Criteria for Successful Salvage of Failing Autogenous Hemodialysis Arteriovenous Fistulae Using Balloon Angioplasty

Thesis

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بسم الله الرحمن الرحيم

قَالوُاسُبحَانَك لاَعِلمَ لنَا إلا مَاعَلمتَنا

إنكَ أَنتَ العَلِيمُ الحَكِيمُ

صدق الله العظيم

(سورة البقرة – الآية ٣٢)

To my dear father who was always supporting me,
To my great mother, who was the reason for where I am today, and without her support and encouragement, this work would have not been possible,
To my lovely wife,
To my brothers and sister,
To all my friends for their support.

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List of Abbreviations

Abb.	Full term
ADMA	Asymmetrical dimethylarginine
APP	Post-intervention assisted primary patency
AV	Arteriovenous
BAM	Balloon assisted maturation
BFGF	Basic fibroblast growth factor
CDUS	Color doppler ultrasonography
CE-MRA	Contrast-enhanced magnetic resonance angiography
CKD	Chronic kidney disease
CP	Cumulative patency rate
DSA	Digital subtraction angiography
DVP	Dynamic venous pressure
EMDA	Endovascular management of the thrombosed or dysfunctional hemodialysis access
EPC	Endothelial progenitor cells
ESRD	End-stage renal disease
FDA	Food and drug administration
HAIDI	Hemodialysis access induced distal ischemia
MMP	Metalloproteinase
MSCTA	Multi-slice computed tomographic angiography
PDGF	Endothelin, platelet-derived growth factor
PMT	Percutaneous mechanical thrombectomy
PP	Post intervention primary patency
PTA	Percutaneous transluminal angioplasty
PTFE	Polytetrafluoroethylene
QA	Flow

List of Abbreviations Cont…

Abb.	Full term
QA	Quality assurance
QBA	Blood flow rate in brachial artery
RANTES	Regulated on activation, normal t-cell expressed and secreted
RRT	Renal replacement therapy
TGF	Transforming growth factor
VNH	Venous neointimal hyperplasia

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Abstract

Background: Hemodialysis arteriovenous fistula dysfunction is a big challenging problem. Maintenance of this vascular access is one of corner stones in the care of patients with end stage renal disease. Balloon angioplasty is the first line of salvage of failing arteriovenous fistula (AVF) due to stenosis of venous outflow**.**

Aim: This prospective study aims at exploring factors affecting the outcome of balloon angioplasty of failing arteriovenous fistula and postulating criteria for success of intervention.

Methods: A convenience sample of patient with failing autogenous arteriovenous fistulae were treated with percutaneous transluminal balloon angioplasty in the period from may 2018 to May 2019. Patients' age, demographics and comorbidities as well as operative details and technical success were recorded as well as follow up events, and data was compared between patients with successful salvage and those with failed access salvage. The variables, including patients' demographics, co-morbidities, medications, fistula age, fistula type, site, number of lesions and degree of stenosis and all were analyzed and correlated with primary and secondary patency rates.

Results: The median age of the AVF in this study was 24 months. Among 40 failing AVFs; 16 (40%) were radiocephalic AVFs, 17 (42.5%) were brachiocephalic AVFs and 7 (17.5%) were bracheobasilic AVFs. The most common cause of autogenous access dysfunction was more than 90% stenosis while the most common site of stenosis was juxta-anastomotic (52.5%). Technical and clinical success rates of the intervention were 97.5% and 95% respectively. The primary patency at 1, 3, 6, 9, 12 months were 87.5%, 75%, 55%,, 40% and 32.5% respectively. Univariate cox regression analysis of the variables that potentially affect success and patency of the procedure concluded that three factors were associated with decrease in both primary and secondary patency rates. Hyperlipidemia was associated with decrease primary patency with HR (95% CI) of 2.475 (1.034 – 5.926) and p-value of 0.042 and decrease in secondary patency with HR (95% CI) of 15.848 (1.839 – 136.586) and p-value of 0.012. Insulin intake was associated with decrease in primary patency with HR (95% CI) 3.531 (1.526 – 8.168) and p-value of 0.003 and decrease in secondary patency with HR (95% CI) 13.452 (1.563– 115.748) and p-value of 0.018. the presence of cephalic arch stenosis was also associated with decrease in primary patency with HR (95% CI) 4.950 (1.983 – 12.355) and p-value of 0.001 and decrease in secondary patency with HR (95% CI) 29.856 (3.418 – 260.795) and with p-value = 0.002. Multivariate cox regression analysis was done for the variables with significant association in univariate analysis (table 3) and found that primary patency was reduced by insulin intake with HR (95% CI) of 2.876 (1.200 – 6.889) and p-value of 0.018 and the presence of cephalic arch stenosis HR (95% CI) of 3.050 (1.158 – 8.030) and p value 0.024. And the secondary patency was found to be reduced only by the presence of cephalic arch stenosis HR (95% CI) of 17.794 (1.463 – 220.814) and p value 0.024.

