Research Article

An evaluation of the diagnostic acumen of noninvasive CT angiography for assessment of abdominal aorta and lower extremity vasculature, using mutli-slice computed tomogaphic acquisition and post processing for vessel analysis

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Abstract

Background: Computed tomographic angiography (CTA) is one of the big success stories in diagnostic radiology. Spiral CT has made it possible to cover body regions so rapidly that the transient enhancement of vascular system following intravenous contract injection could be captured during one scan.

Objective: To evaluate the diagnostic acumen of noninvasive CTA for assessment of abdominal aorta and lower extremity vasculature, using multi-slice computed tomogaphic acquisition and post-processing for vessel analysis.

Materials and Methods: This was a cross-sectional study carried on 60 patients. A detailed demographic and clinical evaluation was carried out. 64 slice CT scan was used for evaluating the abdominal aorta and lower limb arterial system. CTA was performed on MDCT machine using the described protocol.

Result: Atherosclerosis was found the most common cause of the arterial-occlusive disease in this study (42.42%). Vasculitis was the least common cause (15.15%) of the arterial-occlusive disease. Males were mostly affected by atherosclerotic vascular occlusion. Popliteal artery was the most commonly involved segments in the arterial-occlusive group contributing 66.66% of the total cases. A total of seven cases of renal arterial disease was encountered. A total of six cases of abdominal aortic aneurysm were encountered. Angulation of aneurysmal neck was less than 60° in five cases.

Conclusion: In view of the observed evidence, it was concluded that CTA definitely plays an indispensable role in the evaluation of disease of abdominal aorta and peripheral run arteries.

KEY WORDS: Diagnostic acumen, angiography, vessel analysis

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Introduction

Computed Tomographic Angiography (CTA) is one of the big success stories in diagnostic radiology. Spiral CT has made it possible to cover body regions so rapidly that the transient enhancement of vascular system following intravenous contract injection could be captured during one scan.[1] With the introduction of multidetector row technology, CTA gained a tremendous boost and quickly became an easy-to-perform standard technique for vascular imaging.

Computed Tomographic (CT) angiography provides many advantages for imaging the vascular system, including 3-D volumetric analysis, minimally invasive vascular opacification, depiction of mural calcification, and stent-grafts.[2] Multi-detector row CT has had a substantial effect offering shorter acquisition times, lower doses of contrast medium, and improved spatial resolution for assessing smaller arterial branches.

There are two requirements for CT angiography to answer all the clinical questions. First, the vascular lumen must be adequately opacified with iodinated contrast medium.[3] Second, thin section CT scans, which improve *Z*-axis resolution need to be obtained in such a way that the data can be optimally post-processed.

The frequency of atherosclerotic aneurysm of aorta increases with age. These are mainly located in the descending or infrarenal aorta. Most aneurysms are fusiform, only some (20%) are saccular. Penetrating ulcers are a consequence of ulcerative aortic plaques.[4]

Peripheral arterial-occlusive disease of the lower extremities is an important cause of morbidity and an adverse prognostic indicator among the elderly patients.[5] Optimal vessel opacification remains one of the most crucial but difficult aspects of multi-detector row CT angiography. With new generation of MDCT scanners, acquisition times have become substantially shorter.[6] Thus, controlling the level and time-course of arterial enhancement and correct synchronization with CT acquisition has become more difficult and less forgiving.

This study was designed to evaluate the diagnostic acumen of noninvasive CT angiography for assessment of abdominal aorta and lower extremity vasculature, using multi-slice computed tomogaphic acquisition and post processing for vessel analysis.

Material and Methods

This was a cross-sectional study carried on 60 patients in the Department of Radiodiagnosis, of a tertiary care hospital in Uttar Pradesh, India. The patients were referred from Department of General surgery and Orthopaedics, whereas few cases came from Department of General Medicine & Pediatric Surgery. The study was approved by the Ethical Committee of the Institute. The consent was taken from each participant before enrolling in the study.

A detailed demographic and clinical evaluation was carried out. 64 slice CT scan was used for evaluating the abdominal aorta and lower limb arterial system. CT angiography was performed on MDCT machine using the described protocol. Scanning was done in craniocaudal direction just below the diaphragm up to the foot for both abdominal aorta and lower limb vasculature. Smart prep technique was used in smart prep technique monitoring delay was set 3 s for abdominal aorta and 10 s for lower limb angio. Diagnostic delay of 3 s was set after that scan was started. Vessel analysis of abdominal aorta, its branches, and bilateral lower limb arterial system was carried out based on the disease type. The results are presented in percentages.

