ORIGINAL ARTICLE

Physical Examination Of Arteriovenous Fistula: A Basic Approach In AV Fistula Stenosis Detection

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ABSTRACT:

Objectives: To determine the accuracy and equivalence of physical examination, MDCTA and Doppler ultrasound in detection of arteriovenous fistula (AVF) stenosis.

Materials and Methods: We conducted a pilot study in hemodialysis department of PNS Shifa withprospective diagnostic cohort design on 15 patients, referred for evaluation of arteriovenous fistuladysfunction. Physical examination of arteriovenous fistula was done followed by Doppler ultrasound and MDCTangiography.The results of each patient was recorded and sealed. Data analyzed byCohen's Kappa, which determined the level of agreement between the diagnosis made by Physical examination, MDCTangiography and Doppler ultrasound.

Results: There was significant agreement in AVF stenosis detection made by physical examination and MDCTangiography (K: 0.865 for inflow stenosis and K: 0.602 for outflow stenosis).Whereas moderate level of agreement was observed between physical examination and Doppler ultrasound (K: 0.471 for inflow stenosis, K: 0.444 for outflow stenosis). Fair agreement existed between MDCTA and Doppler ultrasound in outflow stenosis detection.

Conclusion: Physical examination is accurate and equivalent in AVF stenosis detection when compared with MDCTangiography and superior in stenosis detection when compared with Doppler ultrasound in our hospital. Doppler Ultrasound is inferior to MDCTA in diagnosis of outflow stenosis.

Key words: Arteriovenous fistula, Stenosis, Physical examination. MDCTA, Doppler ultrasound

INTRODUCTION:

Patients with End Stage Renal Disease undergo hemodialysis through AV fistula on regular basis, which is a preferred access site[1]. Thereby, its dysfunction, mainly inflow and outflow stenosis is not uncommon as well. Earlier, quite a number of studies[2,3] had been done which assessed the accuracy of various arteriovenous detection tools separately, in comparison with the gold standard i.e. angiography.Heye[4] conducted a study in which he assessed the diagnostic value of 64MDCTangiography in evaluation of arteriovenous fistula stenosis detection,when compared with DSA(Digital Subtraction Angiography).Another study assessed the accuracy of doppler ultrasound in detection of inflow stenosis when compared with angiography. This study showed that Doppler ultrasound has 91% sensitivity in inflow stenosis detection[5]. To highlight the importance of physical examination in arteriovenous fistula detection, a study a showed that it had 85% sensitivity in inflow stenosis detection and 92% sensitivity in detectionof outflow stenosis when compared with angiography[6].In all these studies the diagnostic tools; physicalexamination, doppler ultrasound and MDCT angiography; had been compared individuallywith the gold standard, Angiography.

The aim of our study was to compare physical examination withMDCTA and Doppler ultrasound in detection of AVF stenosis, to highlight equivalence and significance of these modalities in stenosis detection. Angiography, an invasive procedure, is a facility not available in most of the armed forces tertiary class A hospitals, like in our setup, so early detection of arteriovenous fistula lesion by the diagnostic modalities discussed above leads to prompt referral of the patients to the interventional facilities. In this study we have also calculated the level of agreement between Doppler ultrasound and MDCT angiography, thereby analyzing the accuracy of the Doppler ultrasound which is in use in most of the hospitals.

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MATERIALS AND METHODS:

Weconducted a pilot study after approval of departmental committee using prospective diagnostic cohort design. Patients were eligible if they had ESRD and were undergoing long-term hemodialysis through a failing AVF. We calculated the sample size needed to test the primary non inferiority hypothesis using methods of Blackwelder.The total number of patientscalculated was 20, which was required for significance threshold of P=0.05 and 80%statistical power.Patients were selected from hemodialysis department, PNS Shifa, whowere on maintenance dialysis for over 6 months and were referred on account of arteriovenous fistula dysfunction (Hemodynamically significant stenosis is defined as a >50% reduction of normal vessel diameter (graft or draining venous system) accompanied by a hemodynamic, functional, or clinical abnormality, such as: elevated static or dynamic pressures, decreased blood flow, elevated access recirculation, a swollen extremity, or unexplained reduction in Kt/V)[7],11arteriovenous fistula of 6months or more maturity,patient'sability to provide written and informed consent. Exclusion criteria included newly formed AVF; contraindication to use of contrast medium,patientswith infection around fistula site at the time of referral and unwillingness of the patients to undergo the examinations.

Diagnostic criteria for inflow stenosis included weak

pulse, absent/decreased thrill and abnormal augmentation test. While diagnostic criteria for outflow stenosis included presence of water hammer pulse and a positive arm elevation test.[5,6] In our study physical examination was done on AVF which had been in use for over 6 months. Physical examination criterion for both inflow stenosis and outflow stenosis was derived from the guidelines of National Kidney Foundation and Beathard GA[7,8] examination. Doppler ultrasound was conducted with a portable system (Mindray Diagnostic Ultrasound system with color Doppler facility, with a frequency of 6-14MHz) criterion for stenosis was >50 %.For MDCTA[9] (16 slice Spiral MDCT, Toshiba Aquillion), contrast was administered in a peripheral vein in contra- lateral arm. Stenosis of 50% or more was considered significant. Images were viewed and reported by consultant radiologist.

The patients who had been referred for evaluation of AVF dysfunction had physical examination of their fistula done by the nephrology team, comprising of consultant Nephrologist and resident in nephrology, followed by Doppler ultrasound and then MDCT angiography, all at the same day before a scheduled hemodialysis session. The results of each investigator were recorded separately and sealed in envelope, and were evaluated by the principle investigator. Study endpoints were demonstrating that Physical examination, MDCTA and Doppler ultrasound are comparable to each other in detection of AVF stenosis.

