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Original Research Article

Comparative Analysis of Conventional Digital Subtraction Angiogram and Color Doppler in Inflammatory Generic Disorders

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Abstract

Background: A patient with infra-genicular peripheral arterial occlusive disease is a common clinical scenario. Other than trauma, thromboembolism, and vasculitis, the most common causes of arterial insufficiency in our system are atherosclerotic disease and Burgers disease, especially in middle-aged smokers from low-income backgrounds. Color doppler (CD) imaging is a useful tool for evaluating the supraventricular artery system; but, because of their deeper placement, the infra-genicular arteries are sometimes difficult to view. An increased risk of lower extremity amputation results from the hardening and constriction of arteries brought on by peripheral arterial occlusive disease (PAOD). As a result, it's important to contrast the accuracy of conventional digital subtraction angiography (CDSA) with non-invasive diagnostic methods like Color Doppler (CD).

Material and Method: This prospective study was carried out in the Department of Radiodiagnosis and included forty patients with lower limb ischemia. Complete demographic data, comorbidities, cardiovascular risk factors, and the clinical stage of peripheral artery disease were gathered for each patient. A total of 150 segments, including three segments from each patient's anterior, posterior, and peroneal arteries, were examined using color doppler and DSA. The blind analysis employed kappa values and two-way contingency tables on a total of 150 vascular segments. The ethical committee approved the study, and the patient gave permission for the catheter angiography.

Results: A total of 150 vascular segments were subjected to blind examination. The outcomes were examined using kappa statistics and two-way contingency tables. 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. The primary risk variables found in the study's history, which was gathered to assess risk factors, were diabetes, hyperlipidemia, smoking, and hypertension. Patients were classified according to the percentage of stenosis: 10% had lesions with a stenotic percentage of 1 to 19%, 20% had a stenotic percentage of 20 to 49%, 32% had a stenotic percentage of 50 to 99%, and 38% had total occlusion.

Conclusion: Ultrasound should be the first modality of examination for patients with arterial insufficiency because of its low cost, non-invasive nature, lack of radiation risk, lack of contrast-related reactions, and lack of nephrotoxicity. The results of this study showed that the inferior genicular arteries had a high NPV (96%) for color Doppler testing, suggesting that arteriography may not be necessary if these arteries have normal spectral waveform and color flow. On the other hand, CT Angiography provides a road map-like image of the arterial system and is a useful tool for assessing collateral circulation and segmental length.

Keywords: DSA, Digital Subtraction Angiography, Peripheral Arterial Occlusive Disease, Multiplanar Reconstruction and Color Doppler.

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Introduction

Peripheral arterial disease is the preferred clinical term for conditions affecting the aorta and its branch arteries that are stenotic, occlusive, and aneurysmal, excluding coronary arteries. [1] As people age, peripheral arterial disease becomes increasingly prevalent. Peripheral arterial disease affects 20% of persons over 60, according to population studies. In addition, the incidence rates are higher in persons with diabetes, coronary artery disease, and smoking. While 20% of people with intermittent claudication will experience symptoms that get worse as critical limb ischemia progresses,

most people with intermittent claudication have stable symptoms. Tobacco, high cholesterol, diabetes, and age over 50 are the primary risk factors for peripheral vascular disease. [2] Peripheral arterial disease (PAD) is a common cause of limb pain, especially in older adults. PAD is a condition where plaque builds up in the distal arteries, limiting circulation and blood flow. [3] The most common cause of lower-extremity PAD is atherosclerosis of the arteries distal to the aortic bifurcation. This condition primarily affects the legs. [4] The word "PAD" is also used in a more generalized sense to describe a range of non-coronary artery illnesses or syndromes caused by modifications to the anatomy or function of the arteries supplying blood to the limbs, brain, and visceral organs. [5]