Result

The youngest patient examined was of 10 years of age whereas the oldest was 80 years of age. Elderly patients (more than 60 years) contributed to only 15% of the patient population [Table 1]. Atherosclerosis was found the most common cause of the arterial-occlusive disease in this study (42.42%) followed by thrombo-embolism (24.24%). Buerger disease contributed 18.18% of arterial-occlusive cases [Table 2].

A total of seven cases of renal arterial disease was encountered. Proximal part of renal artery was most commonly involved (57.14 %), followed by diffuse involvement of renal artery in 42.86% cases. Complete arterial occlusion was observed in two cases (28.57%), whereas five cases (71.42%) showed partial luminal occlusion [Table 3].

A total of six cases of abdominal aortic aneurysm was encountered. Maximum A-P diameter was more than 5.5 cm in four cases. Rim-like peripheral aneurysmal wall calcification was observed in four cases. Length of aneurysmal neck was more than 1.5 cm in five cases. Angulation of aneurysmal neck was less than 60° in five cases. Focal aneurysm of feeding artery was observed in two cases. Anatomical variant contributed maximum number of cases (54.54%) [Table 4].

Table 1: Age and gender incidence of cases

Age (years)	Gender distribution			Percentage
	Male	Female	Total cases	
1–10	1	–	1	1.67
11–20	6	1	7	11.67
21–30	14	–	14	23.33
31–40	11	6	17	28.33
41–50	5	–	5	8.33
51–60	5	2	7	11.67
61–70	5	–	5	8.33
71–80	4	–	4	6.67
Total cases	51	9	60	–

Table 2: Etiological distribution and segmental distribution of occlusive disease

	No of cases			Percentage
	Male	Female	Total	
Occlusive disease (*n* = 33)				
Atherosclerotic	14	–	14	42.42
Thrombo-embolic	5	3	8	24.24
Buerger disease	6	–	6	18.18
Vasculitis	3	2	5	15.15
Vessel-segment (*n* = 33)*				
Abdominal aorta	4	2	6	18.18
Celiac trunk	4	2	6	18.18
Renal	6	1	7	21.21
SMA	1	–	1	3.03
IMA	2	–	2	6.06
Iliac (CIA, EIA and IIA)	8	6	14	42.42
Femoral (CFA, SFA and DFA)	13	4	17	51.51
Popliteal	18	4	22	66.66
Infrapopliteal (ATA, PTA, PA, and TP trunk)	14	1	15	45.45

*Multiple response.

Table 3: CT angiography finding in renal artery and arterial-occlusive disease

Imaging features in renal artery disease (*n* = 7)	No. of cases	Percentage
Site of stenosis		
(a) Proximal	4	57.14
(b) Distal	–	–
(c) Diffuse	3	42.86
Degree of stenosis		
(a) Partial	5	71.42
(b) Complete	2	28.57
Plaque type		
(a) Calcified	1	14.29
(b) Noncalcified	6	87.71
Renal infarct		
(a) Present	4	57.14
(b) Absent	3	42.86
Accessory renal artery		
(a) Present	3	42.86
(b) Absent	4	57.14
CT angiography features arterial-occlusive disease (*n* = 28)		
Length of involved segment		
(a) < 5 cm	5	17.85
(b) 5–10 cm	8	28.57
(c) >10 cm	15	53.57
Degree of Stenosis		
(a) <50%	1	3.57
(b) 50%–90%	9	32.14
(c) Complete occlusion	18	64.28
Distal passage of contrast		
(a) Present	22	78.57
(b) Absent	6	21.43
Presence of collaterals		
(a) Present	17	60.71
(b) Absent	11	39.28
Plaque morphology		
(a) Calcified	11	39.28
(b) Noncalcified	17	60.71

Table 4: CT angiography finding in abdominal aortic aneurysm, AVM in lower limb and Incidence of congenital peripheral vascular disease in peripheral arterial system

Imaging feature	No. of cases
Imaging feature in CT angiography finding in abdominal aortic aneurysm (*n* = 6)	
Size of aneurysm (A-P diameter)	
(a) < 5.5 cm	2
(b) > 5.5 cm	4
Aneurysmal wall calcification	
– Present	4
– Absent	2
Morphology	
– Saccular	1
– Fusiform	5
Length of aneursmal neck	
(a) < 1.5 cm	1
(b) > 1.5 cm	5
Angulation of the neck	
(a) < 60°	5
(b) > 60°	1
Extension into CIA	
– Present	4
– Absent	2
Thrombo-occlusion	
Renal	4
CT angiography feature of AVM in lower limb (*n* = 3)	
Arterial phase enhancement	3
Early venous filling	3
Tortuosity and enlargement of feeding artery	3
Prominent draining vein	3
discrete tangle of vascular structure on 3D reformation	3
Aneurysm of feeding artery	2
Incidence of congenital peripheral vascular disease in peripheral arterial system (*n* = 11)	
AVM	3
Hemangioma	2
Variant anatomy	6

