



Radio-Diagnosis

MATURATION OF ARTERIOVENOUS FISTULAS (AVFS) : TO EVALUATE THE EFFECTIVENESS OF PHYSICAL EXAMINATION VERSUS DOPPLER ULTRASOUND STUDY IN PREDICTING MATURATION – A SINGLE CENTRE RETROSPECTIVE STUDY.

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ABSTRACT This study was done to compare assessment techniques for maturation of arteriovenous fistula (AVF). AVF is a renal replacement therapy (RRT) for end stage renal disease (ESRD) patients, in which an AVF is created surgically to perform hemodialysis and remove the excretory products from the blood, as the kidneys are not able to do so anymore. It is pertinent to mention that hemodialysis can only be performed through a mature AVF. The techniques of palpation of a thrill by physical examination and evaluation of AVF by Doppler ultrasound to ascertain maturation were compared. Gold standard for evaluation was utility of the AVF for hemodialysis. This was a single centre retrospective study. Results were tabulated and analysed.

KEYWORDS : Arteriovenous fistula, maturation, Doppler ultrasound

AIM

To evaluate the effectiveness of physical examination versus Doppler ultrasound study in predicting maturation of arteriovenous fistulas (AVFs) created for hemodialysis access. AV fistula is created for renal replacement therapy in end stage renal failure patients. Maturation of fistula means that the fistula is ready for starting hemodialysis. This assessment is usually done 4 weeks after surgical creation of fistula. The assessment may be done using physical examination by palpation of a thrill. Another method with present technological advances, involves use of Doppler ultrasound. The criteria of 6mm diameter and flow rate of 600 ml/ min is taken as criteria for maturation of AVF by Doppler. End point of this study was the utility of fistula for hemodialysis (gold standard).

OBJECTIVE

To compare the sensitivity and specificity of physical examination and Doppler ultrasound study in detecting AVF maturation.

MATERIAL AND METHODS

This was a single institution retrospective review of 60 patients with primary autogenous AVF creation from June 2015 to April 2019. At our center, left arm end to side brachiocephalic fistulas were created. 4 weeks after the surgery, patients were evaluated for maturation of fistula.

Institutional ethics committee approval was taken. Written, informed consent was taken from the patients prior to the Doppler flow studies.

All patients were assessed by physical examination by an experienced nephrologist for palpation of a thrill. Palpation of a thrill meant that AVF is functional by physical examination method.

This was followed by a Doppler ultrasound study. The patient was assessed in supine position with fistula arm comfortably resting on a pillow. The Doppler was done using linear probe with 7-12MHz frequency. The flow rate was automatically calculated by the machine software and displayed on the screen. The criteria for maturation according to Doppler ultrasound were an AVF diameter of 6 mm or a flow rate of 600ml/min.

A comparison was made between physical exam and Doppler ultrasound examination. Sensitivities and specificities of physical examination and doppler study were compared head-to-head in

predicting unassisted fistula maturation. The gold standard for comparison was whether the fistula was actually useful for hemodialysis (utility for hemodialysis). A mature AVF (according to gold standard) was defined as a fistula that could be repetitively cannulated and provided adequate flow for dialysis. Failure of maturation was defined as an AVF that could never be used for dialysis. Bivariate comparisons were conducted using Pearson's χ^2 , Fishers exact test, and Wilcoxon test depending on distribution. Significance was defined as $P < 0.05$.

RESULTS

This was a single institution retrospective review of 60 patients with primary autogenous AVF creation from Jun 2015 to April 2019. At our center, left arm end to side brachiocephalic fistulas were created.

There were 60 patients with brachiocephalic (BC) fistulas. The mean age at creation was 51.6 years. Patients were followed up for ascertaining utility of fistula for hemodialysis, which was at 4 weeks after creation of fistula.

Among the 60 patients analyzed, 16 (26.7%) patients had maturation failure and 44 (73.3%) patients had successful maturation of AVF as assessed on physical examination.

Among the 60 patients analyzed, 35(58.3%) patients had maturation failure and 25(41.7%) patients had successful maturation on Doppler ultrasound examination.

No comorbidities (diabetes, hypertension) were significantly associated with maturation failure.

A Doppler flow study has 68.6 percent sensitivity for predicting maturation of AV fistula while physical examination has sensitivity of 82.9 percent, if we compare both the examination with the gold standard (utility for hemodialysis). However, an AVF deemed mature by Doppler ultrasound is more likely to be useful for hemodialysis as compared to physical examination.

Table 1: Comparison of physical examination with hemodialysis utility

Physical examination	Haemodialysis utility		Total
	Yes(%)	No(%)	

	Yes (Thrill palpable)	29(82.9)	15(60)	44
	No (Thrill not palpable)	6(17.1)	10(40)	16
	Total	35(100)	25(100)	60

Table 1 shows that when we compare physical examination with hemodialysis utility, 29 patients (82.9%) were having same result and 6 (17.1%) were not having same result.

