ejpmr, 2017,4(7), 241-244

SJIF Impact Factor 4.161

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

VALUE OF MDCT IN THE ASSESSMENT OF ARTERIOVENOUS FISTULAS DYSFUNCTION

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Article Received on 12/05/2017 **Article Revised on 01/06/2017** **Article Accepted on 22/06/2017**

ABSTRACT

Introduction: Arteriovenous fistula dysfunction is a common problem in patients undergoing hemodialysis. Its early diagnosis has a great impact on the prognosis. Physical examination and ultra sonography are usually used to depict fistula stenoses or thromboses. In most cases conventional angiography is performed to evaluate the fistula and the venous outflow segments. It is considered as the method of choice allowing an accurate description of abnormalities. Nevertheless, it is an invasive exam with considerate risk of complication. Recent development in imaging techniques revealed a good accuracy of MDCT angiography as a non invasive reliable tool evaluating the entire vascular tree. **Objective:** The aim of this study was to demonstrate the accuracy of 64-MDCT angiography in the assessment of arteriovenous fistula dysfunction in comparison with conventional angiography. **Subjects and methods:** Prospective study including 40 patients (22 men and 18 women), average age 62.4 years with chronic renal insufficiency in the stage of hemodialysis presenting fistula's dysfunction. All patients underwent conventional angiography first and then 64 row MDCT angiography. CT Images were interpreted by a long experienced radiologist unaware of the results of the angiography. **Results:** Images quality was good for both exams. MDCT had good accuracy in the depiction of arterial and central venous stenosis. It was even superior to conventional angiography for the depiction of distal venous stenosis. MDCT was also superior to fistulography in the detection of aneurysm thromboses. **Conclusion:** MDCT angiography is a non invasive imaging tool exploring arteriovenous fistulas failure with reliable results compared to digital substraction angiography.

KEYWORDS: Arteriovenous fistula, fistulography, MDCT angiography.

INTRODUCTION

Arteriovenous fistula dysfunction is a common problem in patients undergoing hemodialysis. Early depiction of the cause of fistulas failure has a great impact on the quality of life of patients with chronic renal insufficiency. Conventional angiography is widely considered as the method of choice to assess fistulas abnormalities. But it remains an invasive examination with risks of complications. Recent research on MDCT angiography revealed high accuracy of this non invasive imaging tool in the evaluation of the whole vascular tree.

The aim of this study is to demonstrate the usefulness of MDCT angiography in the evaluation of arteriovenous fistulas in comparison with conventional angiography.

METHODS AND MATERIALS

Prospective study including 40 patients (22men and 18women), with average age of 62 years. All patients had native arteriovenous fistulas with clinical suspicion of failure. Conventional angiography was performed first then a 64 MDCT angiography. CT Images were interpreted by a long experienced radiologist in the field of vascular imaging unaware of the results of the angiography. We had the approval of ethics committee and a written informed consent was obtained from our patients.

Scanning protocol: Before the examination an 18 gauge catheter is placed in the arm opposite to the side of fistula. The arm with arteriovenous fistula is placed alongside the body leaving a small gap to avoid venous compression. The down position of the arm is preferred to get rid of motion artifact due to uncomfortable upper arm position especially in old patients. The acquisition range is from the upper margin of the shoulder to the end of the fingers. The bolus tracking technique is used with a region of interest placed in the ascending aorta. 1.5ml/kg of contrast medium is used with a 30 ml of saline chaser. An injection flow of 3.5ml/s with post-threshold delay of 12 s are needed to obtain a good vascular enhancement especially for native distal vessels with slow flow.

The parameters of the acquisition are: Pitch 1.2; collimation 64 ×0.625 mm; rotation time 0.5 s; tube voltage 120 kV; effective tube current 160 mAs.

Axial images are reconstructed with slice thickness of 1mm.

Images interpretation

To analyze tortuous vessels a dedicated post processing workstation is needed. It allows in addition to axial images to get 2D image reconstructions including maximum intensity projection (MIP), multi-planar reformation (MPR) and curved multiplanar reformation (cMPR). 3D volume rendering (VR) technique is also useful to complete the evaluation and to get a global view of the vascular tree (Fig 1).

Figure 1: 1a:2D reconstructions allowing to explore the whole vascular tree, 1b: VR reconstructions offering three dimensional view.

Conventional angiography technique: Fistulography is performed by an experienced radiologist, with the use of digital subtraction technique. A puncture of the AVF venous side, close to surgical anastomosis is first needed. Then 50ml contrast medium is injected in three steps. Opacification of the whole venous tract is required.

RESULTS

The fistula was confectioned in the left arm for 33 patients (80%). Most of fistula were brachial-cephalic (17cases) and brachial basilic(16 cases). 5 patients had radial cephalic fistula and 2 patients had arteriovenous graft. All of them had a long medical history of high blood pressure, diabetes and atherosclerosis. Images quality was good for both exams (87%). Criteria for good CT image quality were optimal vascular enhancement and absence of motion artifacts (fig1). 2D and 3D reconstructions were combined in addition to cross section images to explore the vascular tree. A good correlation between MDCT and conventional angiography findings was seen.

