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Forearm Arteriovenous Fistula Maturation Delay due to Juxta-Anastomotic Stenosis: Role of Percutaneous Angioplasty

Rui Filipe Nogueira[1], Nuno Afonso Oliveira[1,2], Emanuel Ferreira[1,2], Luís Rodrigues[1,2], Helena Pinto[1,2], Ana Belmira[1], Rui Alves[1,2]

[1] Serviço de Nefrologia – Centro Hospitalar e Universitário de Coimbra, Coimbra, Portugal
[2] Faculdade de Medicina – Universidade de Coimbra, Coimbra, Portugal

Contributorship Statement:
- RFN: Acquisition, analysis and interpretation of data; drafting, review and editing of the manuscript and approval of the final version of the manuscript.
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ABSTRACT

Introduction: Arteriovenous fistula is the optimal vascular access for hemodialysis as it has the best long-term patency rate and the lowest complication rate. Although we are still lacking consensus, surgery has been advocated as the best treatment option for maturation delay. We proposed to evaluate the results of endovascular approach of arteriovenous fistula's maturation delay in our hospital.

Methods: We conducted a retrospective study, selecting patients referred to our diagnostic and therapeutic angiography unit due to arteriovenous fistula delayed maturation, between April 2017 and June 2020.

Results: Thirty-four patients were referred to our center due to maturation delay, of which six (17.7%) were excluded as the diagnosis was not confirmed and six (17.7%) because the lesions were not suitable for percutaneous angioplasty. The other 22 patients (64.7%) were subjected to percutaneous endovascular treatment. Mean age was 67.3 ± 13.8 years. Eighteen patients (81.8%) had maturation delay due to peri-anastomotic stenosis; 12 (66.7%) were forearm fistulas (all radio-cephalic). Mean follow-up time was 21.2 ± 11.2 months. Eleven (91.7%) fistulas were salvaged, although four (33.3%) needed reintervention. Primary and assisted primary patencies at 6 and 12 months were 66.7% vs 91.7% and 58.3% vs 91.7%, respectively.

Conclusion: Our results point out that endovascular treatment is a good treatment option for maturation delay of forearm arteriovenous fistulas due to juxta-anastomotic stenosis. Even though surgical treatment appears to have better primary patency, a step-by-step approach seems to be a valid strategy, as our assisted primary patency shows.

Keywords: Arteriovenous Fistula; Endovascular Procedures; Renal Dialysis

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INTRODUCTION

Arteriovenous fistula (AVF) is the optimal vascular access for hemodialysis, being the one with the lowest complication rate and best long-term patency rate, while providing proper dialysis adequacy.[1] However, timely hemodialysis initiation through an AVF is not always possible due to maturation delay, which is defined by the inability to adequately use the AVF for hemodialysis after the appropriate maturation time has elapsed (4 to 6 weeks). Non-maturation can be confirmed using Doppler ultrasound, which may show a low flow (<500 mL/min) AVF with a small calibre (<4 mm), as well as the culprit stenotic lesion.[2] Despite being responsible for most cases (25%-64%), juxta-anastomotic (JA) stenosis treatment in forearm AVFs is still a matter of debate.[3-5] Percutaneous angioplasty has gained importance over the last years, particularly among nephrologists, as it is readily available, less invasive, preserves native vessels better and is more likely to avoid central venous catheter (CVC) placement, in comparison to vascular surgery.[6] On the other hand, surgical revision is associated with fewer relapses.[6-8] While previous works have favoured a step-by-step approach, reserving surgery for relapsing cases, recent research has given preference to surgical revision, in face of the reduced need for reintervention; this is particularly relevant at a time when health expenditures and cost-benefit ratio have become progressively more important.[6-9]

We proposed to evaluate the results of endovascular approach on AVF with maturation delay due to JA stenosis in forearm AVFs at our center.

