

Original Research

Assessment of efficacy of colour Doppler ultrasound (CDUS) in dysfunctional hemodialysis arterio-venous fistula

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ABSTRACT:

Background: Maintenance of functional vascular access is a vital issue for patients on permanent haemodialysis. Arteriovenous fistula (AVF) created with native vessels are the vascular access of choice for hemodialysis: at comparable flow rates, the AVF is associated with a lower incidence of complications and longer survival than prosthetic grafts or central venous catheters. Hence; the present study was undertaken for assessing the effectiveness of colour Doppler ultrasound (CDUS) in dysfunctional hemodialysis arterio-venous fistula. **Materials & methods:** The present study was conducted for assessing the effectiveness of colour Doppler ultrasound (CDUS) in dysfunctional hemodialysis arterio-venous fistula. A total of 20 patients were enrolled. A clinical evaluation of the dialysis access was performed in all patients before US examination. During DU examinations, the patient positioning was most often supine, with the arm relaxed and extended out to the side, with the area to be evaluated closest to the sonographer. Colour Doppler ultrasound (CDUS) in dysfunctional hemodialysis arterio-venous fistula. Digital subtraction angiography was also done for assessing. All the results were recorded and analyzed by SPSS software. **Results:** The mean diameter of the stenotic area was 1.5. The mean pre-stenotic velocity was 71.5, and the mean interstenotic velocity was 246.2. Sensitivity and specificity of CDUS for detection of significant stenosed vessel segment in comparison to DSA (digital subtraction angiography) was 95.6 percent and 97.2 percent respectively. **Conclusion:** CDUS is a non-invasive diagnostic tool for early detection of complications of AVFs that allows monitoring of the AVF blood flow and detection of possible causes of vascular access malfunction.

Key words: Colour Doppler Ultrasound, Hemodialysis

Received: 10 November, 2021

Accepted: 26 November, 2021

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This article may be cited as: Kumar A. Assessment of efficacy of colour Doppler ultrasound (CDUS) in dysfunctional hemodialysis arterio-venous fistula. J Adv Med Dent Sci Res 2021;9(12):160-162.

INTRODUCTION

Maintenance of functional vascular access is a vital issue for patients on permanent haemodialysis. The development of haemodialysis access stenosis and concomitant thrombosis is a major cause of morbidity and multiple hospital admissions. A timely detection and treatment of stenoses may prevent access thrombosis and, therefore, may prolong the functionality of haemodialysis fistulae and grafts. A preferred method of access surveillance involves monitoring of access flow rates with an ultrasound dilution technique. A flow decline at serial measurements suggests the development of a flow limiting stenosis. Vascular access assessment for detection of these stenoses can then be done by a variety of imaging modalities, such as color Doppler ultrasonography, contrast-enhanced magnetic resonance angiography (CE-MRA), multi-detector

computed tomography angiography and digital subtraction angiography (DSA).¹⁻³ Arteriovenous fistula (AVF) created with native vessels are the vascular access of choice for hemodialysis: at comparable flow rates, the AVF is associated with a lower incidence of complications and longer survival than prosthetic grafts or central venous catheters. However, because of the increasing prevalence of advanced age and co-morbidities such as diabetes mellitus and vascular disease among patients requiring dialysis, nephrologists and vascular surgeons are finding it increasingly difficult to locate native vessels suitable for creation of a well-functioning, persistently patent AVF. The use of Doppler ultrasound (DUS) by physicians performing vascular access surgery has increased the number of cases in which AVFs can be created with native vessels by allowing preoperative mapping and

identification of suitable vessels.^{4- 7} Hence; the present study was undertaken for assessing the effectiveness of colour Doppler ultrasound (CDUS) in dysfunctional hemodialysis arterio-venous fistula.

MATERIALS & METHODS

The present study was conducted for assessing the effectiveness of colour Doppler ultrasound (CDUS) in dysfunctional hemodialysis arterio-venous fistula. A total of 20 patients were enrolled. A clinical evaluation of the dialysis access was performed in all patients before US examination. During DU examinations, the patient positioning was most often supine, with the arm relaxed and extended out to the side, with the area to be evaluated closest to the sonographer. Examination included the afferent artery, site of anastomosis, the draining veins as far as the subclavian vein as well as the arterial tree distal to the AVF in cases experiencing steal syndrome. All vessels were examined in both transverse and longitudinal planes using gray-scale and color images. Colour Doppler ultrasound (CDUS) in dysfunctional hemodialysis arterio-venous fistula. Digital subtraction angiography was

also done for assessing. All the results were recorded and analyzed by SPSS software.