A total of two cases of intramuscular hemangioma were encountered in this study. Both cases showed delayed enhancement on CT angiography. Lobulated mass was noted on 3D reformation in both cases. Calcification was not detected in any case. Post-traumatic thrombosis was most commonly seen (46.67%) [Table 5].

In this study, maximum number of patients were having arterial-occlusive disease (55%), followed by trauma group (25%), whereas 18.33% patients had a congenital entity. The aneurysmal disease was observed in 10% patients incidentally [Figure 1].

Discussion

CT angiography has become an important technique in the evaluation of the vascular system. Volumetric data permit three-dimensional visualization from any angle of view and permit quantification that is unattainable with projection techniques, such as conventional arteriography.[7] In fact, CT angiography has demonstrated diagnostic superiority over conventional arteriography in several applications.[8]

In this study, a total of 60 cases have been evaluated for their varied vascular problems. Majority of the patients in this study were male (85%) whereas 15% were female having different vascular disease patterns. In a study by Cambria et al.,[9] prevalence of the peripheral arterial-occlusive disease was 65% and congenital disorder contributed to 3% cases. In this study, maximum number of the patients were in the arterio-occlusive disease group (55%) and the incidence of aneurysmal disease was 10%.

In this study, atherosclerosis was the most common cause of peripheral arterial-occlusive disease (42.42%). A study by Pasternak et al.[10] showed increased prevalence of the atherosclerosis by increasing age. In this, elderly patients (age >60 years) contributed maximum number of

Table 5: CT angiography feature of hemangioma and Incidence of posttraumatic vascular disease

	No. of cases
Imaging feature in CT angiography feature of hemangioma (n = 2)	
Enhancement	
Early (arterial)	-
Delayed (late venous)	2
Tortuosity and enlargement of feeding artery	Absent
Early venous filling	Absent
Lobulated mass on 3D reformation	2
Presence of calcification	–
Incidence of post-traumatic vascular disease (n = 15)	
Thrombosis	7
A-V fistula	5
Pseudoaneurysm	2
Active hemorrhage	1

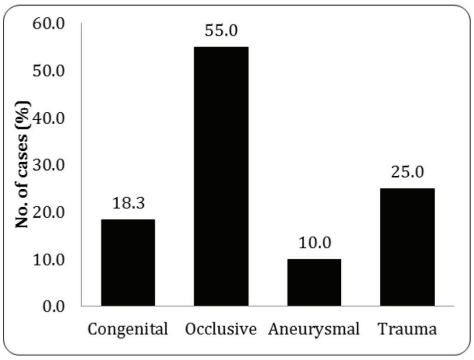

Figure 1: Distribution of diseases of abdominal aorta and peripheral arterial system

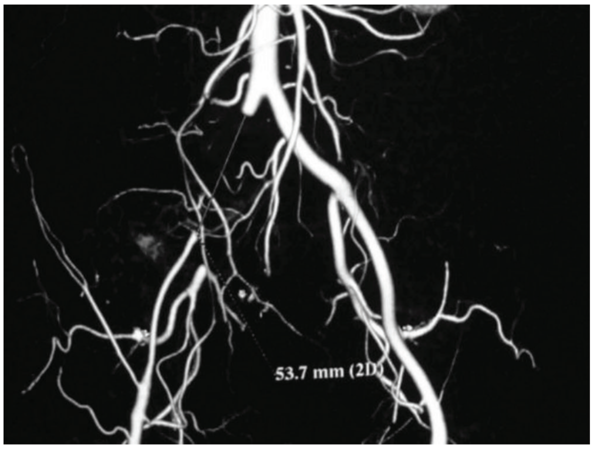

Figure 3: Atherosclerotic thrombosis- CT angiography 3D volume rendered image shows occlusion of right common iliac artery, right external iliac, and proximal part of the right internal iliac artery

