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Research Article

CT ARTERIOGRAPHY IN THE EVALUATION OF PERIPHERAL VASCULAR DISEASES

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Abstract :

Peripheral vascular disease is a disorder with substantial morbidity. The risk factors associated with it have increased mainifolds thereby increasing its prevalence. A variety of invasive and noninvasive imaging techniques are available for its evaluation. Of these CT angiography has emerged as a noninvasive accurate technique for evaluation of peripheral vascular disease. The benefits include using less contrast material, using a less invasive approach and movement of angiography to an outpatient setting. The recent introduction of multi–detector row CT with four channels of simultaneous acquisition has resulted in producing images that simulate conventional angiograms. The result is an image that provides a single, comprehensive vascular map of the arteries and veins. The aim of present study was to evaluate the diagnostic accuracy of CT Arteriography of upper and lower extremities in the diagnosis of peripheral vascular diseases. This retrospective study included all the patients with complaints like claudication, ulceration, gangrene etc in whom CT Arteriography was done The surgical findings were compared with CT Arteriography findings. The CT Arteriography was found to have 98.53% sensitivity and 75% specificity in the evaluation of PVD. Conventional angiography is considered as the gold standard for investigating vascular diseases. But it is invasive and sometimes, it can fail to demonstrate eccentric stenosis. Arterial puncture is not required and eccentric stenosis is well demonstrated in CT Arteriography. As CT Arteriography had good sensitivity and specificity it can be used as primary diagnostic modality in the evaluation of peripheral vascular diseases and trauma.

KEY WORDS: Arteriography, Computed Tomography(CT), Peripheral Vascular Disease

INTRODUCTION

The upper and lower limb arterial disease is a common circulatory problem in which narrowed arteries reduce the blood flow to lower extremities. Each year, 500-1,000 new cases of critical limb ischemia are diagnosed per million of the population[1]. The common symptoms associated with peripheral vascular disease are intermittent claudication, rest pain, non-healing ulcer and gangrene. With the availability of percutaneous transluminal angioplasty and surgical revascularization techniques as well as refined pharmacological interventions, it is important to accurately diagnose peripheral vascular disease and provide information regarding location, number, length, extent and severity of the arterial involvement. The advantages of instant acquisition, real time information, increased contrast sensitivity and the ability to electronically manipulate images have made digital imaging a superior method of imaging. The benefits include using less contrast material, using a less

invasive approach and movement of angiography to an outpatient setting. Until the recent introduction of multi–detector row CT, CT angiography was limited to not more than 40 cm of craniocaudal coverage during a single intravenous iodine-based contrast material injection. While this was sufficient for imaging the majority of systemic arteries, it was insufficient for studying the arterial inflow and runoff of the lower extremities. Multi–detector row CT with four channels of simultaneous acquisition has eliminated this limitation. Once conventional CT data are obtained, 3D post-processing techniques are employed to produce images that simulate conventional angiograms.The result is an image that provides a single, comprehensive vascular map of the arteries and veins. The user can produce an angioscopic view that can be helpful for identifying a vascular orifice and vascular stenosis[2].Due to its high sensitivity, specificity and accuracy, more number of limb salvaging procedures like Percutaneous Transluminal Angioplasty and surgical revascularization can be performed. MDCT has overcome the difficulties with other modalities like invasiveness, observer dependence and limited spatial resolution.

AIMS AND OBJECTIVES

To evaluate the diagnostic accuracy of CT Arteriography of upper and lower extremities in the diagnosis of peripheral vascular diseases.

MATERIALS AND METHODS

This retrospective study included all the patients with complaints like claudication, ulceration, gangrene etc in whom CT Arteriography was done in deptt of Radiology between May2012 to Oct 2013. The study comprised a total of 72 patients. CT imaging of these patients were performed on a multislice (64) multidetector helical CT machine. The patients were advised to fast for a period of 4-6hrs prior to the examination. Intravenous line was secured to the patient in antecubital fossa for lower limb arteriography and in leg veins for upper limb arteriography. Proper positioning of the patient was ensured and a topogram was taken initially. For the examination of upper extremities patient lies supine with both upper extremities raised above the head. Both arms were secured with an adhesive tape with a support between them to reduce movements. Patient was placed head first position. For lower limb arteriography patient lies supine. Patient was placed feet first. Plain scan, followed by contrast enhanced scans were taken. Nonionic contrast medium was given through pressure injector at the rate 4.5 ml/sec followed by saline chase. Total volume to be used was calculated as :- (Total Scan Time + Post Threshold Delay)x Flow Rate. Delayed scans for venous phase were taken 50sec after contrast injection. Retrospective reconstruction of overlapping slices, coronal, sagittal, multiplanar reconstruction images was obtained using raw data. Bony reconstruction was also done retrospectively. The surgical findings were compared with CT Arteriography findings. Qualitative data was represented in form of frequency and percentage. Association between qualitative variables were assessed by Chi-Square test with Continuity Correction for all 2 X 2 tables. Quantitative data was represented using mean±sd (standard deviation) and Median & IQR (Interquartile range). Diagnostic efficacy was calculated through Sensitivity, Specificity, Positive Predictive Value(PPV), Negative Predictive Value(NPV), Positive Likelihood measurements.