The increased occurrence of this illness among Indians can be attributed to a shift in lifestyle that involves sedentary habits and inadequate physical exercise. Peripheral arterial disease (PAD) is one of the most well-known consequences of diabetes mellitus and a pandemic, despite the fact that disease morbidity has considerably increased. Pathologically, it manifests as inadequate tissue perfusion caused by changes in the atherosclerotic plaque, which can be severely intensified by thrombotic or embolic events. It is a clinical disorder characterized by stenosis and/or occlusion of aortic branches, with a significantly higher incidence for lower limbs than upper limbs. It shares distinct clinical characteristics with ischemia and claudication. [6] As clinical symptoms worsen, patients may experience amputation, critical ischemia, ulceration, gangrene, and discomfort while rest. In an attempt to avoid invasive angiographic examinations, there was a need for non-invasive procedures that could not only determine the presence and severity of disease but also be an invaluable tool in the follow-up of these cases and reduce morbidity as well as mortality. A clinical evaluation is the cornerstone for a specific diagnosis of this disease process, and it is followed by non-invasive imaging with CDUS and CTA. Despite its limitations in assessing the hemodynamic significance of stenotic artery segments, conventional arteriography remains the gold standard imaging tool for the assessment of PAD. [7] The degree and extent of hemodynamic and anatomical information can be obtained from CDUS-detected occlusive lesions. Popular, dependable, affordable, and safe is CDUS.[8] Ultrasound arterial color Doppler (CD) is often used as the first modality to evaluate a patient with peripheral artery occlusive disease since it is accessible, inexpensive, noninvasive, quick, and does not cause contrast allergies. [8] It also provides two-dimensional grayscale images for analyzing the overall morphology of arterial trees and waveform analysis for evaluating and quantifying hemodynamic state and flow pattern. It can also determine the extent of the illness in an artery and the difference between stenosis and complete blockage. [9]

Controlled studies and clinical trials have shown excellent concordance between CD and digital subtraction angiography (DSA). [10,11] 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 was carried out in the Department of Radiodiagnosis and included forty patients with lower limb ischemia. Complete demographic data, comorbidities, cardiovascular risk factors, and the clinical stage of peripheral artery disease were gathered for each patient. A total of 150 segments, including three segments from each patient's anterior, posterior, and peroneal arteries, were examined using color doppler and DSA. The blind analysis employed kappa values and two-way contingency tables on a total of 150 vascular segments. The ethical committee approved the study, and the patient gave permission for the catheter angiography.

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

Subjects included people with diabetes mellitus or other cardiovascular risk factors, as well as those who consented in writing and received a patient information booklet before agreeing to the treatment. Participants were excluded if they had an allergy to iodinated contrast media, abnormal renal parameters, were pregnant, failed to provide written consent, or disagreed with the study's design.

Doppler Assessment: Then, each patient was assessed using CDUS and CTA. Lower extremity artery doppler was done using an Esaote My Lab 60 integrated real-time B mode imaging system with a pulsed and continuous wave doppler. During the CDUS scan, the patients were first scanned using a 7.5–10 MHz frequency transducer from the level of the common femoral arteries proximally to the level of the ankle distally, and then a 2.5–3.0 MHz frequency curved transducer from the aortic bifurcation to the origin of the common femoral arteries. The connected vessels' stenosis, thrombosis, intimal-medial wall thickness, and presence of any plaque with a description were evaluated using gray scale analysis. The degree of stenosis was subsequently graded using a doppler evaluation based on the spectral flow pattern, peak systolic velocities, collateral development, and the presence of thrombosis. The smallest color box was chosen, the pulse repetition frequency and sample

volume size were adjusted to their ideal values, and the Doppler angle was kept below 60 degrees in order to identify the ideal velocity and color flow pattern.

