

## COMPARATIVE EVALUATION OF COLOR DOPPLER AND CONVENTIONAL DIGITAL SUBTRACTION ANGIOGRAPHY IN INFRA GENICULAR ARTERIAL DISEASE

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### Abstract

**BACKGROUND:** A frequent clinical situation involves a patient who has infra-genicular peripheral arterial occlusive disease. Apart from vasculitis, thromboembolism, and trauma, Burgers Disease and Atherosclerotic Disease are the most prevalent causes of arterial insufficiency in our system, particularly in middle-aged smokers of low socioeconomic level. The supra-ventricular artery system can be evaluated well with color doppler (CD), however the infra-genicular arteries are frequently difficult to observe due to their deeper location. Due to the hardening and constriction of arteries caused by peripheral artery occlusive disease (PAOD), there is a higher risk of lower extremity amputation. Therefore, it is necessary to compare the precision of non-invasive diagnostic techniques like Color Doppler (CD) to that of traditional digital subtraction angiography (CDSA).

**AIM:** This study compares infra-genicular arterial disease patients' color doppler and traditional digital subtraction angiography results.

**MATERIAL AND METHOD:** This prospective study involved 40 patients with lower limb ischemia and was conducted in the Department of Radiodiagnosis. The patients' complete demographic information, cardiovascular risk factors, comorbidities, and peripheral artery disease clinical stage were collected. Three segments from each patient's anterior tibial, posterior tibial, and peroneal arteries were investigated by color doppler and DSA in 150 segments total. A total of 150 vascular segments were used in the blind analysis, which used two-way contingency tables and kappa values. The study received ethics committee approval, and the patient's consent was obtained for catheter angiography.

**RESULTS:** 150 vascular segments in total underwent blind analysis of the data. Two-way contingency tables and kappa statistics were used to examine the results. In our investigation, we found that color doppler had Sensitivity = 83%, Specificity = 92%, PPV = 66%, and NPV = 96% in the infra-genicular arterial system disorder. Smoking, hyperlipidemia, hypertension, and diabetes were the main risk variables identified in the study's history, which was collected for the purpose of evaluating risk factors. When patients were categorized based on the percentage of stenosis, 10% of them had lesions that were 1 to 19% stenotic, 20% had lesions that were 20 to 49% stenotic, 32% had lesions that were 50 to 99% stenotic, and 38% had total occlusion.

**CONCLUSION:** Due to its low cost, non-invasive nature, lack of radiation risk, lack of contrast-related responses, and lack of nephrotoxicity, ultrasound should be used as the initial assessment modality for patients with arterial insufficiency. In this investigation, we discovered that the inferior genicular arteries had a high NPV (96%) of color Doppler testing, indicating that the presence of normal color flow and normal spectral waveform in these arteries may remove the necessity for arteriography. On the other hand, CT Angiography is a helpful method for determining segmental length and collateral circulation in addition to offering a replica of the arterial system's road map.

**KEYWORDS:** Color Doppler, DSA, Digital subtraction angiography, peripheral arterial occlusive disease Multiplanar reconstruction, Peak systolic velocity, Vascular stenosis.

## Introduction

The recommended clinical term for stenotic, occlusive, and aneurysmal illnesses of the aorta and its branch arteries, exclusive of the coronary arteries, is peripheral arterial disease.<sup>1</sup> Peripheral arterial disease is more common as people age. According to population surveys, peripheral arterial disease affects 20% of adults over the age of 60. Additionally, those who smoke, have diabetes, or have coronary artery disease have higher incidence rates. The majority of persons with intermittent claudication experience stable symptoms, while 20% will experience symptoms that worsen as critical limb ischemia develops. Age over 50, diabetes, smoking, and high cholesterol are the main risk factors for peripheral vascular disease.<sup>2</sup> One of the most frequent causes of limb pain, particularly in senior individuals, is peripheral arterial disease (PAD), in which plaque accumulates in the distal arteries and restricts blood flow and circulation.<sup>3</sup> Lower-extremity PAD, which most frequently affects the legs, is defined as atherosclerosis of arteries distal to the aortic bifurcation.<sup>4</sup> The term "PAD" is often used in a broader sense to refer to a variety of non-coronary artery disorders or syndromes that are brought on by changes in the structure or operation of arteries that provide blood to the brain, visceral organs, and limbs.<sup>5</sup>