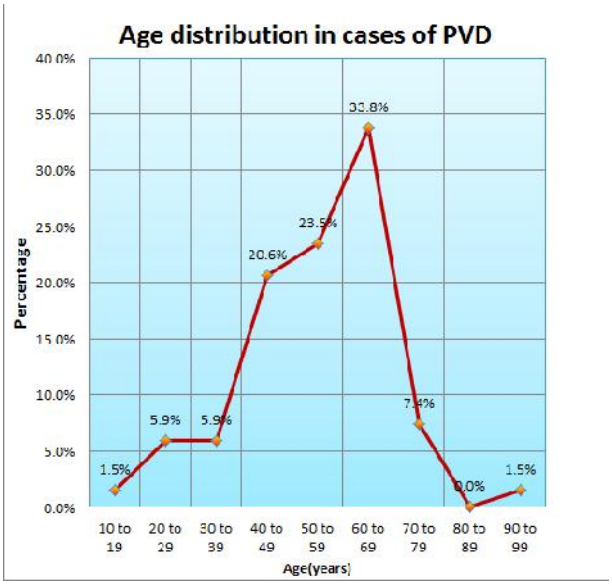
RESULTS:

Table 1: Distribution of patients of PVD according to final diagnosis

CT Findings		Final Diagnosis		Total
		PVD	No PVD	
PVD	No.	67	1	68
	%	98.5%	25.0%	94.4%
No PVD	No.	1	3	4
	%	1.5%	75.0%	5.6%
Total	No.	68	4	72
	%	100.0%	100.0%	100.0%

In the present study among 72 patients who had symptoms of PVD final diagnosis of PVD was confirmed in 68 patients. In these 68 patients, maximum numbers of patients were in the age group of 60-69 years(33.8% of patients). The next age group affected was 50-59 years (23.5% of patients).

Figure 1: Age distribution of patients in PVD



The present study had more number of male patients as compared to females. The most common presenting complaint was Intermittent Claudication(33.8%). History of smoking was present in 21 patients(30.9%), Diabetes Mellitus in 23 patients (33.8%), and Hypertension in 16 patients (23.5%). Color Doppler confirmed the disease in 51 patients(70.8%).

Table 2: Segmental arterial involvement of lower limbs

Segments	No.	Percentage
Aortoiliac	14	28%
CFA	4	8%
SFA	24	48%
PA	12	24%
Small Arteries Of Lower Limbs	24	48%

Table 3: Segmental arterial involvement in upper limbs

Segments	No.	Percentage
Subclavian	11	61.1%
Axillary	6	33.3%
Brachial	5	27.8%
Small Arteries	4	22.2%

In lower limb small arteries and superficial femoral artery involvement is the commonest observation seen in 24 patients (48%) each. 42 patients (58.3%) developed collaterals.

The CT Arteriography had 98.53% sensitivity and 75 percent specificity in the evaluation of PVD.

A B

Figure 2: Coronal MIP(Maximum Intensity Projection)images showing:
A: thrombosis of left subclavian artery(SCA). B: thrombosis of left brachial artery(BA).

