



## PRE-OPERATIVE DUPLEX ULTRASOUND MAPPING (DUSM) EVALUATION IMPROVES THE OUTCOME OF ARTERIOVENOUS FISTULAS CREATION: A RETROSPECTIVE STUDY

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### ABSTRACT

**Background:** Pre-operative duplex ultrasound mapping (DUSM) is widely used for arteriovenous fistula creation and some authors even advocate that it be used routinely. To date, however, there are no prospective randomized data to support this suggestion. This study investigated whether routine preoperative vascular ultrasound results in better AVF outcome than physical examination. Preoperative duplex ultrasound mapping may increase options for AVF with identification of veins that are not clinically evident.

**Materials and Methods:** Data was collected from operative records of patients who had native AVF creation from 2008 till 2012 (May). Epidemiological information types of AVF and preoperative duplex ultrasound mapping (DUSM) parameters such as diameter of radial artery (RA), brachial artery (BA), cephalic vein (CV) and basilic vein (BV) were obtained. A total of 159 AV fistula were created on 135 patients. We divided them into 2 categories 1) AVF with DUSM (N=104) and 2) AVF without DUSM that is been created by clinical judgment (N=55).

**Results:** 159 AVF were performed on 135 patients. Rate of re-do was 24 AVF from 19 patients. The median age of the patient was 53 years (19 - 79 years). The number of patients with preoperative duplex ultrasound was 104 while without duplex ultrasound or clinically measured was 55 patients. Radio- cephalic fistula (RCF) is the most performed AVF (53.5%), followed by brachial- cephalic fistula (BCF) (36.5%) and brachial basilic fistula (BBF) (10.1%). 104 patients had preoperative duplex ultrasound mapping (DUSM), and 70.6% of them had successful maturation. Out of those failed, only 10 patients had preoperative duplex ultrasound vein mapping; while 12 patients had no preoperative ultrasound vein mapping done. Rate of AVF maturation failure was 14.2%, mostly from BCF and RCF (n=8). The distribution of radial artery, basilic vein, and cephalic vein diameters were the same across categories of AVF (p >0.005). However the distribution of brachial artery diameter is different between AVF categories (p = 0.043). The difference were found between BBF and BCF (p = 0.039). Most of the patients who had BV diameter greater than 2.0mm producing a successful maturation (n=62), followed by BA (n=58), CV (n=50) and RA (n=34).

**Conclusions:** Routine preoperative vascular ultrasound in addition to clinical assessment improves AVF outcomes in terms of patency. Proper pre-operative assessment is essential in planning the best procedure possible for the patient. The evaluation must include both the arterial and venous systems to aid in the selection of the most appropriate conduits.

**Keywords:** duplex ultrasound mapping, arteriovenous fistula, maturation, dialysis

**INTRODUCTION**

This objective of this study to investigated whether routine preoperative vascular ultrasound results in better AVF outcome than physical examination. Preoperative duplex ultrasound mapping may increase options for AVF with identification of veins that are not clinically evident.

**METHODOLOGY**

**Population**

In this retrospective study (January 2008 to May 2012), we received the operative records of patients who had native AVF creation in 135 patients of 159 AV Fistula creation. During this study period, a total of 104 AVF were created with DUSM and 55 AVF were created without DUSM.

**Evaluation**

Rate of redo, maturation success and failure and rate of complications were measured for each AVF creation. Parameters measured by DUSM were the internal diameter of radial artery, brachial artery, cephalic vein, and basilica vein.

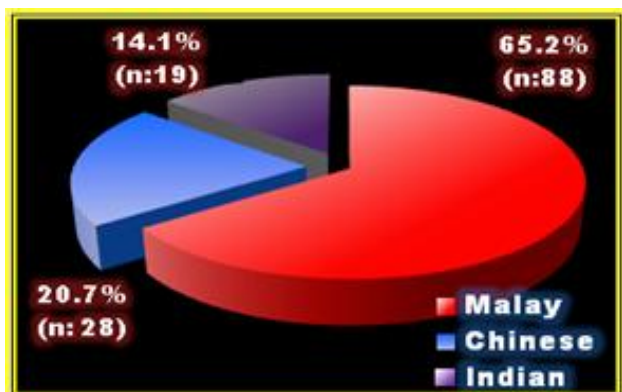
**Statistical Analysis**

Chi- square test were used to test the association in rate of redo, rate of complications, and rate of successful maturation between AVF with DUSM and clinical judgment ( without DUSM).