The rise in the prevalence of this disease among Indians is due to a changing lifestyle that includes sedentary behaviors and insufficient physical activity. Despite significantly increasing disease morbidity, peripheral arterial disease (PAD) is a pandemic and one of the most well-known sequelae of diabetes mellitus. It presents pathologically as insufficient tissue perfusion brought on by atherosclerotic alterations, which may be acutely exacerbated by thrombotic or embolic events. It is a clinical condition with unique clinical identities of claudication and ischemia and is defined by stenosis and/or blockage of branches of the aorta with a substantially higher affliction for lower than upper limbs.<sup>6</sup> Clinical symptoms that progress further result in rest discomfort, critical ischemia, ulceration, gangrene, and maybe amputation. The

need for non-invasive procedures that could not only identify the existence and extent of disease but also be a valuable tool in the follow-up of these cases and reduce morbidity as well as mortality was felt in an effort to avoid invasive angiographic studies. The mainstay for a certain diagnosis of this disease process is a clinical evaluation followed by non-invasive imaging using CDUS and CTA. The gold standard imaging technique for the assessment of PAD is conventional arteriography, notwithstanding its limitations in determining the relevance of stenotic arterial segments in terms of hemodynamics.<sup>7</sup> The degree and extent of occlusive lesions, which are determined by CDUS, can be used to determine both anatomical and hemodynamic information. CDUS is a popular, safe, repeatable, cost-effective method.<sup>8</sup> Because it is affordable, accessible, noninvasive, takes less time, and has no contrast allergy, ultrasound arterial color Doppler (CD) is frequently the initial modality to assess a patient with peripheral artery occlusive disease. Additionally, it offers two-dimensional grayscale images for the examination of the general morphology of arterial trees, as well as waveform analysis for the assessment and quantification of flow pattern and hemodynamic condition. It also has the ability to distinguish between stenosis and total blockage, as well as the length of the disease in an artery.<sup>9</sup>

Excellent agreement between CD and digital subtraction angiography (DSA) has been documented in controlled research and clinical trials.<sup>10,11</sup> Additionally, the CD is frequently used as a substitute for follow-up angiography in research settings in order to measure re-stenosis following percutaneous peripheral treatments.

## MATERIAL AND METHODS

This prospective study involved 40 patients with lower limb ischemia and was conducted in the Department of Radiodiagnosis. The patients' complete demographic information, cardiovascular risk factors, comorbidities, and peripheral artery disease clinical stage were

collected. Three segments from each patient's anterior tibial, posterior tibial, and peroneal arteries were investigated by color doppler and DSA in 150 segments total. A total of 150 vascular segments were used in the blind analysis, which used two-way contingency tables and kappa values. The study received ethics committee approval, and the patient's consent was obtained for catheter angiography.

Color Doppler sonography and multi-detector CT angiography were done on each patient, and they were compared.

Those with diabetes mellitus or other cardiovascular risk factors were included as subjects, as were those who agreed to participate in the procedure after receiving a patient information leaflet and given written consent. Patients who were allergic to iodinated contrast media, had abnormal renal parameters, were pregnant, did not consent in writing, or did not agree to the study's protocol were not allowed to participate.

#### **DUPLEX ULTRASOUND:**

ALOKA SSD 4000 was used to perform high-resolution B-mode ultrasonography and duplex scanning utilizing a 7.5-MHz linear transducer. Color-coded duplex sonography, Doppler measurements, and wave-form analysis were routinely used to scan the whole arterial tree of the target limb from the aortic bifurcation down to the level of the foot. A total of 40 individuals' 150 infra-genicular arterial segments were evaluated. For the anterior, posterior, and peroneal arterial segments, CD findings were noted. The results were shown on a standardized spreadsheet that detailed the lesion's length and location as well as the peak systolic velocity ratio (PSVR) for the relevant section. 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:**

In the presence of an anesthesiologist, the patient's written and informed consent was obtained before the procedure. Betadine was applied to the inguinal area, and draping followed. The Seldinger technique was used to palpate and puncture the femoral artery. A catheter was then inserted after a guidewire was used to go to the problematic vascular. Through the use of a catheter, the concerned vessel was injected with contrast, and the bolus chased method was employed to monitor the vessel's filling. The degree and length of a lesion in the segments were assessed by visual assessment in an anterior-posterior (AP) perspective because no quantitative angiography software was available. Results were recorded and contrasted with color Doppler results. Significant Stenosis was taken at 50% or higher.