METHODS

We conducted a retrospective analysis, selecting patients referred to our diagnostic and therapeutic angiography unit due to AVF delayed maturation, between the 1st of April 2017 and the 30th of June 2020. We accessed patient's clinical records and procedure reports, and contacted the hemodialysis center to ascertain whether the selected patients were still using the same vascular access, the number of interventions needed to preserve patency, and if the fistula had ever thrombosed.

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Physical examination and Doppler ultrasound were used to confirm AVF delayed maturation. Arteriovenous (AV) fistula non-maturation was defined as the inability to perform adequate hemodialysis through it, in association with low blood flow (<500 mL/min) and/or small caliber of the corresponding arterialized vein (<4 mm). Patients in whom AVF maturation delay was not confirmed were excluded from the analysis. Patients with maturation delay due to lesions not amenable to percutaneous angioplasty, such as extensive arterial or multiple extensive outflow stenosis, were also excluded from further analysis. Patients with more than one lesion were included and classified according to the clinically most significant stenosis (the stenosis intervened on).

The interventions were all performed by nephrologists with experience in AV access percutaneous angioplasty. Johnson's PowerFlex Extreme® balloons (4 or 5 X 40 mm) were used in more tortuous/curved lesions, especially when it was necessary to angioplasty the anastomotic zone; Bard's Dorado® balloons (6 x 40 mm) were reserved for more rectilinear lesions, whenever it was possible to do the procedure without entering the feeding artery. Intervention success was defined by residual stenosis of less than 30%, AVF thrill improvement and, mandatorily, consistent successful use of the AVF for hemodialysis.

We defined primary patency (PP) as the interval between the first endovascular procedure and the next intervention. Assisted primary patency (aPP) was defined as the interval between the first procedure and the need for reintervention because of AVF thrombosis. Secondary patency (SP) was defined as the access cumulative patency (Figure 1).

Statistical analysis was done with IBM® SPSS Statistics v26 software using basic descriptive statistics and Kaplan-Meyer survival analysis for patency rates.

RESULTS

Thirty-four patients were referred to our unit due to AVF maturation delay, however this diagnosis was not confirmed in six patients (17.7%). Decision not to intervene was made in other six patients (17.7%), as it was considered their AVF's lesions were unsuitable for endovascular treatment**.** These lesions included the presence of collaterals (proposed for collateral ligation), extensive radial artery stenosis, in which case proximal reanastomosis was proposed, or cases with multiple extensive outflow stenosis, in which the access was abandoned. We also excluded from the analysis nine arm AV fistulas (seven brachiocephalic and two brachiobasilic) and one forearm AVF (radiocephalic) with maturation delay due to outflow stenosis, as these did not belong to the group we proposed to study (Figure 2).

We treated 12 patients with forearm AVF delayed maturation due to juxta-anastomotic stenosis using percutaneous angioplasty (PTA). Patient's mean age was 67 ± 14.3 years and most (75%) were male. Seven patients (58.3%) had diabetes mellitus. The median elapsed time between AVF creation and the endovascular intervention motivated by delayed maturation was 119 days (IQR 72 days). Patients with AVFs intervened on more than 130 days after the AVF creation were patients who had their access constructed before starting hemodialysis.

1. Juxta-anastomotic stenosis in forearm fistulas (n=12)

All the forearm AVFs were radiocephalic. The JA stenosis was most commonly located in the post-anastomotic vein (n=10; 83.3%); there was one AVF with radial artery stenosis and another with stenosis both in the artery and the efferent vein.

We managed to salvage 11 (91.7%) forearm AVFs with JA stenosis. Mean follow-up was 21.2 ± 11.2 months. Primary patency and assisted primary patency were 66.7% vs 91.7% and 58.3% vs 91.7%, at 6 and 12 months, respectively (Fig. 3). The estimated mean PP and aPP are 26.2 ± 4.9 and 42.5 ± 3.4 months, respectively.

2. Reintervention rate

Four patients (36.4%) required reintervention during follow-up period because of relapsing stenosis, comprising a total of five reinterventions and a reintervention rate of 0.204 events/patient-year (1 event per 58.94 patient-months). Only one of the reinterventions was surgical (proximal arteriovenous reanastomosis).

