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ORIGINAL ARTICLE

COMPARATIVE EVALUATION OF COLOR DOPPLER AND CONVENTIONAL DIGITAL SUBTRACTION ANGIOGRAPHY IN INFRA GENICULAR ARTERIAL DISEASE: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT: Patient suffering from infragenicular peripheral arterial occlusive disease is not an uncommon clinical scenario. In our setup Buergers Disease and Atherosclerotic disease are the most common cause of arterial insufficiency, particularly in middle aged smokers of low socioeconomic status apart from vasculitis, thromboembolism and trauma. Color Doppler (CD) is a good modality for assessment of supragenicular arterial system, however infragenicular arteries are many times cannot be examined properly because of their deeper position. Digital Subtraction Arteriography (DSA) is a better modality in this situation. The aim of this study is to compare color doppler and conventionional digital subtraction arteriography in patients of infragenicular arterial disease. This prospective study was designed in the department of Radiodiagnosis G.R. Medical College Gwalior Madhya-Pradesh, India.50 patients of lower limb ischemia formed the subjects and their affected lower limbs were evaluated by CD (COLOR DOPPLER) and DSA (Digital Subtraction Arteriography), for localization and grading of lesions in the arteries, into normal, insignificant stenosis, significant stenosis and occlusion. The results were analyzed in a blind fashion in a total of 150 vascular segments. Results were analyzed by two way contingency tables and kappa statistics. In our study we observed that in the infragenicular arterial system disease, color doppler had a Sensitivity = 83%, Specificity = 92%, PPV = 66%, NPV = 96% Therefore it can be concluded that a normal color flow and spectral waveform in Color Doppler examination of inferiorgenicular arteries excludes the need of arteriography. However DSA is definitely helpful in patient where abnormal/absent color flow and/or spectral wave form is seen because of lower PPV (66%) Color Doppler.
KEYWORDS: Color Doppler, DSA.

INTRODUCTION: Peripheral arterial disease is the preferred clinical term that should be used to denote stenotic, occlusive, and aneurysmal diseases of the aorta and its branch arteries, exclusive of the coronary arteries.[1]

The incidence of peripheral arterial disease increases with age. Population studies have found that about 20% of people aged over 60 years have some degree of peripheral arterial disease. Incidence is also high in people who smoke, people with diabetes and people with coronary artery disease. In most people with intermittent claudication the symptoms remain stable but approximately 20% will develop increasingly severe symptoms with the development of critical limb ischemia. Most common risk factors for peripheral vascular disease are age >50 years, diabetes, smoking and bad cholesterol.[2]

Peripheral arterial disease has a diversity of causes beyond atherosclerosis and Buergers disease, like fibromuscular dysplasia, or arteritis, thromboembolic causes, inflammatory or

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aneurysmal disease; by trauma, adventitial cysts, or entrapment syndromes; or by congenital abnormalities.[3]

Ultrasound arterial color Doppler (CD) is often the first modality to examine the patient suffering from peripheral arterial occlusive disease because it is cheap, easily available, noninvasive and less time consuming and has no contrast allergy. It also provides two dimensional gray scale images for assessment of gross morphology of arterial tree and flow pattern and hemodynamic status can be assessed and quantified by waveform analysis. It can also establish the length of the disease in an artery along with capability to differentiate stenosis to complete occlusion. However limitations of CD are there as it is highly operator dependent and requires experience. Further calcification if present limits visualization of arterial lumen and provides no functional information. Arteries which are deep situated like infragenicular arteries of lower limbs may not be assessable to examination especially if edema is present.[4]

Criteria for classifying Peripheral Artery Lesion:

Classification	Features
Normal	**Triphasic waveform; no spectral broadening**
1%-19% diameter reduction	Triphasic waveform with minimal spectral broadening only; peak systolic velocities increased < 30% relative to the adjacent proximal segment; proximal and distal wave form remain normal.
20% - 49% diameter reduction	Triphasic waveform usually maintained, although reverse flow component may be diminished; spectral broadening is prominent. With filling in of clear area under the systolic peak; peak systolic velocity is increased from 30% - 100% relative to the adjacent proximal segment; proximal and distal waveforms remain normal.
50% - 99% diameter reduction	Monophasic waveform with loss of reverse flow component and forward flow throughout cardiac cycle; extensive spectral broadening; peak systolic velocity is increased > 100% relative to adjacent proximal segment; distal waveform is monophasic, with reduced systolic velocity
Occlusion	No flow detected within imaged arterial segment preocclusive " thump" may be heard just proximal to site of occlusion; distal waveform are monophasic, with reduced systolic velocities.

On the other hand Digital subtraction-angiography (DSA) is also a commonly used modality for diagnosis of PAOD.[5] It has advantages like it can detect slow flow of small vessels and collaterals much better when compared to ultrasound, percentage of stenosis and occlusion is better determined and it is not operator dependent, provides better anatomical details and deep seated arteries like infra genicular arteries are much better visualized. But DSA also has disadvantages like risk of radiation, contrast related nephrotoxicity and allergic reactions and it is an invasive procedure and requires skill to perform the procedure and interpretation of result. Post procedure complication like hematoma formation, aneurysm, thromboembolism etc are also seen.[5,6]

Within controlled studies and clinical trials, excellent agreement between CD and digital subtraction angiography (DSA) has been reported.[7,8] Furthermore, CD is a commonly applied tool to quantify re-stenosis after percutaneous peripheral interventions and tends to replace follow-up angiography for study purposes.

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Aims and objectives of this prospective comparative study was to compare the findings of Color Doppler with digital subtraction arteriography as the gold standard, in PAOD of infragenicular arteries of the lower extremities.

MATERIAL AND METHOD: This was a prospective study which was carried out in the Department of Radiodiagnosis, GR Medical College, Gwalior for a period of 12 months, from September 2012 to August 2013 on total of 50 patients of lower limb ischemia. Detailed Demographic data, cardiovascular risk factors, comorbidities, and the clinical stage of peripheral artery disease were taken from the patients. 150 segments i.e. three segments in each patient viz anterior tibial artery segment, Posterior tibial arterial segment and peroneal arterial segment were examined by color doppler and DSA. The results were analyzed in a blind fashion in a total of 150 vascular segments by two way contingency tables and kappa statistics. Approval from ethical committee was done for study, and consent from patient was taken for catheter angiography.

DUPLEX ULTRASOUND: High-resolution B-mode ultrasonography and duplex scanning were done on ALOKA SSD_4000 using a 7.5-MHz linear transducer. Routinely, the entire arterial tree of the target limb starting at the aortic bifurcation down to the level of the foot was scanned using color-coded duplex sonography, as well as Doppler measurements and wave-form analysis. Total 150 infragenicular arterial segments of 50 patients were assessed. Findings of CD were recorded for anterior tibial, posterior tibial and peroneal arterial segments. Findings were displayed on a standardized worksheet specifying the location and length of the lesion and the peak systolic velocity ratio (PSVR) for the respective segment. A PSVR of 2 or more was considered significant stenosis (50% or more). The target site for the planned intervention according to the CD investigation was specified.

DIGITAL SUBTRACTION ANGIOGRAPHY: The procedure was done after taking written and informed consent of the patient in presence of anesthesiologist. Inguinal region was painted with betadine and drapping done. Femoral artery palpated and punctured with Seldginger technique. Guide wire was navigated to reach the concerned vessel followed by catheter. Contrast was injected through catheter into concerned vessel and bolus chased method was used to record the filling the vessel. Because no quantitative angiography software was available, the severity and length of a lesion in the segments was evaluated by visual estimation in an anterior-posterior (AP) view. Findings were noted and were compared with color Doppler finding. 50% or more Stenosis was taken significant.