#### **Doppler Assessment:**

Then CDUS and CTA were used to evaluate every patient. Esaote My Lab 60 integrated real-time B mode imaging equipment with pulsed and continuous wave doppler performed the lower extremity arterial doppler. In CDUS, the patients were scanned using a 2.5-3.0 MHz frequency curved transducer from the aortic bifurcation to the origin of the common femoral arteries, and then a 7.5-10 MHz frequency transducer from the level of the common femoral arteries proximally to the level of the ankle distally. Gray scale analysis was used to assess the associated vessels' stenosis, thrombosis, intimal-medial wall thickness, and the existence of any plaque with a description. A doppler evaluation was then performed to grade the degree of stenosis based on the spectral flow pattern, peak systolic velocities, presence of thrombosis, or collateral formation. To detect the best velocity and color flow pattern, the Doppler angle was kept below 60 degrees, the smallest color box was selected, and the pulse repetition frequency and sample volume size were set optimally.

## STATISTICAL ANALYSIS

It was a study of diagnostic precision. Tables, charts, and diagrams were used to examine and show the data that had been gathered. Comparative sensitivity, specificity, and positive and negative predictive values of the two imaging modalities were calculated using a 2x2 contingency table of true positive, true negative, false positive, and false negative findings on both

CDUS and CTA. MedCalc Version 13.2.2.0 was the calculation software.

## RESULT: -

All cases in our study underwent pertinent history, color Doppler, and DSA examinations. Males were more frequently impacted than females. Cases range in age from 25 to 70. Both males and females aged 50 to 62 made up the majority of cases. The patients' average age was 45.

**TABLE 1: Showing Risk Factor Wise Distribution of Patients**

Risk factor	No. of Patients	Percentage
Hypertension	21	50%
Smoking	32	80%
Alcohol	11	26%
IHD	3	10%
Hyperlipidemia	21	50%

The history taken during the study for risk factor evaluation, it showed that smoking, hyperlipidemia, hypertension, and diabetes were the major risk factors.

**TABLE 2: Showing Distribution of Patients Based on Percentage of Stenosis on Color Doppler and DSA**

Percentage of stenosis	No. of patients on CD	Percentage	No patients on DSA	Percentage
1-19%	2	10%	2	10%
20-49%	7	20%	13	30%
50-99%	14	32%	18	40%
<b>Total occlusion</b>	17	38%	7	20%
<b>TOTAL</b>	50	100%	50	100%

When patients were categorized based on the percentage of stenosis, 10% of them had lesions that were 1 to 19% stenotic, 20% had lesions that were 20 to 49% stenotic, 32% had lesions that were 50 to 99% stenotic, and 38% had total occlusion. 60% of them displayed considerable stenosis when undergoing DSA, compared to 40% who displayed non-significant stenosis (50%). DSA was therefore more adept at detecting total occlusion.

**TABLE 3: Showing Distribution of Patients Based on PSV Ratio on Color Doppler**

PSV ratio	No. of patients	percentage
<2:1	13	30%
2-4:1	10	24%
>4	2	8%
Total Occlusion	15	38%

30% of the patients under study had a PSV ratio of less than 2, 24% had one between 4 and 8, 8% had more than 4, and 38% displayed a total block. The ultrasound results reveal details about soft tissue plaques, thrombosis, collateral circulation, recanalization, and pre- and post-operative flow evaluation in addition to the breadth and severity of the disease. Since USG contrast chemicals have been developed, it is now possible to estimate flow more accurately in difficult instances without being exposed to radiation or risking allergic responses, as opposed to CT Angiography.

## DISCUSSION

Both CDUS and CTA were used to evaluate a total of 40 individuals. 25 of the 40 cases were men and 15 were women. The average age of the patients was 45 years, and the bulk of them were in the 50 to 62 age range. Diabetes mellitus was the most prevalent related risk factor, followed by smoking and hypertension, which were also prevalent in this study.<sup>12</sup> In accordance with findings from a different study, analysis of the clinical history revealed that intermittent claudication was the primary presenting symptom, followed by rest pain.<sup>13</sup> According to a different study, diabetes is a risk factor in the progression of claudication to critical limb ischemia.<sup>14</sup>

**Aly s et al1998**<sup>15</sup> found that compared with angiography, duplex imaging was able to detect arterial disease with an overall sensitivity of 92 percent, specificity of 99 percent, a positive predictive value of 91 percent, and negative predictive value of 100 percent, and a K value of 0.87 (95 percent confidence interval). **Koolemay et al2009**<sup>16</sup> in their review article concluded that CD is an excellent tool in the noninvasive workup of patients with PAOD, in the aortoiliac and femoropopliteal segment.<sup>17</sup>