**RESULTS**

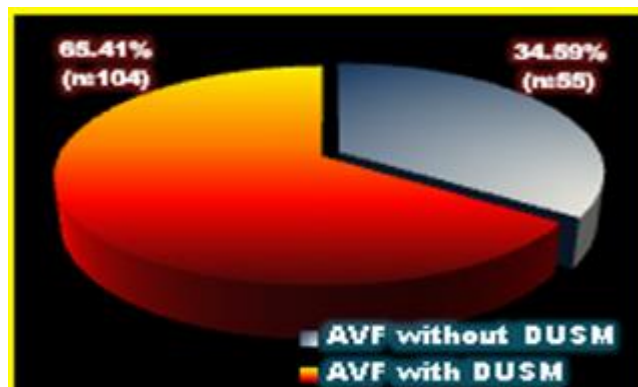
**Table 1: Demographic Data of Patients**

Age, years	N = 135	
Mean (SD)	52.44 (14.28)	
Minimum	19	
Maximum	79	
Age Group	n	%
< 30	11	8.1
30 - 40	16	11.9
41 - 50	30	22.2
51 - 60	32	23.7
>60	46	34.1
Ethnicity		
Malay	88	65.2
Chinese	28	20.7
Indian	19	14.1



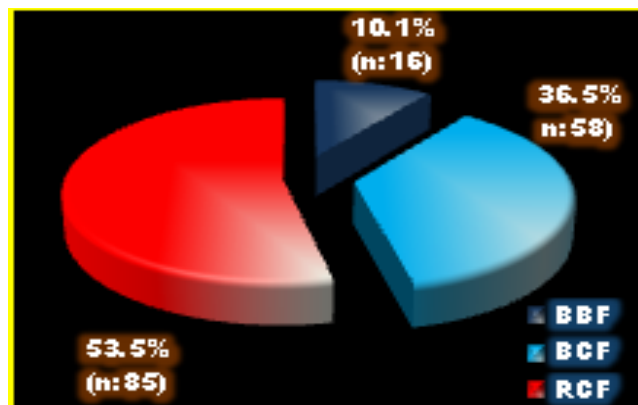
**Fig. 1: Distribution of Patients by Ethnicity**

The mean age of the patient was 52 years. The youngest age was 19 years and the oldest was 79 years. About a third (34.1%) of these patients was in the age group of more than 60 years, 23.7% were in the group of 51 to 60 years and 22.2% were in the group of 41 to 50 years at presentation. There were more male (61.5%) than female (38.5%), and the majority were from Malay ethnicity (65.2%), followed by Chinese (20.7%) and Indians (14.1%).



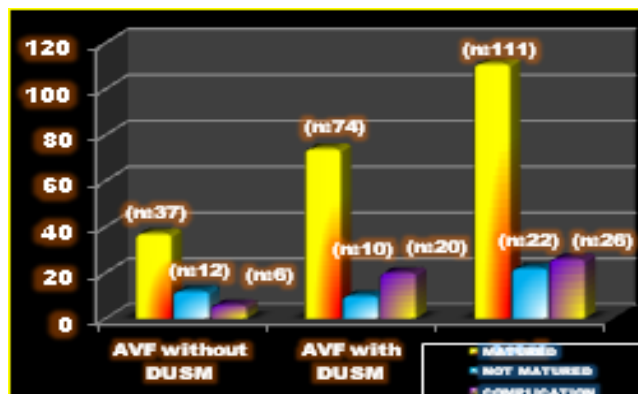
**Fig. 2: Categorization of Patients**

The number of AVF with preoperative duplex ultrasound was 104 while without duplex ultrasound or clinically measured was 55.



**Fig. 3: Types of AVF creation**

Radio-cephalic fistula (RCF) is the most performed AVF (53.5%), followed by brachial- cephalic fistula (BCF) (36.5%) and brachial basilic fistula (BBF) (10.1%).



**Fig.4: Rate of maturation with preoperative duplex ultrasound mapping (DUSM)**

104 patients had preoperative duplex ultrasound mapping (DUSM), and 71.2% of them had successful maturation. Out of those failed, only 10 patients had preoperative duplex ultrasound vein mapping; while 12 patients had no preoperative ultrasound vein mapping done.

