affecting fistula maturation. Small arteries and veins have higher initial failure rates, more frequent failure to mature and poorer long term patency. It has been suggested that a cut-off of 2 mm for both the arterial and venous diameters should be used.^{20,21} Fortunately; we found that as long as the artery and vein minimum diameters (<2 mm for the artery and 2.5 mm for the vein); there was no correlation between vessel diameter and likelihood of fistula maturation.

Access position is a matter of wise judgment. More proximal AV fistulae have improved blood flow and patency but left fewer options for access in the event of failure.^{16,13} In our study; we encountered early maturation of proximal fistula than distal one.

Finally; the preoperative vein mapping is very important in this regard as it allows one to choose the best vein the first time rather than the traditional approach that places a high value on starting the quest in the non-dominant arm, in the most distal available vein, reserving other sites for subsequent remedial operations. Preoperative ultrasound vein mapping should be the principal guide to which arm and to which vein to use, with the intent being to perform the best operation the first time using the best vein.¹³

In conclusion; primary access is best provided by a distal autogenous AVF in the non-dominant (whenever possible) arm. Proximal AVF may be required in patients with poor veins or patients with diabetes. Fistula patency and maturation is worse in women & diabetics. Preoperative duplex scanning facilitates proper choosing.

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