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%
Total occlusion	17	38%	7	20%
TOTAL	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

A total of forty people were evaluated using CDUS and CTA. Men made up 25 of the 40 cases, while women made up 15. The majority of the patients were between the ages of 50 and 62, with an average age of 45. The most common associated risk factor in this study was diabetes mellitus, which was followed by smoking and hypertension.[12] Analysis of the clinical history showed that intermittent claudication was the main presenting symptom, followed by rest pain, which was consistent with results from another study.[13] According to a different study, diabetes is a risk factor in the progression of claudication to critical limb ischemia.[14]

Aly S et al.1998 [15] 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. Koelemay et al2009 [16] 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. [17]

Arteries that showed no discernible blood flow on color Doppler but were easily evident using DSA were the source of false positive occlusions. This could be the result of collaterals diverting the majority of the blood flow from the vessel, which causes the blood flow to move very slowly. This is a recognized consequence of dispersed proximal disease. Respiratory activity, gas covering the intestines, or a badly calcified arterial wall are further concerns. Segments that were visible on color Doppler but invisible with DSA led to false negative occlusions. Filling with non-opacified blood, especially in a section distant to an occlusion, may be the cause of non-visualization with DSA. This causes the color Doppler's sensitivity to be reduced as DSA may overestimate the duration of an occluded portion. Another possibility is that Doppler accidentally sampled the collateral channel when it was still unclear which major artery segment was obstructed. [17]

A portion that the color Doppler recorded as stenosed but that the DSA determined to be normal gave rise to false negative stenosis. Owing to the high degree of subjectivity associated with Doppler, there's a chance that a lesion was missed by uniplanar DSA or that a reporting error occurred. It could also be affected by poor visualization. As a result, pre-angiographic evaluation of the kind and severity of artery disease in the lower limbs may be facilitated by CD (COLOR DOPPLER). Fewer patients with symptoms not requiring surgery or endovascular intervention undergo unnecessary diagnostic arteriography since serious lesions are almost completely excluded by normal CD.

Poor outcomes may occur when employing arteriography as the "gold standard," as segments patent on CD are not visualized. [18] A high NPV indicates that large lesions in the arterial tracts can be confidently excluded in patients whose symptoms do not justify a surgical or endovascular procedure, which can help reduce the frequency of diagnostic angiographies. The study found that when a scan reveals a normal artery, angiograms likewise show a normal section. As a result, the CD has progressed from being an extra diagnostic tool to an essential component of the diagnostic workup for patients with lower extremity chronic artery occlusive disease, raising the possibility that it will eventually displace angiography as the primary diagnostic imaging modality.

A few CDUSG limitations need to be considered, such as operator dependence, time consumption, edema, bowel gas, and obesity, in contrast 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). [19]

Martin ML et al.2003 [20], found that CTA underestimates the degree of stenosis more frequently than overestimation either due to suboptimal or delayed opacification of leg arteries. This discrepancy can also emerge from variations in the study protocol's technical specifications and the interpretation of the data using various post-processing methods. [21] All grades of stenosis showed a statistically significant difference between CDUS and CTA, suggesting that one study is superior to the other across various 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 [22]

CDUS is superior to CTA in assessing the hemodynamic significance of stenotic lesions. Using this quantitative assessment to determine whether patients need CTA can lead to better outcomes and enable a more accurate multimodality approach to patient care. Three-dimensional CTA technology provides information about the vessel being photographed as well as surrounding structures. It is a safe and successful outpatient surgery that just requires vascular access. Generally, post-processing with appropriate window selection and multiplanar reconstruction enable the confident distinction between intravascular contrast media and vascular calcification. This feature is useful for endovascular procedure planning. [23]

Conclusion

Ultrasound should be the first modality of examination for patients with arterial insufficiency because of its low cost, non-invasive nature, lack of radiation risk, lack of contrast-related reactions, and lack of nephrotoxicity. The results of this study showed that the inferior genicular arteries had a high NPV (96%) for color Doppler testing, suggesting that arteriography may not be necessary if these arteries have normal spectral waveform and color flow. However, DSA is clearly helpful in patients who have abnormal/absent color flow and/or spectral waveform because of the lower PPV (66%) of Color Doppler. In summary Since CDUSG is affordable, noninvasive, and has good clinical results, it is often suggested as a first diagnostic technique after a comprehensive physical examination. On the other hand, CT Angiography provides a road map-like image of the arterial system and is a useful tool for assessing collateral circulation and segmental length.

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