False positive occlusions were caused by arteries that were clearly visible utilizing DSA but had no discernible blood flow on color Doppler. This might be because the vessel's blood flow is

moving very slowly and most of the blood is being diverted by collaterals. This is a known effect of diffuse proximal illness. Other factors include respiratory activity, overlaying intestinal gas, or a severely calcified artery wall. False negative occlusions were caused by segments that were not visible utilizing DSA but were visible on color Doppler. Non-visualization with DSA may be caused by filling, particularly in a segment distal to an occlusion, with non-opacified blood. As a result, DSA can overestimate the length of an occluded section, decreasing the color Doppler's sensitivity. Another explanation could be that the collateral channel was unintentionally sampled by Doppler while the main arterial segment that was occluded was still unknown.<sup>17</sup>

False negative stenosis resulted from a section that color Doppler recorded as stenosed but which DSA found to be normal. Due of Doppler's high degree of subjectivity, it is possible that a lesion was overlooked by uniplanar DSA or that an error was made in its reporting. It might also be impacted by inadequate visualization. Therefore, CD (COLOR DOPPLER) can make it easier to pre-angiographically assess the type and severity of artery disease in the lower limbs. As severe lesions are virtually excluded by normal CD, fewer patients with symptoms not necessitating surgical or endovascular intervention undergo needless diagnostic arteriography.

Due to the non-visualization of segments patent on CD when using arteriography as the "gold standard," subpar results can be obtained.<sup>18</sup> In patients whose symptoms do not warrant a surgical or endovascular procedure, a high NPV demonstrates that major lesions in the vascular tracts may be confidently excluded, which can assist lower the number of diagnostic angiographies. According to the study, angiograms also display a normal segment when a scan shows a normal artery. Thus, for patients with chronic arterial occlusive disease of the lower extremities, the CD has evolved from an

additional diagnostic tool to a crucial part of the diagnostic workup, increasing the likelihood that it will replace angiography as the main diagnostic imaging modality.

In comparison to CT angiography, which is minimally invasive (only requires an intravenous injection of contrast medium but also involves radiation exposure and an inherent risk of allergic reactions), there are a few CDUSG limitations that need to be taken into account, such as operator dependence, time consumption, edema, bowel gas, and obesity.<sup>19</sup>

**Martin ML et al.2003**<sup>20</sup>, found that CTA underestimates the degree of stenosis more frequently than overestimation either due to suboptimal or delayed opacification of leg arteries. This disparity may also be due to technical differences in the study protocol as well as interpreting results based on different post-processing techniques.<sup>21</sup> A statistically significant difference was established between CDUS and CTA across all grades of stenosis, implying one investigation is better than another across different segments. The overall sensitivity, specificity, and accuracy of CDUS as compared to CTA in our study was 91%, 87%, and 89% compared to the study by **Chidambaram PK et al.2016**<sup>22</sup>

When determining the hemodynamic importance of stenotic lesions, CDUS offers an advantage over CTA. This quantitative assessment can be used to decide which patients should have CTA, improving outcomes and allowing for a more precise multimodality approach to illness care. CTA is a three-dimensional technology that offers details about the vessel being photographed and nearby structures. It just needs vascular access and can be performed safely and effectively as an outpatient procedure. The ability to confidently distinguish between vascular calcification and intravascular contrast media is typically made possible by post-processing with suitable window selection and the use of multiplanar reconstruction. When planning

endovascular procedures, this trait is advantageous.<sup>23</sup>

## CONCLUSION:

Due to its low cost, non-invasive nature, lack of radiation risk, lack of contrast-related responses, and lack of nephrotoxicity, ultrasound should be used as the initial assessment modality for patients with arterial insufficiency. In this investigation, we discovered that the inferior genicular arteries had a high NPV (96%) of color Doppler testing, indicating that the presence of normal color flow and normal spectral waveform in these arteries may remove the necessity for arteriography. However, due to the reduced PPV (66%) of Color Doppler, DSA is unquestionably beneficial in patients who exhibit abnormal/absent color flow and/or spectral waveform. Conclusion Following a thorough physical examination, CDUSG is frequently recommended as an initial diagnostic method because it is economical, noninvasive, and has positive clinical outcomes. On the other hand, CT Angiography is a helpful method for determining segmental length and collateral circulation in addition to offering a replica of the arterial system's road map.

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