The following patients were excluded from the Study:

- Pregnant females.
- Having blood dyscrasias/diatheses.
- Patients sensitive to contrast agents.
- History of previous vascular surgery or endovascular procedure.
- Mentally retarded and uncooperative psychiatric patients.

The collected data was analyzed with the aid of calculator and SPSS software.

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RESULTS AND DISCUSSION: In our study all cases were subjected to relevant history and colour Doppler and DSA examination. Males were affected more commonly than females. Age of cases range 25-70 years. The maximum number of cases belonged to 51-60 years in males as well as in females. Mean Age of patients was 47 years.

The main presenting symptoms of cases were intermittent claudication and rest pain.

In the history taken during the study for risk factor evaluation, it showed that smoking, hyperlipidemia, hypertension and diabetes were the major risk factors. (Table 1)

Most of the lesions were in anterior-tibial artery, followed by posterior tibial artery.

On categorizing patients on Color doppler based on percentage stenosis, 10% of them showed 1-19% stenotic lesion, 20% of them showed 20-49% stenosis, 32% showed 50-99% stenosis and 38% of them showed total occlusion(Table 2). While in DSA 60% of them showed significant (50% or more), and 40% showed non-significant (<50%) stenosis. Hence DSA was more specific to pick up complete occlusion (Table 4).

Among the patients studied, 30% of them had PSV ratio <2, 24% had in between 2-4, 8% had more than 4 and 38% showed total block.(Table 3)

In our study we found that by examining the patient using color Doppler ultrasound there were 20 true positive, 10 false positive, 116 true negative and 4 false negative segments.In our study we found for infragenicular arterial segments color Doppler ultrasound has Sensitivity = 83%, Specificity = 92%, PPV = 66%, NPV = 96%, which are comparable to previous studies.[6,7,8]

Aly s et el found that compared with angiography, duplex imaging was able to detect arterial disease with an overall sensitivity of 92 per cent, specificity of 99 per cent, positive predictive value 91 per cent and negative predictive value 100 per cent, and with a κ value of 0.87 (95 per cent confidence interval (c.i.) 0.81–0.93).[9]

He also found that even in most experienced centers,5-20% of patients were impossible to insunate sufficiently on color Doppler due to ulcer, edema, pain, heavy calcification, and obesity.

Koelemay et al in their review article concluded that CD is an excellent tool in the noninvasive work up of patients with PAOD, in aortoiliac and femoropopliteal segment.[8,10]

False positive occlusions were due to vessels having no demonstrable blood flow on color Doppler, but were well visualized using DSA. This could be due to extremely sluggish blood flow in the vessel, with collaterals diverting away most of the blood. Diffuse proximal disease is known to cause this. Other causes are obscuration by overlying bowel gas, respiratory movements, or heavily calcified vessel wall.

False negative occlusions were due to segments seen to be patent on color Doppler, but not visualized using DSA. Non-visualization with DSA could be due to filling with non-opacified blood, especially in a segment distal to an occlusion. Thus, DSA can overestimate the length of an occluded segment, resulting in a lowering of the sensitivity of color Doppler. Another reason could be the inadvertent Doppler sampling of a collateral vessel, while the occluded main arterial segment remained unidentified.

False positive stenosis were due to vessels seen as stenosed by color Doppler, but as normal on DSA. This is a limitation of uniplanar angiography, as the vessel can appear normal if the plaque is on an anterior or posterior wall.

False negative stenosis was due to a segment reported as stenosed by color Doppler but seen as normal on DSA. This could be due to either lesion missed by uniplanar DSA or mistaken reporting by Doppler, due to its high degree of subjectivity. It could also be influenced by poor visualization.

Thus, CD (COLOR DOPPLER) can facilitate the pre-angiographic determination of the nature and extent of arterial disease in the lower limbs. Normal CD virtually excludes significant lesion, which in turn helps reducing the number of unnecessary diagnostic arteriography in patients with symptoms not justifying the surgical or endovascular procedure.