Table 2: Comparison of Doppler ultrasound study with hemodialysis utility

Doppler flow study	Utility on hemodialysis			Total
	Yes(%)	No(%)		
	Yes (fistula functional)	24(68.6)	1(4)	25
	No (fistula not functional)	11(21.4)	24(96)	35
	Total	35	25	60

Table 2 shows that when we compare Doppler ultrasound study with hemodialysis utility (gold standard), 24(68.6%) patients were having functional AVF as predicted by Doppler and 11(21.4%) were not having same result. The sensitivity and specificity were 68.6 and 96 percent respectively.

Table 3: Distribution according to Physical examination and Doppler ultrasound

	Yes(%)	No(%)
Fistula functional (Doppler ultrasound)	25(41.7)	35(59.3)
Fistula functional (physical examination)	44(73.3)	16(26.7)

Table 3 shows that 25(41.7%), 44(73.3%) patients were having AVF matured in Doppler ultrasound and physical examination respectively. While 35(59.3%), 16(26.7%) patients were not having matured AVF on Doppler ultrasound and physical examination respectively.

Table 4 : Distribution of patients, age group-wise, with maturation of fistula as assessed by physical examination and Doppler ultrasound.

Age group (years)	Fistula functional (Doppler USG)		Fistula functional (physical examination)	
	Yes(%)	No(%)	Yes(%)	No(%)
<30	5(20)	7(20)	9(20.5)	3(18.8)
31-50	6(24)	12(34.3)	14(31.8)	4(25)
>50	14(56)	16(45.7)	21(47.7)	9(56.3)

Table 4 shows distribution of patients, age group-wise. Among the total 60 patients in the age group < 30 years 5(20%), 31-50 years 6(24%) and >50 years 14(56%) were having Fistula functional on USG. In the age group < 30 years 9(20.5%), 31-50 years 14(31.8%) and >50 years 21(47.7%) were having Fistula functional on physical examination.

DISCUSSION

Comparison of physical examination with utility for hemodialysis (gold standard) (Table 1) reveals that physical examination method is a sensitive method to assess AVF maturation, with sensitivity of 82.9 percent. It can be done easily on bedside by an experienced nephrologist or a hemodialysis technician. It does not require any equipment. Hence, it can be recommended as a screening test. However, its specificity of 40%, is less as compared to Doppler flow study.

Comparison of Doppler ultrasound study with hemodialysis utility (gold standard) (Table 2) reveals that the sensitivity and specificity of Doppler ultrasound for AVF maturation is 68.6 and 96 percent respectively. That is, Doppler flow study has high specificity, but, less sensitivity, as compared to physical examination to ascertain fistula maturation. Doppler flow study is a very good confirmatory test. However, it is equipment and training intensive.

In a similar study by Caputo et al (1), it was shown that Doppler ultrasound is a better tool to assess early maturation failure and cause of maturation failure.

The study by Itoga NK et al (2), emphasized the use of Doppler ultrasound to confirm AVF maturation prior attempting first session of hemodialysis.

The shortfall of this study is that it is a single centre experience with limited number of patients. Similar study with larger sample size may be undertaken. The fistula studied were all left arm brachiocephalic end to side fistulas. Other combination of fistulas could not be included in the study as at this centre, the mentioned surgical technique was preferred.

CONCLUSION

Creation of AVF gives a new lease of life to patients with end stage renal disease (ESRD) in the form of renal replacement therapy (RRT). Physical examination by palpation of a thrill at the site of AVF has higher sensitivity in assessing maturation of AVF. It is a simple, widely available test. It is easy to train paramedics for performing evaluation of AVF for a palpable thrill. No equipment is required. It can be easily done bedside. It is a good screening test. However, its specificity is low. This means that not all fistulas which are deemed to be functional by physical exam will be useful for hemodialysis.

Here comes the importance of doppler study for fistula maturation. The Doppler ultrasound study has the disadvantage of being equipment dependent and training intensive. However, it is a specific test to ascertain fistula maturation with certainty, compared to physical examination alone. If the diameter of fistula is <6 mm or flow rate is < 600ml/ min, early vascular intervention can be done to make the AVF hemodialysis worthy, saving the patient the risk of losing a route for RRT.

Therefore, we advocate assessment of maturation of AVF by doppler study. The physical exam still holds utility in hemodialysis suite where the technicians are taught to ascertain thrill prior puncture for dialysis. But, physical exam alone cannot ascertain maturation of AVF with certainty. Labelling a fistula not useful by physical exam alone, may cause loss of potential route for RRT.

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