However, the prevalence of maturity group between DUSM (71.2%) and clinical measurement (67.3%) are not significantly different (chi-square=5.473; df= 2; P = 0.065). Therefore there is no association between maturity group and patient type of AVF measurement.

**Table 2: The Rate of successful of AVF maturation by internal diameter of radial artery, brachial artery, basilic vein and cephalic vein**

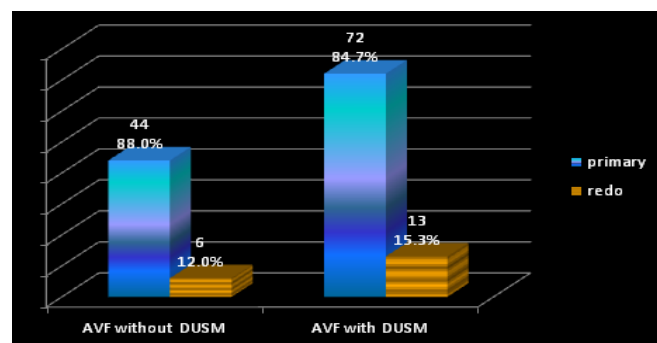
	< 2 mm	2mm	> 2mm	Total
<b>Radial Artery</b>	14 19.2%	25 34.2%	34 46.6%	73 100.0%
<b>Brachial Artery</b>	4 5.5%	11 15.1%	58 79.5%	73 100%
<b>Basilic Vein</b>	1 1.4%	7 9.7%	64 88.9%	72 100%
<b>Cephalic Vein</b>	11 15.1%	10 13.7%	52 71.2%	73 100%

The RCF that was created using Radial Artery and Cephalic Vein shows high maturity rate in diameter of 2mm and more; n=59 and n=62 respectively. The BCF that was created using Brachial Artery and Cephalic Vein have a good successful maturation in diameter of 2mm and more; n:69 and n:62 respectively. The BBF that was created using Brachial Artery and Basilic Vein shows high maturity rate in internal diameter of 2mm and more; n= 69 and n:71 respectively.

The most common complications post operatively were hematoma, infected, and stenosis (26.9%) followed by thrombosis (11.5%), pseudoaneuysm and steel syndrome 3.8% respectively.

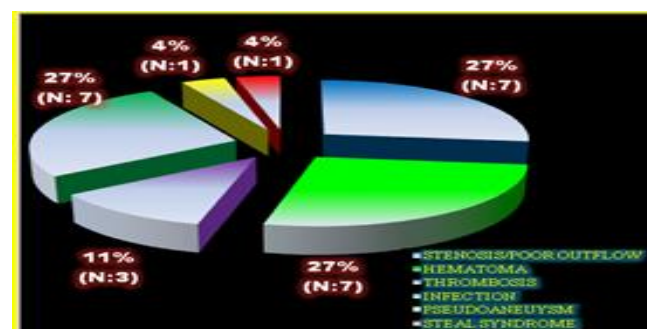
**DISCUSSION**

Recent guidelines published by the National Kidney Foundation Dialysis Outcome Quality Initiative (DOQI) on vascular access has suggested that for patients requiring chronic hemodialysis, the preferred site for access is a native arteriovenous fistula (AVF) [1] however it has a considerable failure rate and complications. This study investigated whether routine preoperative doppler ultrasound results is better AVF outcome than physical examination [2]. Different outcomes of AVF have been reported in studies examining the effect of pre-operative evaluation: immediate outcome [3], functional primary patency [4], AVF survival and early and primary failure .The Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines recommend the use of routine ultrasound mapping for all patients .Increasing use of primary arteriovenous fistulae (pAVFs) is a desired goal in hemodialysis patients However, in many instances, pAVFs fail to adequately mature due to ill-defined mechanisms. The Vascular Access Work Group, of the National Kidney Foundation (NKF), identified two primary goals to improve quality of life and overall outcomes for patients on hemodialysis. These goals are addressed in the Dialysis Outcome Quality Initiative (DOQI) guidelines [1].United States, only 31% of patients on hemodialysis dialyze through an AVF, and the incidence of AVF creation is a disappointing 28% [5]. This prospective, randomized, controlled study compared PUSM and physical examination in relation to short-term outcome after AVF creation [6].



