Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2016; 4(8D):3009-3014 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com DOI: 10.36347/sjams.2016.v04i08.053

Original Research Article

Over and under estimation of arterial stenosis grade by Doppler and comparison with CT angiography

Amlendu Nagar*, Pramod Sakhi, Sheetal Singh.
Department of Radiodiagnosis, Index Medical College Hospital & Research Centre, Index City, Near Khudel Village, Nemawar Road, Indore-452016, Madhya Pradesh, India

***Corresponding author**
Dr. Amlendu Nagar
Email: dramlendu@gmail.com

Abstract: The aim of our study was to compare stenosis grade in peripheral arterial diseases by color Doppler and MDCT angiography. 75 patients having symptoms related to lower or upper limb peripheral arterial occlusive disease were examined by Doppler USG and CT angiography. The data were analyzed in 13 arterial segments. (5 in upper limb and 8 in lower limbs). Stenosis grading was assigned from 1 to 5, one as normal and 5 as complete block. The sensitivity, specificity and accuracy of Doppler USG and CTA were determined using statistics. A total of 1071 arterial segments were compared on CT angiography and Doppler USG. We found 419 (39.1%) abnormal disease arterial segments on CT angio. The sensitivity, specificity, and accuracy of MDCT angiography was 92.9%, 82.2 %, and 85.6%, respectively. Color Doppler ultrasonography for peripheral arterial disease is excellent first investigation for evaluation of peripheral arterial disease in upper or lower limbs beyond inguinal region and beyond 2nd part of subclavian A in upper limbs.
Keywords: Arterial Stenosis, Peripheral arterial disease, Ischemia, Intermittent Claudication, Arterial segments, CT angio and Doppler USG.

INTRODUCTION:

The purpose of our study is to evaluate diagnostic accuracy of Multi detector CT angiography (MDCTA) in comparison with Color Doppler in patients with chronic long standing ischemia. Intermittent claudication is common presenting complaint in approximately 3 to 6 percent of elderly population [1, 2]. Advancements of CT technique covers entire limbs within few seconds. Optimization of I.V. contrast with blood flow and CT scanning gives higher spatial resolution and coverage of more than 120 cm [2]. Images are displayed using 3D VRT and curved planer technique. Imaging of the entire arterial system is possible using CT angiography and has found excellent concordance with digital subtraction imaging [3]. A comparison of segmental assessment of peripheral arterial system was done by Color Doppler and CT Angiography.

MATERIAL AND METHODS:

We have included examination results of 75 patients referred to department of Radio diagnosis for either Color Doppler or CT angio having symptoms of intermittent claudication and/or other features of peripheral arterial disease. The patients included were form 26 to 84 years with Median age of 47 years. Male female ratio was 80:20.

All these patients were evaluated by both duplex Doppler and CT angiography for peripheral arterial system. A written consent was taken from all willing patients. Pregnant patients and others allergic to contrast were not included in this study. A clinical history and examination was recorded. Doppler USG examination was performed then CT angiography on subsequent day. Out of seventy five patients 66 patients were having complaints in lower limb. Other 9 patients had upper limb symptoms. 3 patients had unilateral below knee amputation. 1 patient had unilateral above knee amputation.

Duplex Color Doppler examination were done on Siemens acuson 300 ultrasound(Siemens LTD) using linear 5-12 MHz and multi frequency 3-5 MHz curved transducers. Examination of abdominal aorta, iliac, femoral popliteal and tibial arteries was performed in supine/prone position. Upper limb evaluation was done in supine position. Optimal PRF and base line settings were done to display best velocity and Color flow in various arterial segments. The artery was considered

normal when the lumen is clear and has thin uniform walls. Atheromatous plaques either calcified or soft are seen with in the vessel lumen. Large thrombus with luminal narrowing and abnormal dilatations are noted on B mode examination. Color Doppler examination demonstrated pulsatile directional flow. Spectral Doppler was analyzed for low resistance in distal segments. Turbulent Color flow was noted at the sites of severe stenosis. Stenotic areas showing turbulence of Color flow were further investigated for hemodynamic changes in spectral wave form. Stenotic areas were recorded and compared with normal lumen proximal to it.