Statistical Analysis:

Study variables were Dichotomousi.e. presence or absence of lesion,were analyzed using Cohen's Kappa value, which determined the level of agreement beyond chance between the diagnosis made by physical examination and that by MDCTA and Doppler ultrasound.Kvalue: 0.0-1.0 interpretation: zero indicates no agreement beyond chance, whereas 1.0 denotes perfect agreement beyond chance. 0.0-0.2 to 0.2-0.4 implies fair agreement,0.4-0.6 implies moderate agreement and >0.6 indicates significant agreement. Data was recorded in Microsoft Office 2007 using SPSS20.

RESULTS:

20 patients were found eligible for the study as per inclusion criteria. However, 5 declined to enter into the study. Rest of the 15 patients completed the study. No patient had any reaction to the contrast (low osmolar, nonionic) given. Data of 15 patients with AVF dysfunction; who had undergone physical examination, Doppler ultrasound and MDCTA; was analyzed. Demographic characteristics of the study cases are shown in (Table 1). Out of 15, 9 fistulas were located in upper arm and 6 in forearm.The data analysis revealed that 4 out of 15 showed normal physical examination and MDCTA and Doppler ultrasound did not reveal any abnormality in those 4 cases as well. On the other hand 11 patients showed gross abnormalities on physical examination and 9 out of 11 had the same abnormality on MDCTA. On comparison with Doppler ultrasound, 6 out of 11 detected the same lesion, while it did not detect 5 cases as were detected by both physical examination and MDCTA(Table 1)Cohen's Kappa value calculated for detection of inflow stenosis between physical examinationand MDCTA was K: 0.865which showed significant level of agreement betweenboth. Kappa value for inflow stenosis, between physical examinationand Doppler ultrasound was K: 0.471, whichshowed moderate level of agreement. The Kappa value for outflowstenosis, between physical examination and MDCTA was K: 0.602 and that for comparison between physical examination anddoppler ultrasound was K: 0.444.This showed that Doppler ultrasound was inferior in both inflow and outflow stenosis detection when compared with physical examination.Level of agreement was also calculated between MDCTA and doppler ultrasound which showed k: 0.545 for inflow stenosis and k: 0.375 for outflow stenosis, which was moderate and fair level of agreement, respectively. (Table2).Analysis of the forearm and upper arm fistulas showed no difference in level of agreement between these 3 modalities.

TABLE 1
Demographic characteristics of the study cases

No. of cases	15
Gender	
Male	10
Female	5
Causes of ESRD	
Hypertension	4
Diabetic nephropathy	5
Glomerulonephritis	3
Obstructive uropathy	3
Type of Fistula	
Forearm	6
Arm	9

TABLE 2

Parameter	Inflow Stenosis	Outflow Stenosis
Physical exam./MDCTA	K:0.865	K:0.602
Physical exam./Doppler u/s	K:0.471	K:0.444
MDCTA/Doppler u/s	K:0.545	K:0.375

DISCUSSION:

AVF stenosis and its detection had been an important area of discussion and research in interventional nephrology and radiology.[10,11] Quite a number of studies have been conducted toemphasize on variety of diagnostic toolsin detection of stenosis.[12,13]. A study determined the accuracy of Doppler ultrasound in detectionof AVF stenosis when compared with angiography[14]. In this study they used portable Doppler ultrasound (sonosite, St.Paul.MN) results showed increased sensitivity and specificity of Doppler ultrasoundin detection of lesion (91% and 98%, respectively) but it did not mentioned the technical specification of the Doppler ultrasound. However, our study showed that ColorDoppler (6-14 MHz) was inferior to MDCTA in detecting outflow stenosis.Studies have[15,16,17]highlighted the accuracy of physical examination in detection of AVF stenosis when compared with angiography, the gold standard. In one of the studies the examination was done by a resident who was given training in examination of the fistula. Studies[18,19,20] have showed significant agreement and therefore high accuracy of physical examination when compared to MDCTA in stenosis detection. However, in our study the clinical examination was done by a consultant Nephrologist. A study compared accuracy of 64MDCTA Scanner (somatom sensation 64, Siemens medical solutions) with digital subtraction angiography. This study revealed that 64 MDCTA had 90.2% sensitivity in stenosis detection[21].Our study compared 3 modalities i.e. physical examination, Dopplerultrasound and MDCTA in detection of AVF stenosis and results thereby inferred that physical examination was equivalent, non inferior to MDCTA and superior to Doppler ultrasound in detection of the lesion.For outflow stenosis Doppler ultrasound was inferior to both physical examination and MDCTA[22,23,24,25].

This study has some limitations like the small sample size and that the physical examinations were done by a consultant Nephrologist, with a considerable experience in the test.

In future, further studies in this context should be done on a larger sample of patients and by multiple examiners of different level of training, to further authenticate results of this study and comparison of different Doppler ultrasound machines to establish technical specifications as the cause of inferiority or superiority in AVF stenosis detection.

CONCLUSION:

Physical examination is an important tool in AVF stenosis detection and is found to be superior to Doppler ultrasound in lesion detection especially outflow stenosis. MDCTA can be considered as an alternative to conventional angiography in armed forces class A hospitals for detecting AV fistula stenosis in order to decide transfer of the patient to tertiary care center for definitive management i.e. angioplasty or stenting.

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