For the arterial vessels, MDCT detected two arterial stenoses with sensitivity of 70%, specificity 97%.

For the proximal venous system, MDCT detected 6 aneurysm and 25 stenosis. The sensivity and specificity of MDCT were 94% and 90% respectively (Fig 2).

Both MDCT and conventional angiography detected 6 aneurysms on the central venous system.

For distal venous system, MDCT depicted 11 stenoses while fistulography showed only 6.One case of distal aneurysm was detected by MDCT.

For venous stenosis grading we considered as most authors

Grade 0: stenoses from 0 to 25%
Grade 1:stenoses from 25 to 50%
Grade2: stenoses from 50 to 75%
Grade 3:stenoses more than 75%
grade4: total occlusion

Discordance between MDCT and subtraction angiography was seen in stenoses grading. In fact, three cases of venous stenoses grade 3 in angiography were considered as grade 4 at MDCT (Fig 3).

In some cases conventional angiography did not allow to get optimal view of the arteriovenous fistula while MDCT offered better results(Fig 4).

MDCT showed two aneurysm thromboses undetected on fistulography (Fig 5).

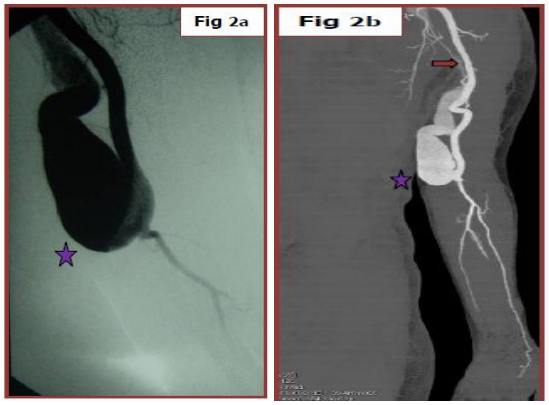

Fig 2: 2 a: conventional angiography showing an aneurysm in the proximal vein
2 b: 3D Reconstruction angiography with the same findings as conventional angiography, it shows in addition a proximal vein stenosis (red arrow)

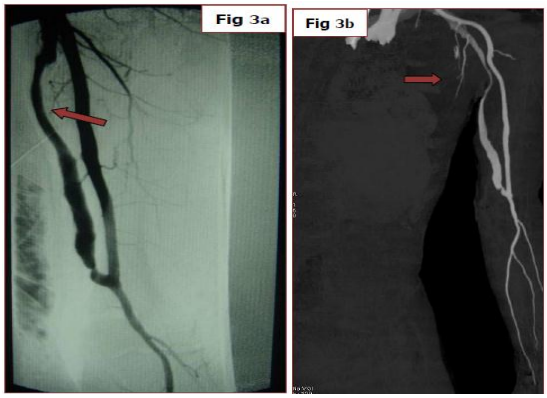

Figure 3: 3a: fistulography showing proximal and distal venous stenoses (stage 3)
3b: CT reconstruction in the same patient showing a more important distal venous stenoses (stage 4)

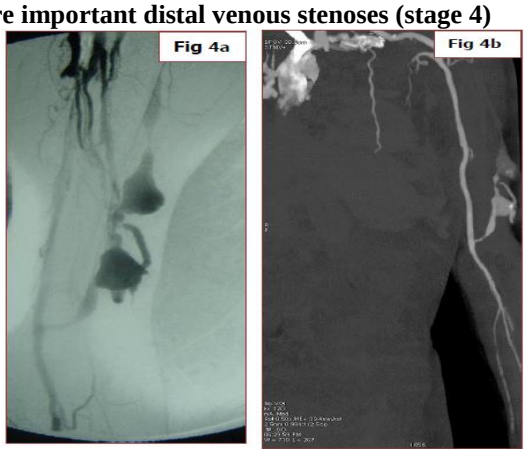

Figure 4: 4a : Fistulography showing two venous aneurysm with a deficient opacification of the fistula and proximal veins
4b: CT reconsctructions allowing better exploration of the fistula and proximal venous system

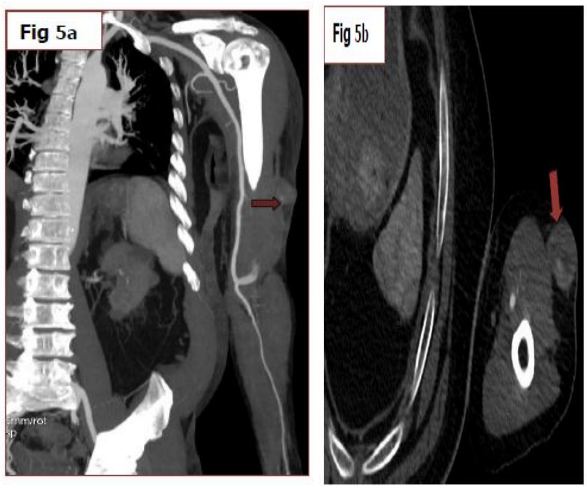

Figure 5: 5a: MIP CT reconstructions showing an aneurysm thromboses
5b: axial images showing the aneurysm thrombosis