RESULTS

A total of 20 patients were enrolled. Mean age of the patients were 41.9 years. 80 percent of the patients were males while the remaining were females. Out of 20 patients with Color Doppler ultrasound detected complications, 55 percent of the patients had a brachiocephalic fistula, 25 percent of the patients had a Radiocephalic fistula, and 20 percent of the patients had a Brachio basilic fistula. Previous history of AVF was seen in 10 percent of the patients. Stenosis was seen in 40 percent of the patients while venous thrombosis and aneurysmal dilatation was seen in 5 percent of the patients. Pseudo-aneurysmal formation was seen in 10 percent of the patients while infection was seen in 5 percent of the patients. The mean diameter of the stenotic area was 1.5. The mean pre-stenotic velocity was 71.5, and the mean interstenotic velocity was 246.2. Sensitivity and specificity of CDUS for detection of significant stenosed vessel segment in comparison to DSA (digital subtraction angiography) was 95.6 percent and 97.2 percent respectively.

Table 1: Color Doppler ultrasound detected complications

Color Doppler ultrasound detected complications	Number of patients	Percentage
Brachiocephalic fistula	11	55
Radiocephalic fistula	5	25
Brachio basilic fistula	4	20
Total	20	100

Table 2: Mean diameter of Stenotic area, Pre-stenotic velocity and Mean interstenotic velocity

Variable	Mean	SD
Mean diameter of the stenotic area	1.5	0.5
Mean Prestenotic velocity	71.5	21.6
Mean interstenotic velocity	246.2	47.6

Table 3: Sensitivity and specificity of CDUS for detection of significant stenosed vessel segment in comparison to DSA (digital subtraction angiography)

Variable	Value
Sensitivity	95.6%
Specificity	97.2%
Positive predictive value	91.6%
Negative predictive value	94.8%
Accuracy	94.8%

DISCUSSION

The long-term survival and quality of life of patients with chronic end-stage renal failure on hemodialysis (HD) are dependent on the adequacy of dialysis via an appropriately placed vascular access. Arteriovenous fistulas (AVFs) are the preferred initial HD access owing to their longer patency than prosthetic arteriovenous grafts. However, arteriovenous grafts remain clinically important in patients whom AVFs are not feasible, and possibly in special populations such as the elderly. The creation

and maintenance of a patent and well-functioning AVF have become a real challenge to nephrologists and vascular surgeons. Complications associated with HD vascular access are considered one of the most important causes of morbidity among patients with end-stage renal disease. Access failure is usually owing to thrombosis associated with anastomotic or outflow vein stenosis. Multiple salvage procedures are required to restore functionality or creation of a new access. Early detection of access dysfunction and subsequent intervention may help to decrease

access failure rate. AVFs are constructed to be superficial, and they are easily accessible by Doppler ultrasound (DU). DU is very important in a patient-centered VA evaluation. It is mobile, cost effective, and noninvasive, and also, it provides morphologic and functional information of the access flow. It can provide all aspects of vascular access care, including vascular mapping, maturation evaluation, and surveillance.⁸⁻¹⁰ Hence; the present study was undertaken for assessing the effectiveness of colour Doppler ultrasound (CDUS) in dysfunctional hemodialysis arterio-venous fistula.

A total of 20 patients were enrolled. Mean age of the patients were 41.9 years. 80 percent of the patients were males while the remaining were females. Out of 20 patients with Color Doppler ultrasound detected complications, 55 percent of the patients had a brachiocephalic fistula, 25 percent of the patients had a Radiocephalic fistula, and 20 percent of the patients had a Brachio basilic fistula. Previous history of AVF was seen in 10 percent of the patients. Stenosis was seen in 40 percent of the patients while venous thrombosis and aneurysmal dilatation was seen in 5 percent of the patients. The relationship between arterial diameters and AVF outcomes has been studied in radial-cephalic fistulas. Immediate (on the day of surgery) and early (within the first 8–12 weeks after surgery) AVF failures were found to be quite frequent when small-caliber (<1.5–1.6 mm) arteries were used to create the fistula. Malovrh et al. reported immediate and early failure rates of 55 and 64 %, respectively, when the arteries used had diameters of ≤ 1.5 mm, whereas much lower rates (8 and 17 %, respectively) were observed when the arterial diameters were > 1.5 mm. Parmar et al reported an early failure rate of 46 % for arteries with diameters of < 1.5 mm, while no failures were observed when vessel diameters were > 1.5 mm.⁷⁻¹¹

In the present study, pseudo-aneurysmal formation was seen in 10 percent of the patients while infection was seen in 5 percent of the patients. The mean diameter of the stenotic area was 1.5. The mean pre-stenotic velocity was 71.5, and the mean interstenotic velocity was 246.2. Sensitivity and specificity of CDUS for detection of significant stenosed vessel segment in comparison to DSA (digital subtraction angiography) was 95.6 percent and 97.2 percent respectively. Wong et al. encountered premature failures with all AVFs created with arteries whose diameters were ≤ 1.6 mm. In another study, patent fistulae had preoperative radial diameters of 2.7 mm as opposed to 1.9 mm for AVFs that failed. Silva et al. proposed a minimal diameter of 2 mm, which in their experience was associated with an early failure

rate of 8 % and a 1-year primary patency rate of 83 %.⁷⁻¹¹

CONCLUSION

CDUS is a non-invasive diagnostic tool for early detection of complications of AVFs that allows monitoring of the AVF blood flow and detection of possible causes of vascular access malfunction.

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