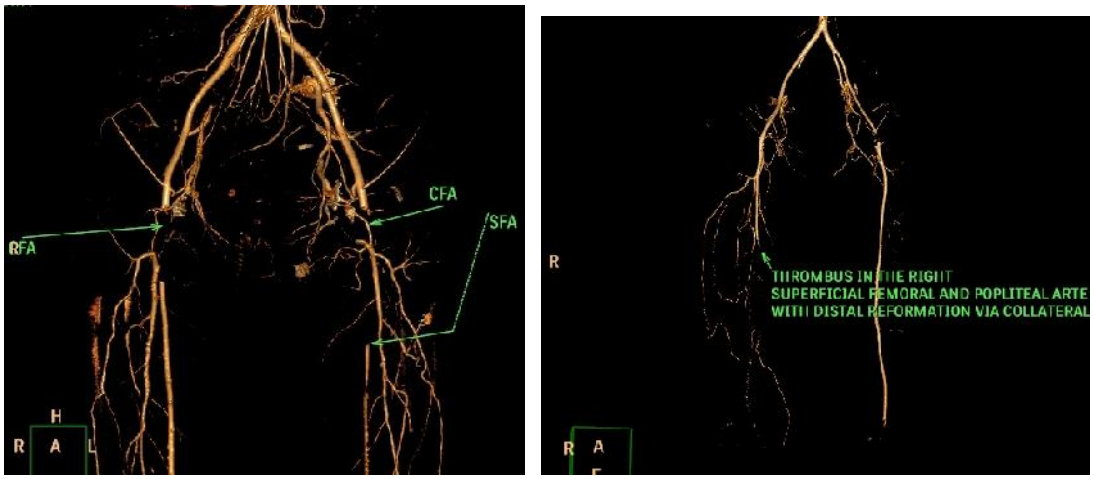
Table 4: Diagnostic accuracy of CT arteriography in PVD

CT Findings		Final Diagnosis		Total
		PVD	No PVD	
PVD	No.	67	1	68
	%	98.5%	25.0%	94.4%
No PVD	No.	1	3	4
	%	1.5%	75.0%	5.6%
Total	No.	68	4	72
	%	100.0%	100.0%	100.0%

Variables	Value	95% Confidence Interval	
		Lower	Upper
Sensitivity	98.53%	92.08%	99.96%
Specificity	75.00%	19.41%	99.37%
Positive Predictive Value	98.53%	92.08%	99.96%
Negative Predictive Value	75.00%	19.41%	99.37%
Positive Likelihood Ratio	3.94	0.72	21.52
Negative Likelihood Ratio	0.02	0.00	0.15

DISCUSSION:

Peripheral vascular disease is a disorder with substantial morbidity. The risk factors associated with it have increased mainifolds thereby increasing its prevalence. A variety of invasive and noninvasive imaging techniques are available for its evaluation. Of these CT angiography has emerged as a noninvasive accurate technique for evaluation of peripheral vascular disease. PVD is believed to be more common in males. TheFramingham Study found a twofold male predominance, with an incidence rate similar to that of the Quebec Cardiovascular Study (3.6 and 4.1, respectively). [3,4] The present study of 72 patients with history of PVD, the diagnosis of PVD was confirmed in 68 patients. Out of these 68 patients, 48 patients(70.6%) were male and 20 patients(29.4%) were female. Thus our study shows male predominance in PVD. The incidence of PVD increases with age. Most epidemiological studies report the prevalence of PVD to be about 10%–25% in men

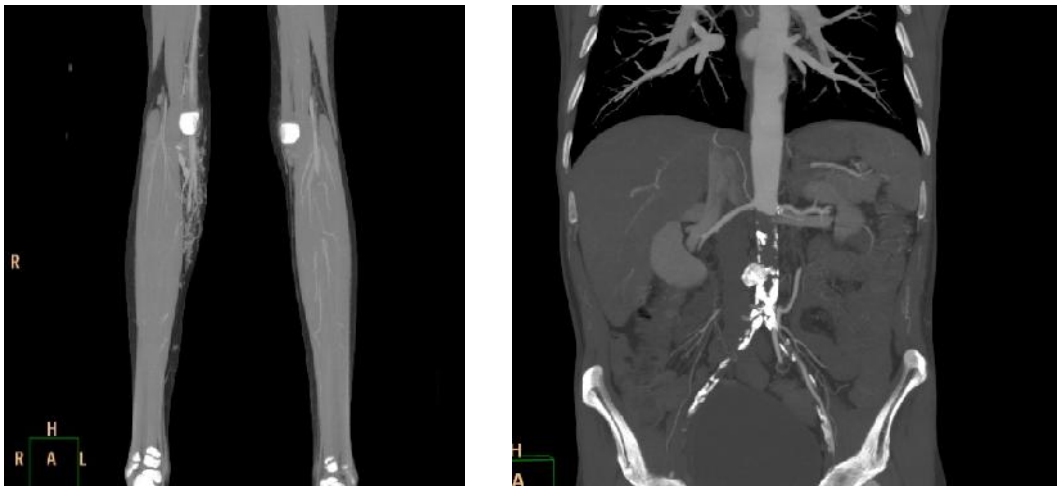


A B

Figure 3: Coronal volume rendered three dimensional images showing:
A: thrombosis of bilateral common femoral arteries (CFA) and left superficial femoral arteries(SFA) with distal reformation. B: thrombus in the right superficial femoral and popliteal arteries with distal reformation by collaterals.