With arteriography as the 'gold standard', deceptively poor results can be produced, due to non-visualization of segments patent on CD.[11] A high NPV shows that significant lesions in the vascular tracts can be reliably excluded, which can help reduce the number of diagnostic angiographies, in patients with symptoms not justifying a surgical or endovascular procedure. The study found that, when scan demonstrates normal artery, the angiogram also shows normal segment. Thus, CD has grown from an ancillary diagnostic aid, to a critical component in the diagnostic workup, raising the possibility of displacing arteriography as the primary diagnostic imaging modality, for patients with chronic arterial occlusive disease of the lower extremity.

CONCLUSION: Ultrasound should be the first modality to asses the patient having arterial insufficiency because of low cost, non-invasive, no risk for radiation, no contrast related reactions and nephrotoxicity. In our study we found that NPV (96%) of color Doppler examination of inferior genicular arteries are high suggesting that presence of normal color flow and normal spectral wave form in these arteries may exclude the need of arteriography. However DSA is definitely helpful in patient where abnormal/absent color flow and/or spectral wave form is seen because of lower PPV (66%) of Color Doppler.

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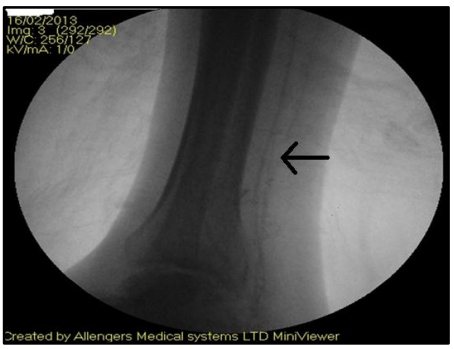

Fig. 1: Partial Filling Of PTA

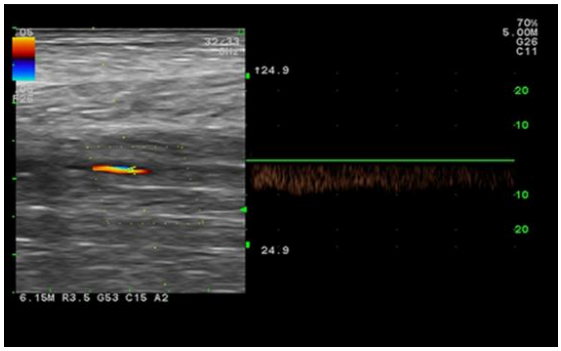

Fig. 2: Dampened Monophasic flow in ATA

Risk factor	No. of Patients	Percentage
Hypertension	25	50%
Smoking	40	80%
Alcohol	13	26%
Diabetes mellitus	23	46%
IHD	5	10%
Hyperlipidemia	25	50%

TABLE 1: SHOWING RISK FACTORE WISE DISTRIBUTION OF PATIENTS

Percentage of stenosis	No. of patients on CD	Percentage	No of patients on DSA	Percentage
1-19%	5	10%	5	10%
20-49%	10	20%	15	30%
50-99%	16	32%	20	40%
Total occlusion	19	38%	10	20%
TOTAL	**50**	**100%**	**50**	**100%**

TABLE 2: SHOWING DISTRIBUTION OF PATIENTS BASED ON PERCENTAGE OF STENOSIS ON COLOR DOPPLER AND DSA

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PSV ratio	No. of patients	percentage
<2:1	15	30%
2-4:1	12	24%
>4	4	8%
Total Occlusion	**19**	**38%**
Total	**50**	**100%**

TABLE 3: SHOWING DISTRIBUTION OF PATIENTS BASED ON PSV RATIO ON COLOR DOPPLER

	COLOR DOPPLER	DSA
Significant (>50%)	35(70%)	30(60%)
Not significant (<50%)	15(30%)	20(40%)
Total	**50**	**50**

TABLE 4: SHOWING COMPARISION OF COLOR DOPPLER AND DSA IN DETECTION OF SIGNIFICANT STENOSIS IN INFRAGENICULAR SEGMENTS

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