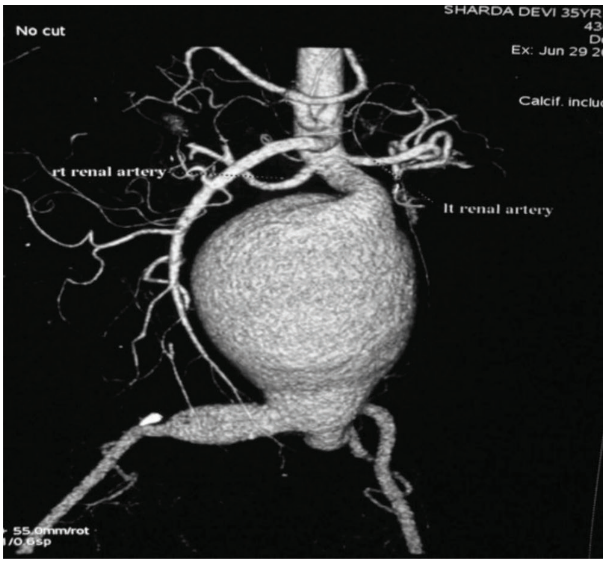

Figure 2: Abdominal aortic aneurysm-3D volume rendered CT angiography shows gross infrarenal abdominal aortic aneurysm with extension into bilateral common iliac artery.

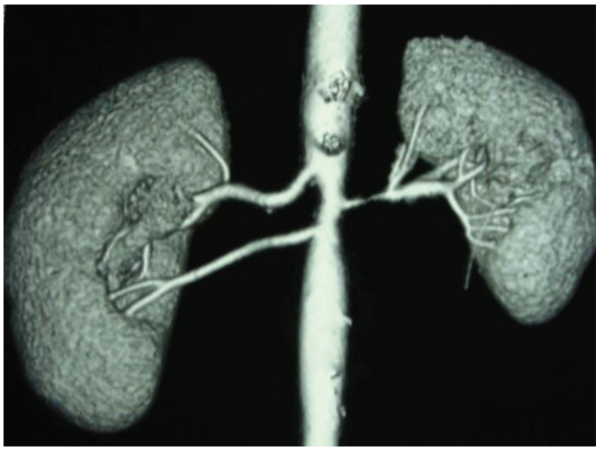

Figure 4: Takayasu arteritis-CT angiography 3D volume rendered image shows stenosis of left renal artery with small kidney. Accessory renal artery noted on the right side

atherosclerotic vascular disease in 27.27% cases. Buerger disease usually affects young male adults with the onset of its clinical signs and symptoms generally occurring before the age of 40 years.[11]

Segmental distribution of Buerger disease showed involvement of femoropopliteal segment in 40% cases which was in agreement with the study by Suzuki et al.[11]. Suzuki et al. believed that the presence of corkscrew-shaped vessels is the most characteristic feature of Buerger disease.[11] In a study of Yamada et al.,[12] average age of Takayasu arteritis was 34 years. A study by Cambria et al.[9] revealed segmental distribution of the atherosclerotic disease with involvement of the aorto-iliac segment in 26% cases. In this study, aorto-iliac segment was involved in 39.39%, femoro-popliteal segment in 75.75% cases, whereas infra popliteal segment was involved in 21.21% cases.

Atherosclerotic renal artery disease was estimated to vary from 6% to 8%.[10] In this study, atherosclerotic renal artery stenosis was noted in 8.33% cases. CT angiography depicted mural changes, including wall thickening, calcification, and mural thrombi not seen with conventional angiography.[13] In this study, 15.15% cases had arterial-occlusive disease due to vasculitis predominantly affecting the renal arteries (12.12%). Most of thrombo-embolic events occurred in younger patients (<50 years).[14] In this study, abdominal aneurysm was noted in 10% instance**.** Maximum incidence of the aneurysm cases belonged to the eighth decade in this study (5%) and also all cases of intramuscular hemangioma were noted in the second decade. However, deep-seated hemangiomas such as intramuscular hemangiomas are relatively uncommon.[15]

MDCT angiography has a reported accuracy of 97–98% compared with conventional angiography for detecting arterial variants.[16] In this study, two cases of replaced right hepatic artery originating from the SMA were identified. Lower pole accessory arteries usually arise from the mid-abdominal aorta but may arise from the distal aorta or common iliac artery.[17] A study by Darbari et al.[18] on vascular trauma patients, showed maximum incidence of the cases in the middle age groups (average age 29.5 years). In this study maximum incidence of trauma cases with arterial involvement were seen in age group of 20–30 years (13.33%). A study by Joshi et al.[19] on 23 trauma patients revealed posttraumatic arterial thrombosis/contusion/arterial spasm in 47.82%. In this study, posttraumatic arterial thrombosis was noted in 46.67% cases. Darbari et al.[18] reported 13.33% incidence of the pseudoaneurysm in road traffic accident. In this study, 13.33% of the trauma cases had pseudoaneurysm. A single case of posttraumatic anterior tibial artery pseudoaneurysm was noted in this study.