DISCUSSSION

Arteriovenous fistula is the major vascular access in patients under hemodialysis. It is preferred to arteriovenous graft and tunneled catheter because of its better longevity and low risk of complications.[1]

Nevertheless early or late complications may occur. Early dysfunction is due to inflow problems while late one is usually related to stenosis, thrombosis or aneurysm. These complications have a great impact on morbidity or even mortality rate. Clinical examination suspects fistulas failure in case of oedema or collateral vessels, discontinuous thrill or high resistance in dialysis. Color Doppler ultrasound is usually first performed to explore the fistula.[2] It is a non invasive and available tool allowing locating and characterizing vascular abnormalities. It gives morphologic and functional information. Yet it doesn't allow an accurate and exhaustive analysis of the vascular tree especially for central veins. Besides it is user dependant and is limited in case of subcutaneous edema or hematoma in the access site. Subtraction angiography is usually performed after ultrasound to get a vascular map before surgery. It is widely considered as the gold standard for fistulas evaluation. It is a reliable technique providing complete and precise vessels analysis. It also offers the possibility of interventional treatment. The main inconvenience is that subtraction angiography is an invasive imaging technique with a risk of fistula thrombosis and contrast material extravasation.[7] It is limited in the detection of thrombotic aneurysm or vascular thrombi since it doesn't explore the vascular wall and provides only 2D images. It doesn't provide information about extra vascular structures especially in case of external compression. Another limitation of subtraction angiography is the difficulty of visualizing central veins requiring multiple injections. MRI angiography is also an interesting imaging tool with the advantage of avoiding radiation exposure and contrast agent nephrotoxicity. Yet, it is less performant in case of high vascular turbulence, it also requires a long time examination and is less available than other imaging techniques. Recently, many researches showed encouraging results of MDCT angiography in the assessment of fistulas dysfunction. A 64 row computed tomography is usually needed. In fact, it allows a short time acquisition with a large field of view and a good resolution. Nevertheless, some studies showed good results with even 4 row computed tomography. Peripheral venous access in the offside side to the fistula is used. Rigorous technique is needed including:

-A good scanning position avoiding motion artifacts and discomfort for the patient. Some authors prefer to place the arm above the head to avoid artifact; others recommend to place it along the body leaving a small gap since it is more comfort for old and fragile patients.

- An optimal vascular enhancement. For that, bolus tracking technique with an adequate flow rate contrast material injection is required.

A dedicated post processing workstation is then used allowing to get 2D image reconstructions including maximum intensity projection (MIP), multi-planar reformation (MPR) and curved multiplanar reformation (cMPR). 3D volume rendering (VR) technique is also useful to complete the evaluation and to get a global view of the vascular tree.

Heye et al[7] showed, through a study including 36 patients, a high accuracy of MDCT for the detection of stenosis superior to 50% and fistulas occlusion.

Karadeli et al[8] realized a prospective study over 30 patients with 16 row computed tomography, comparing the results of different 3D plans reconstructions. They found a high sensitivity of coronal MIP reconstruction in the assessment of venous stenosis in comparison with axial source images. It showed a low sensitivity of CT scan to explore central vein because of the proximity of bones even for VRT reconstruction. However, CT was accurate in the depiction of aneurysms thromboses while conventional angiography was interpreted as normal.3D VRT images were particularly useful in the depiction of venous stenosis.

In our study MDCT had an excellent accuracy in the depiction of venous stenosis in comparison with subtraction angiography. MDCT detected two aneurysm thromboses while subtraction was interpreted as normal. It provided in addition to native axial images multiplanar vascular reconstruction and three dimensional analyses with high images quality. Discordance between MDCT and subtraction angiography was seen in stenoses grading. In fact, three cases of venous stenoses grade 3 in angiography were considered as grade 4 at MDCT.

The main inconvenience with MDCT is the use of higher dose of contrast material and higher radiation exposure. For that CT examination was scheduled a day before hemodialysis and CT parameters were adjusted to obtain as low radiation dose as possible.

There were no complications related to MDCT procedure in our study but cases of anaphylactic reaction, vascular rupture due to high injection flow rate are reported(5).

A major limitation in our study is little number of patients. Therefore, more researches above large number of patients are needed.

CONCLUSION

A patent and well functioning arteriovenous fistula guarantees long survival and quality of life in patients undergoing hemodialysis. Therfore, early depiction of fistula dysfunction is quite important. Recent improvement in MDCT encouraged many researchers to try to assess its accuracy in the screening of fistula complications. Most studies showed a high correlation between MDCT and digital subtraction with even better results in the analysis of the vascular tree. Further studies are required to improve this technique and make it performed in routine.

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