3. Complication rate

Among the 12 AVFs intervened on, we registered three vascular ruptures (complication rate – 25%). Two were minor vascular ruptures easily controlled with low atmosphere endoluminal hemostasis. The third case consisted of a radial artery tear, after stenotic dilation with a 4 mm balloon, and required the placement of a covered stent in order to stop the bleeding – this AVF thrombosed in less than 24 hours.

There were no further complications.

DISCUSSION

Arteriovenous fistula construction should be timely prepared in patients with chronic kidney disease (CKD).[5] This is done to gain some time, in case any problem with AVF maturation arises and anticipating the steeper curve of CKD progression in its later stage. Maturation delay may be due to stenotic lesions, collateral veins, central vein stenosis or feeding artery lesions.[10,11] Among these, the most common cause (25%-64% of cases) is the JA stenosis, defined as a stenosis located in an area of 3 to 5 cm adjacent to the anastomosis, which can affect both the afferent artery and the efferent vein.[3-6] Despite being the main responsible for delaying fistula maturation, we are still lacking consensus on the best therapeutic approach, essentially because there are no randomized controlled trials on this matter.[4,5] Therefore, available data consists mainly in retrospective and prospective analysis of patient cohorts.[6-9] In addition, most works on AVF's JA stenosis therapy did not focus on the maturation delay issue.[9]

Tessitore *et al* (2006) showed higher restenosis rate with PTA than with surgical revision but similar aPP with both techniques, suggesting they should be considered equally effective and chosen according to each patient.[6] Napoli *et al* (2010) work led to similar conclusions, suggesting a step-by-step approach, performing PTA first and

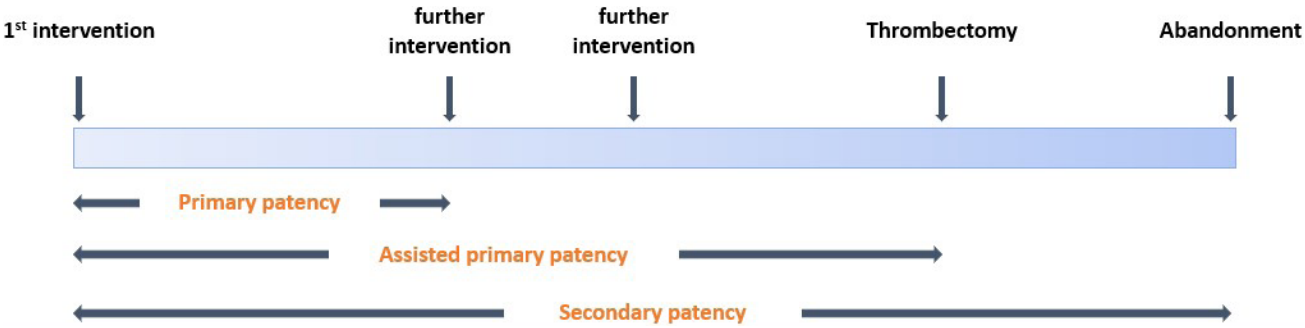
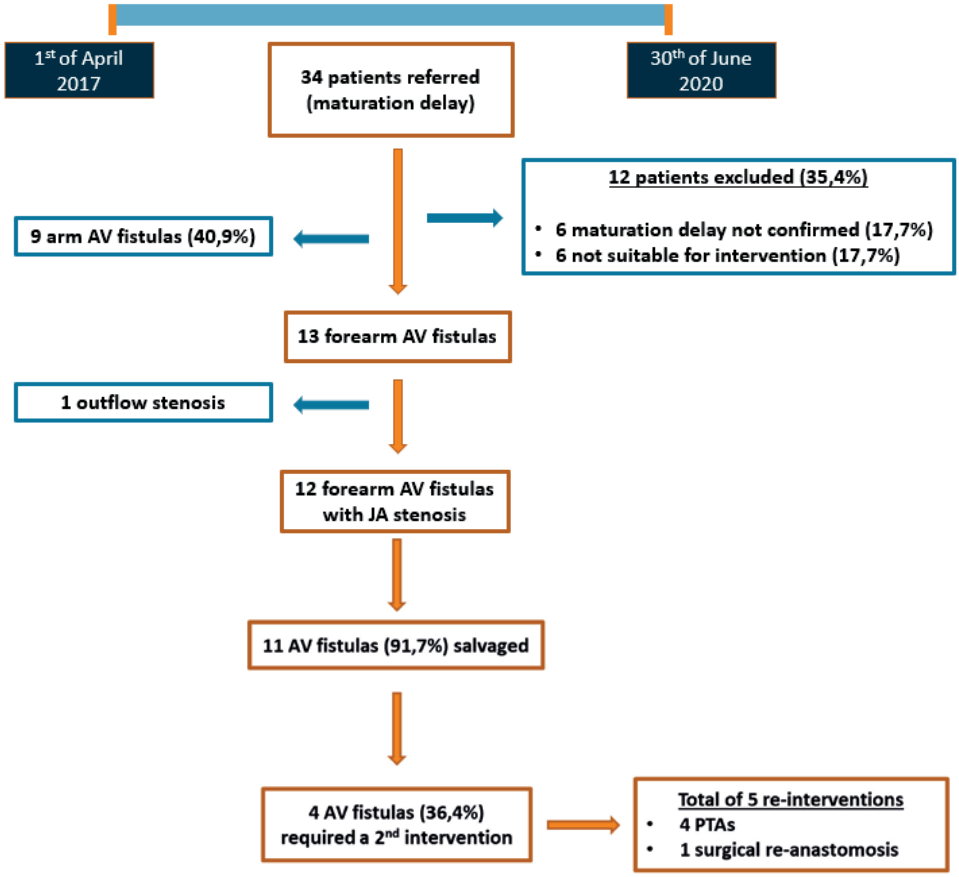