Table 1: Stenosis grading by Doppler Ultrasonography and CT angio.([8,13])

Grade of stenosis	Criteria
1	Normal patency
2	Mild (stenosis of less than <50% diameter)
3	Moderate(stenosis of 50-70% of diameter
4	More than 70% stenosis
5	Complete occlusion

CT angiography was done on 128 slice CT scanner machine (definition AS from Siemens) patients were put on supine position. All lower limb angiography patients were placed as feet first. Upper limb angio patients were positioned to include thoracic outlet and one upper limb. Topogram was obtained followed by non contrast series to include infra renal aorta in lower limb angiogram. Arch of aorta was included in upper limb angio.

The mean coverage was 1100 mm. All patients were injected nonionic iodinated contrast media (Inj. Iohexol 350 mg/ml). Total of 75 to 100 ml (mean 80ml) was given by automated pressure injector at 4.5 ml/sec flow rated followed by saline flush of 30ml. Bolus tracking technique was adopted and the region of interest was put at aorta. Data acquisition was performed in cranio caudal direction with slice thickness of 0.6 mm, table feed of 15 mm per rotation and 0.33 seconds of gantry rotation time. Axial reconstructions were obtained with a thickness of 1 mm and no interslice gap and it has generated approximately 1550 axial images (range 1350-1800). The procedure was well tolerated by all patients. All CTA images were transferred to syngo.via workstation (Siemens). Multiple images were generated using 3D reconstructions, maximum intensity (MIP) and volume rendering (VRT) images. Axial and reconstructed images were analyzed and graded as shown in table 1.

RESULTS

We have studied 1094 arterial segments on CT angiography and 1071 arterial segments on color Doppler USG. We could not asses 2 subclavian and 21 iliac arterial segments on USG because of bone interference or bowel gas. Thus 1071 segments were studied on both CTA and color Doppler. Abnormal disease segments on CTA were seen in 419 segments (39.1%). Out of these 51 were mild stenosis and 41 were focal severe stenosis. Rest 86 segments were diffuse severe stenosis and complete occlusion was seen in 241 segments on CTA. There was overestimation of degree of stenosis on Doppler USG by one grade in 87 segment. 18 segments were overestimated as two grades, 57 segments by 3 grade and 39 segments by four grades overestimation.

In 48 segments the degree of stenosis was underestimated by 1grade, 15 segments underestimated by 2grades, 10 segments by 3 grades and 6 segments by 4 grades (Table 2). Under and over estimation of grade 5 was similar in both Doppler and CT angio. We have found 92.9 percent sensitivity of Doppler USG compared to CT angiography. 82.20 % specificity and 85.6% accuracy of Doppler as compared to CTA.

Table-2: Cross tabulation of grading of stenosis by Doppler and CTA

		CT Angio Grade					
		1	**2**	**3**	**4**	**5**	**Total**
DOPPLER GRADE	**1**	**536**	**9**	**6**	**5**	**4**	**560**
	2	**62**	**10**	**9**	**1**	**2**	**84**
	3	**2**	**7**	**14**	**14**	**7**	**44**
	4	**30**	**16**	**6**	**34**	**35**	**121**
	5	**22**	**9**	**6**	**32**	**193**	**262**
		652	**51**	**41**	**86**	**241**	**1071**

Fig 1 showing CIA, EIA and aortic bifurcation occlusion

Fig 2: showing block in popliteal Arteries

As compared to earlier studies there was similar sensitivity of CTA and DSA while lower specificity of Doppler USG with CTA.