Conclusion: Balloon angioplasty is an important method for salvage of failing hemodialysis arteriovenous fistulae but the primary and secondary patency of the intervention are significantly decreased by the location of stenosis being cephalic arch, and the use of some drugs as insulin. There is no proved association between medical comorbidities and patency.

Keywords: Hemodialysis autogenous arteriovenous fistula, failing arteriovenous fistula, vascular access salvage, cephalic arch stenosis, end stage renal disease.

INTRODUCTION

Hemodialysis is the primary modality of renal replacement therapy and is administered to 84.3% of new patients with end-stage renal disease (ESRD). Successful hemodialysis depends on the ability to maintain vascular access capable of sustaining high blood flow ***(Collins et al., 2009).*** Owing to its lower complication rate and higher long-term patency compared with synthetic vascular access, AVF is the preferred method of providing vascular access for long-term hemodialysis patients, and its use is encouraged by current practice guidelines ***(Lok et al., 2020)***.

A malfunctioning vascular access remains a leading cause of morbidity and possible mortality, and increases the expenses necessary for end-stage renal disease patients on chronic maintenance hemodialysis therapy. Most AVFs fail because of the development of juxta-anastomotic stenoses as a result of neo-intimal hyperplasia. The “failing to mature” arteriovenous fistula (AVF) can be defined as a surgically created AVF that failed to properly grow to become usable for the purpose of hemodialysis (HD) in 8 to 12 weeks after its creation. Such failure is clinically manifest as difficult cannulation, inadequate AVF flow characteristics, or both ***(Nassar et al., 2006).***

Thrombosis following stenosis of arterio-venous fistulae results in loss of vascular access for hemodialysis in patients with chronic renal failure. To provide adequate dialysis therapy and to ensure the longevity of the vascular access, such stenotic lesions need to be diagnosed early and effectively treated before total thrombosis and subsequent access failure ensues.

In comparison with surgical revision, percutaneous trans-luminal angioplasty (PTA) has the advantages that it is a shorter procedure, causes less stress to patients, obviates the need for hospitalization, enables immediate dialysis without the need for central venous catheters, reduces the risk of infection and saves the patient's native vein ***(Thomas et al., 2017).***

Aim of the Work

This prospective study aims at exploring factors affecting the outcome of balloon angioplasty of failing arteriovenous fistula and postulating criteria for success of intervention.

Chapter 1

THE VEINS OF THE UPPER EXTREMITY

A- Introduction:

Venous return to the upper extremity is provided by two sets of veins namely the superficial and the deep veins. The main superficial veins are superficial to the deep fascia and are often located at or below the investing layer of superficial fascia in the subcutaneous tissue (**Fig. 1**). Deep veins are situated deep to the deep fascia and often accompany the artery and the nerves supplying the limb forming a neurovascular bundle. Small superficial veins that drain blood into the named main superficial veins are referred to as venous tributaries ***(Nguyen & Duong, 2019).***

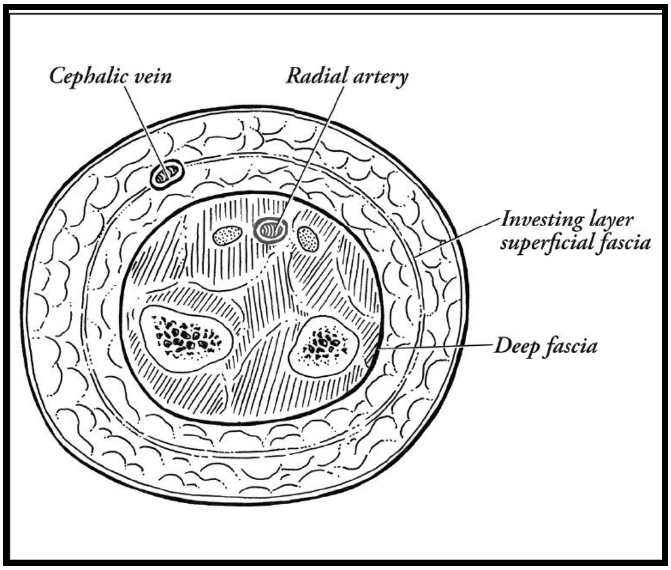

Figure (1): Anatomic location of superficial and deep veins ***(Nguyen & Duong, 2019).***