Figure 1

Vascular access patency definitions



AV – arteriovenous; JA – juxta-anastomotic; PTA – percutaneous angioplasty

Figure 2

Patient selection and intervention outcomes flow diagram

reserving surgical revision for restenosis.[7] These suggestions are based on the fact that endovascular treatment is less invasive, preserves native vessels and usually avoids the placement of a CVC. A good vascular access surveillance program can detect stenosis recurrence in time and avoid fistula failure, ensuring a similar aPP between the PTA-first and surgery-first strategies.[6] However, achieving the same aPP can have substantially different health costs, depending on the number of reinterventions. This problem was brought up by Long *et*

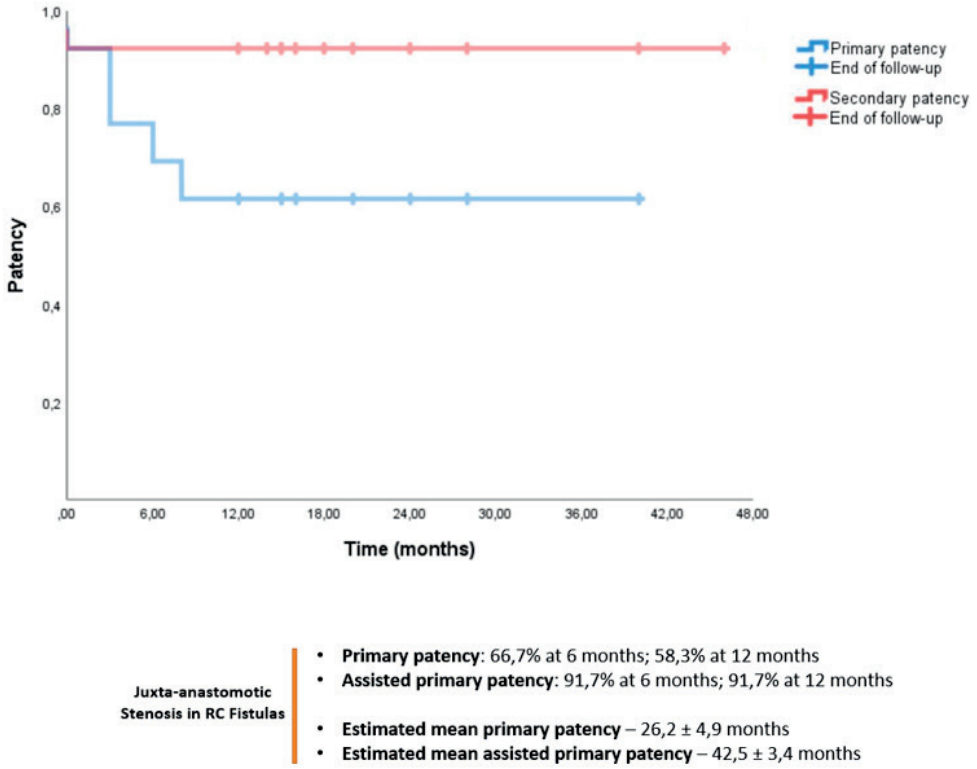


Figure 3

Primary and assisted primary patencies of forearm AVFs with juxta-anastomotic stenosis treated with percutaneous angioplasty

al (2010), who suggested the treatment of peri-anastomotic stenoses should be surgical rather than endovascular because there was an increased need for reintervention in the later, despite having similar aPP rates.[8] This higher reintervention rate increases health expenditures, increasing the cost/benefit ratio, which has become a matter of debate. Nonetheless, we should take into consideration the fact that central venous stenosis development from repeated catheterisation for CVC placement, may preclude future AVF development and perpetuate CVC use for hemodialysis, increasing infection and hospitalization rate and, consequently, health costs.[12-14] This adds to the obvious harm to patient's morbidity and quality of life, particularly in young patients with CKD and an anticipated prolonged renal replacement therapy run.

Although our endovascular treatment results do not differ much from those published in previous works, our aim is not to compare to other centres but to show that endovascular treatment is a valid approach to forearm AVF maturation delay caused by JA stenosis, as our aPP of 91.7% at 12 months suggests.