Table 3: comparison with previous studies

	Sensitivity %	Specificity %	Accuracy %	Agreement	Study	Done by
CTA v/s DSA	96	93	94	NA	n=50 4 MDCT	Carlo catalano *et al* [4]
	96	97	NA	-	n=39 16 MDCT	Jurgen K *et al* [5]
Doppler v/s DSA	98	81	-	K=0.81	PSV considered	Sensier *et al* [6]
	86(74-91)	97 (94-99)	NA	-	Meta analysis	Koelemay *et al* [7]
	NA	NA	-	K=0.81	CFI considered	Mc carthy *et al.* [8]
Doppler v/s CTA	92.9	82.2	85.6	73.4 %	n=75 PSV&CFI considered 128 MDCT	Our study

NA-Not available, K =Kappa, MDCT=Multi-Detector Computed Tomography, CTA=CT Angiography, DSA=Digital Subtraction Angiography, PSV=Peak Systolic Velocity, CFI=Color Flow Imaging.

In the upper limb arteries and proximal arteries of lower limbs the CTA and Color Doppler USG estimation was comparable. In distal run off arteries of lower limbs the Doppler overestimated grade of stenosis. There was excellent sensitivity 92.9% and specificity 82.2% in grading of stenosis by Doppler USG compared to CTA. How ever there was significant overestimation of stenosis by Doppler.

Fig 3: showing left popliteal occlusion

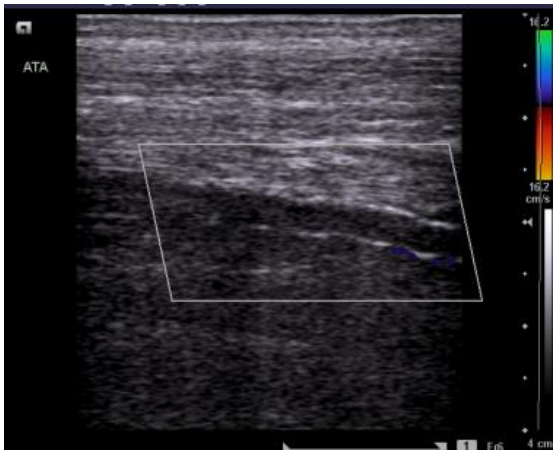

Fig 4: showing ATA block

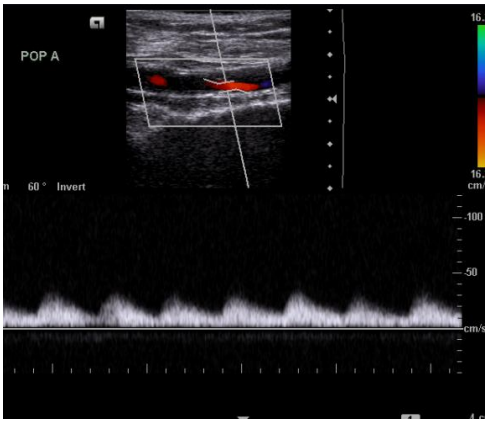

Fig 5: showing post stenotic dampened Tardus Pavus wave form in Popliteal A

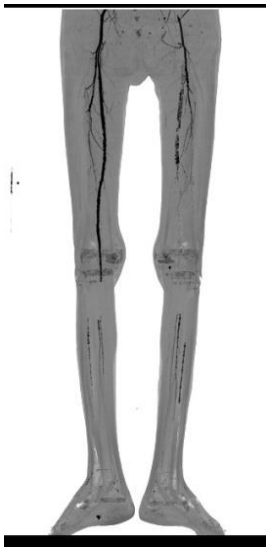

Fig 6: showing multiple occlusion in SFA, Popliteal and Tibial A

Fig 7: showing upper limb occlusion in Ulnar A and stenosis in Radial A

Fig 8: showing occlusion in Right CIA

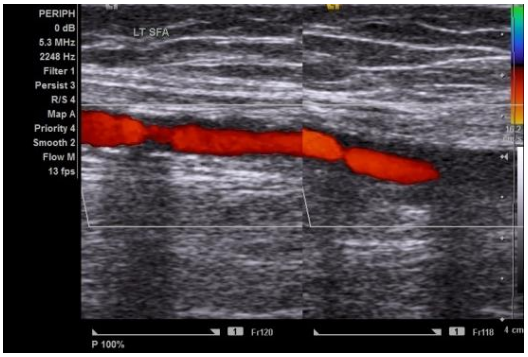

Fig 9: showing 70% stenosis in SGFA in a 85 year male

Fig 10: Showing stenosis calculation in CFA

DISCUSSION:

Patients with peripheral arterial disease are investigated by Doppler USG and angiography for defining anatomy and assessing vascular narrowing [9]. Peripheral arterial disease is an important cause of morbidity among elderly males [10]. Intermittent Claudication is common presenting symptom in patients with peripheral arterial disease.