and women over 55 years of age.[5] In the present study most common age group involved was 60-69 years. Most of the literature mentions intermittent claudication as the most typical symptom of PVD[6] , in the present study out of 68 PVD patients, 23 patients (33.8%) presented with intermittent claudication. Over 80% of patients with PAD are current or ex-smokers[7].Smoking results in earlier onset of symptoms and the severity of PVD increases with the number of cigarettes smoked. In the present study out of 68 PVD patients, 21 patients(30.9%) were smokers. Diabetes Mellitus causes between two and four times increased risk of PVD by causing endothelial and smooth muscle cell dysfunction in peripheral arteries and the risk of developing lower extremity peripheral arterial disease is proportional to the severity and duration of diabetes.[8] In the present study out of 68 PVD patients, 23 patients(33.8%) had history of DM. Elevated blood pressure is correlated with an increase in the risk of developing PVD, as well as in associated coronary and cerebrovascular events (heart attack and stroke).Hypertension increased the risk of intermittent claudication 2.5- to 4-fold in men and women,respectively.[9] In the present study out of 68 PVD patients, 16 patients (23.5%) had history of HT. In our study (85%) had thrombosis, (2.3%) had atherosclerosis without significant thrombosis, 1patient had hemangioma, and 4 patients had normal study. In lower limb the arteries commonly involved are superficial femoral arteries. Meyer Reum and others in their study observed that 27% of aorto-iliac, 23% of femoropopliteal and 40% of leg arteries are diseased in lower limb arterial disease.[10] The present study revealed that the small arteries below the knee were involved in 24 patients(48%) along with superficial femoral artery in 24 patients(48%).Thus the present study showed that small arteries of lower limb and superficial femoral arteries both were commonly involved in lower limb PVD. The present literature does not mentions about the common arteries involved in upper extremity PVD. In our study subclavian artery was involved in 11patients (61.10%) of upper limb PVD, followed by axillary artery which was involved in 6 patients (33.33%). Multiple studies[11,12] for the evaluation of diagnostic accuracy of Multidetector CTA in the peripheral vascular diseases demonstrated that CTA has sensitivity and specificity both ranging from 90-100%.The present study included 72 patients with history suggestive of PVD. CTA correctly diagnosed 67 patients from 68 patients of

PVD. In 3 patients CTA excluded PVD. In 1 patient CTA failed to diagnose PVD and in 1 patient it diagnosed the PVD even though it was not present. Thus, the sensitivity and specificity of CTA in diagnosing PVD cases in present study was 98.53% and 75% respectively. The study by Arya and others had shown development of collaterals in 48% ofpatients in their angiographic examination.[13] The present study revealed development of collaterals in 42 patients (61.8 %) of PVD. CT Arteriography findings of 59 patients(81.9%) were confirmed on surgery. The number of patients in whom findings were confirmed on Conventional Angiography and MR Angiography were 7(9.7%) and 4(5.5%) patients respectively. Thus the CT arteriography findings were confirmed in overall 68 patients(94.4%). Presently, conventional angiography is considered as the gold standard for investigating vascular diseases. But it is invasive as it requires arterial puncture with its attendant complications. Furthermore, it can fail to demonstrate eccentric stenosis. Arterial puncture is not required and eccentric stenosis is well demonstrated in CT Arteriography. As CT Arteriography had good sensitivity and specificity it can be used as primary diagnostic modality in the evaluation of peripheral vascular diseases.



A B

Figure 4: Coronal MIP (Maximum Intensity Projection) images showing:
A: hemangioma over medial aspect of right upper leg. B: thrombosis of infrarenal aorta extending to bilateral common iliac arteries with distal reformation.

CONCLUSIONS

From the present study it was noted that, CT arteriography in upper and lower limb arterial disease is a comprehensive and non-invasive, safe and in-vivo diagnostic modality for delineation of vascular anatomy, diagnosis of upper and lower limb arterial disease, its extent of involvement and collateral circulation. In addition, it was also found to be an effective alternative to the digital subtraction angiography in the diagnosis of upper and lower limb arterial disease which is invasive and associated with some morbidity and mortality. CT Arteriography had overall good sensitivity and specificity of 97.40% and 90%. It can be used as primary diagnostic modality and can replace the conventional angiography in the evaluation of peripheral vascular diseases.

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