[6-8] We believe surgery should be reserved for delayed maturation associated with stenosis relapse, in line with a step-by-step approach, unless it can be performed expeditiously and without the anticipated need to place a CVC, in which case it may be considered as the first option. The GEMAV Spanish clinical guidelines suggest surgery as the first treatment option, when it is possible.[4] When it is feasible to correct the problem surgically while avoiding additional morbidity to the patient, such as CVC placement, surgery seems to be, indeed, the best option. Besides, there are forearm AVF lesions more suitable for surgical revision, such as a threadlike feeding artery with extensive stenosis proximal to the anastomosis. In these cases, percutaneous angioplasty is not an option. Among our patient sample, there were two such cases and we proposed them for surgical evaluation.

In our patient group, reintervention rate was considerably low (0.204 events/patient-year), contributing to a low health expenditure and further validating our approach. Our results are strengthened by the fact that our cohort was followed for a mean of 21.2 ± 11.2 months, excluding lack of reintervention related to short follow-up time.

In summary, we consider endovascular treatment and surgery complementary approaches and believe patients with forearm AVFs with delayed maturation due to JA stenosis should be evaluated on a case-by-case basis. Percutaneous angioplasty should be the first option unless the lesions are unsuitable for PTA or surgery can be performed expeditiously without the anticipated need for CVC placement.

Our study has several limitations, such as the small patient sample (n=12), the retrospective nature of the analysis, the absence of a surgically approached control group and the variability of the patient's follow-up time. In addition, the treatment choice was made by the interventional nephrologists, possibly excluding patients that might have had worse outcomes with endovascular treatment.

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Corresponding Author:
Rui Filipe Nogueira
Serviço de Nefrologia
Centro Hospitalar e Universitário de Coimbra, Coimbra
E-mail: rui_filipe_10@live.com.pt