Catheter Digital subtraction angiography is gold standard for evaluation of limb ischemia. Multi-slice CT scans demonstrating angiographic like images in vascular diseases have been used since late 1990s. CTA has replaced catheter based angiography for clinical assessment of the aorta and its branches [3, 11, 12].

Doppler USG for evaluation of peripheral arterial disease is first investigation of choice as it does not involve radiation. The studies can be repeated and velocity quantification and functional evaluation of blood flow can be well studied. It also offers direct measurement of thrombus and stenosis. Drawbacks with Doppler USG are variable parameters with different observers, limited reproducibility and long examination time.

CT angiography reproduces entire arterial tree within few minutes. The study can be performed by single intravenous injection of iodinated contrast. Mapping of arterial reformation and collateral is better with CT angiography. Major drawbacks with CTA are radiation and cannot be performed in renal compromised patients.

In our study arterial narrowing was graded using stenosis calculator on MIP images in CTA and B mode images in Doppler USG. We could not asses 3 subclavian and 23 iliac arterial segments (4%) on Doppler USG because of bone interference or bowel gas. Grading of stenosis by Doppler USG was done using peak systolic velocity (PSV) as per Sensier *et al*, or anatomical imaging from color or power mode as per Mc Carthy *et al*., [8, 13]. USG also gave more information on atherosclerotic arterial disease, thrombus and stenosis. Dense calcification was deterrent in evaluation of lumen because of acoustic shadowing. B and Color Doppler findings were correlated with spectral waveforms.

Doppler USG over estimated grade of stenosis in distal tibial vessels in correlation with CTA. It is difficult to assess tiny lesions in multi-segmental peripheral occlusive arterial disease. Another reason was lack of flow in distal arteries in patients with proximal occlusive lesions. There was statistical difference between Doppler USG and CTA in all grades of stenosis thus one investigation is better than other. Overall the sensitivity, specificity and accuracy of Doppler USG v/s CTA was 92.9%, 82.2% and 85.6%. it also showed 73.4% agreement between two studies. Region wise sensitivity was good in all regions (91-97%). There was wide difference in specificity (61-94%) and inconsistence specificity in distal run off arteries of lower limb (61%) and (73%) of upper limb arteries.

Doppler USG can be first investigation of choice for investigation of patients with peripheral arterial system disease as it offers good sensitivity (92.9) and high negative predictivity (95.5%). Other patients with aneurysms, haemangiomas, thrombus and follow up of arterial grafts can be equally evaluated by both modalities. These patients require further studies for evaluation of specific diseases. In our studies dense calcification is deterrent to correct grading of stenosis in atherosclerotic arteries particularly in patients with diabetes and hypertension. The lumen was considered patent if distal vessel show luminal contrast of similar density and no significant collaterals were present. Subtraction method using plain and contrast sequences were helpful.

Table 4: Segmental over or under estimation by doppler

	On Doppler	Under estimation						Over estimation				
S.No	Artery	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
1	SCA	0	0	0	1	0	6	0	0	0	0	0
2	AXA	0	0	0	0	0	5	3	0	1	0	0
3	BRA	0	0	0	0	2	5	2	0	0	0	0
4	RA	0	0	0	0	1	4	2	0	2	0	0
5	UA	0	0	0	0	0	4	3	1	1	0	0
6	CIA	0	0	0	0	3	115	0	0	2	1	0
7	EIA	0	0	0	0	2	109	5	2	2	2	0
8	CFA	0	2	0	3	7	112	3	0	2	3	0
9	SFA	0	2	1	1	5	116	4	0	0	3	0
10	POP A	0	2	2	5	4	99	10	4	5	0	0
11	ATA	0	0	2	3	4	73	22	5	12	10	0
12	PTA	0	0	1	1	11	63	24	2	21	8	0
13	DPA	0	0	4	1	9	76	13	4	9	12	0
	Total	0	6	10	15	48	787	87	18	57	39	