**Fig. 5: Rate of redo with preoperative duplex ultrasound mapping (DUSM)**

The prevalence of rate of redo between DUSM (84.7%) and clinical measurement (88.0%) are not significantly different (Fisher Exact Test; P = 0.065). Therefore there is no association between rate of redo and patient type of AVF measurement.



**Fig. 6: Type of complications**

Vascular access procedures and subsequent complications represent a major cause of morbidity, hospitalization, and cost for hemodialysis patients [7]. Native arteriovenous fistulas (AVFs) re preferable to synthetic arteriovenous grafts because they are associated with a lower frequency of thrombosis and

infection, as well as greater longevity [8,9]. AVFs that are never usable and early graft failures are associated with the common problem of inadequate vessel (artery or vein) selection. The surgeon's preoperative physical examination is the primary basis for AVF versus graft selection [10]. Only palpable veins are considered for construction of AVFs, and the more proximal draining venous anatomy is not known prior to the operation. The work of Silva et al [11] suggests that ultrasonographic (US) preoperative data on nonpalpable and proximal veins, as well as on arterial inflow, improve the rate of appropriate AVF or graft selection. We therefore implemented a program to increase the anatomic data available to the surgeon by using preoperative US. The purpose of this prospective analysis was to assess the effect of preoperative US mapping on surgical selection and placement of AVFs and grafts. Physical examination is the traditional surgical evaluation performed prior to hemodialysis access placement. Palpation and inspection are difficult in obese arms, and few patients have vessels that are visible throughout their entire course. US is a noninvasive method that is commonly used in vascular assessment however, to our knowledge, there are few articles in which US vessel mapping prior to hemodialysis access placement has been investigated. Comeaux et al [12]. 66% (33 of 50) of patients who had not undergone surgery previously had vascular abnormalities at preoperative. US mapping. Silva et al successfully used preoperative duplex Doppler vascular mapping to decrease early access failure rates and increase the percentage of AVF placements. With US, vessels can be assessed for size, stenosis, and occlusion. The increased anatomic knowledge obtained with US mapping assists in surgical planning and during the surgery itself and is especially valuable in patients who are difficult surgical cases (eg, obesity, diabetes, history of prior access, elderly women).

Most haemodialysis patients nowadays are older and have diabetes or cardiovascular disease. These vascular risk factors are associated with increased arterial disease and an increased risk of AVF failure. Pre-existing arterial disease can be assessed by ultrasound assessment that is particularly important. Furthermore, clinical assessment may be inconclusive in a considerable proportion of patients, for instance when veins are not apparent in the obese. Pre-operative doppler ultrasound assessment predicts AVF patency and maturation for dialysis. Doppler ultrasound is of particular benefit when physical examination is insufficient but has little added value when physical examination is satisfactory. Routine preoperative doppler ultrasound in addition to clinical assessment improves AVF outcomes in terms of patency, maturation of the fistula and use for dialysis.

Our randomized trial shows that routine preoperative ultrasound in addition to physical examination improves AVF outcome and dialysis use in a patient population without complex access problems. Specifically, ultrasound results in less immediate failure, less early AVF thrombosis, and better assisted primary AVF survival. Ultrasound is effective with a small number of ultrasound scans needed to prevent failure [13]

Our finding that immediate failure is significantly reduced by preoperative ultrasound is consistent with another randomized trial, which showed significantly

less failure (6% versus 25%) on the day of surgery in the ultrasound compared with the clinical group [14]. Inadequate vessels can be identified by ultrasound, which reduces the rate of immediate failure [13]

## CONCLUSIONS

Native AVF creation is commonly performed and is still the preferred choice of dialysis in renal failure patient. Routine preoperative vascular ultrasound in addition to clinical assessment improves AVF outcomes in terms of patency. Proper pre-operative assessment is essential in planning the best procedure possible for the patient. The evaluation must include both the arterial and venous systems to aid in the selection of the most appropriate conduits. However, pre-operative ultrasound mapping is essential to ensure the success of AVF maturation. Complications of AVF creation remained common. Several factors such as post-operative care and complication, and cannulation by inexperience personal during dialysis are the reasons for shorter lifespan of the AVF.

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