A good number of patients (40%) were managed conservatively if there was good distal flow in CTA. Large artery occlusion were treated with grafting (12%).Further distal arterial disease involving tibial arteries were treated with amputation (14%) or whether ischemic gangrene has developed and also as per the clinical condition guided

CONCLUSION:

Color Doppler ultrasonography for peripheral arterial disease is excellent investigation for evaluation of lower limbs beyond inguinal region and beyond 2nd part of subclavian A in upper limbs. There was statistical difference between CTA and color Doppler USG which suggest one method is better than other. Since Doppler USG overestimates stenosis, CTA has to be preferred in multi-segmental distal arterial disease. Color Doppler USG can be the first investigation in all peripheral arterial disease.

REFERENCES

1. Dormandy JA, Rutherford RB. Management of peripheral arterial disease (PAD). TASC Working Group. TransAtlanitic Inter-Society Consensus (TASC) J Vasc Surg. 2000:31 (1 Pt 2): S1 –S296.
2. Ota H, Takase K, Igarashi K, Chiba Y, Haga K, Saito H, *et al*. MDCT compared with digital subtraction angiography for assessment of lower extremity arterial occlusive disease: importance of reviewing corss-sectional images. AJR Am J Roentgenol. 2004; 182 (1):201-09.
3. Rubin GD, Schmidt AJ, Logan LJ, Sofilos MC. Multi detector row CT angiography of lower extremity arterial inflow and runoff: initial experience. Radiology. 2001; 221(1):146-58.
4. Catalano C, Fraioli F, Laghi A, Napoli A, Bezzi M, Pediconi F, *et al*. Infrarenal aortic and lower extremity arterial disease: diagnostic performance of multi-detector cow CT angiography. Radiology. 2004; 231 (2):555-63.
5. Willmann JK, Baumert B, Schertler T, Wildermuth S, Pfammatter T, Verdun FR, *et al*. Aortoiliac and lower extremity arteries assessed with 16-detector row CT angiography: prospective comparison with digital subtraction angiography. Radiology. 2005; 236 (3): 1083-93.
6. Sensier Y, Fishwick G, Owen R, Pemberton M, Bell PR, London NJ. A comparison between colour duplex ultrasonography and arteriography for imaging infrapopliteal arterial lesions. Eur J Vasc Endovasc Surg. 1998; 15 (1): 44-50.
7. Koelemay MJ, den Hartog D, Prins MH, Kromhout JG, Legemate DA, Jacobs MJ. Diagnosis of arterial disease of the lower extremities with duplex ultrasonography. Br J Surg. 1996; 83 (3): 404-09.
8. McCarthy MJ, Nydahl S, Hartshorne T, Naylor AR, Bell PR, London NJ. Colour-coded duplex imaging and dependent Doppler ultrasonography in the assessment of cruropedal vessels. Br J Surg. 1999; 86 (1):33-37.
9. Abrams HL, Baum S, Pentecost MJ. Abrans' Angiography: Interventional Radiology. Lippincott Williams & Wilkins; 2006.
10. Kannel WB, McGee DL. Update on some epidemiologic features of intermittent claudication: the Framingham Study. J AM Geriatr Soc. 1985; 33 (1): 13-18.
11. Rubin GD, Dake MD, Napel SA, McDonnell CH, Jeffrey RB. Three-dimensional spiral CT angiography of the abdomen: initial clinical experience. Radiology. 1993; 186 (1): 147-52.
12. Rubin GD, Dake MD, Semba CP. Current status of three-dimensional spiral CT scanning for imaging the vasculature. Radiol Clin North Am. 1995; 33 (1): 51-70.
13. Sensier Y, Bell PR, London NJ. The ability of qualitative assessment of the common femoral Doppler waveform to screen for significant aortoiliac disease. Eur J Endovasc Surg. 1998; 15 (4): 357-64