The limited number of cases in this short-term study is a drawback and hence calls in for further evaluation on a larger scale, with visual perception of well-known vascular abnormalities in format of VR and CPR image.

Conclusion

In view of the observed evidence, it is concluded that CTA definitely plays an indispensable role in the evaluation of disease of abdominal aorta and peripheral run arteries.

References

1. Prokop M. Principles of computed tomographic angiography. In: *CT and MR Angiography Comprehensive Vascular Assessment*, Rubin and Rofsky (Eds.). Lippicott Williams and Wilkins, 2008.
2. Rubin GD, Schmidt AJ, Logan LJ, Sofilos MC. Multi-detector row CT angiography of lower extremity arterial inflow and runoff: initial experience. Radiology 2001;221:146–58.
3. Macari M, Israel GM, Berman P, Lisi M, Tolia AJ, Adelman M, et al. Infrarenal abdnominal aortic aneurysms at multi-detector row CT angiography: intravascular enhancement without a timing acquisition. Radiology 2001;220:519–23.
4. Prokop M, Galanski M. Spiral and multislice computed tomography of the body. New York: Thieme, 2003.
5. Fraioli F, Catalano C, Napoli A, Francone M, Venditti F, Danti M, et al. Low-dose multi-detector row CT angiography of infra-renal aorta and lower extremity vessels: image quality and diagnostic accuracy in comparison with standard DSA. Eur Radiol 2006;16:137–46.
6. Fleischman D. *Contrast Medium Delivery for Vascular MDCT – Principles and Rationale*. In: Reiser et al. (Ed.). Multislice, CT: Springer, 2004.
7. Rubin GD, Dake MD, Napel SA, McDonnell CH, Jeffrey RBJ. Abdominal spiral CT angiography: initial clinical experience. Radiology 1993;186:147–52.
8. Katz DS, Jorgensen MJ, Rubin GD. Detection and follow-up of important extraarterial lesions with helical CT angiography. Clin Radiol 1999;54:294–300.
9. Cambria RP, Brewster DC, Gertler J, Moncure AC, Gusberg R, Tilson MD, et al. Vascular complications associated with spontaneous aortic dissection. J Vasc Surg 1988;7:199–209.
10. Pasternak RC, Criqui MH, Benjamin EJ, Fowkes FG, Isselbacher EM, McCullough PA, et al. Atherosclerotic vascular disease conference: writing group I: epidemiology. Circulation 2004;109:2605–12.
11. Suzuki S, Yamada I, Himeno Y. Angiographic finding in Buerger disease. Int J Cardiol 1996;54:S189–S195.
12. Yamato M, Lecky JW, Hiramatsu K, Kohda E. Takayasu arteritis: radiographic and angiographic findings in 59 patients. Radiology 1986;161:329–34.
13. Yamada I, Nakagawa T, Himeno Y, Numano F, Shibuya H. Takayasu arteritis: evaluation of the thoracic aorta with CT angiography. Radiology 1998;209:103–9.
14. Panetta T, Thompson JE, Talkington CM, Garrett WV, Smith BL. Arterial embolectomy: a 34-year experience with 400 cases. Surg Clin North Am 1986;66:339–53.
15. Hawnaur JM, Whitehouse RW, Jenkins JP, Isherwood I. Musculoskeletal haemangiomas: comparison of MRI with CT. Skeletal Radiol 1990;19:251–8.
16. Sahani D, Saini S, Pena C, Nichols S, Prasad SR, Hahn PF, et al. Using multidetector CT for preoperative vascular evaluation of liver neoplasms: technique and results. AJR 2002;179:53–9.

17. Takahashi S, Murakami T, Takamura M, Kim T, Hori M, Narumi Y, et al. Multi-detector row helical CT angiography of hepatic vessels: depiction with dual-arterial phase acquisition during single breath hold. Radiology 2002;222:81–8.
18. Darbari A, Tandon S, Chandra G, Dwivedi SK, Kumar A, Gupta A. Post-traumatic peripheral arterial pseudoaneurysms: our experience. Ind J Thorac Cardiovasc Surg 2006;22:182–7.
19. Joshi A, Nimbkar V, Merchant S, Mhashelkar Y, Talekar K. Role of CT angiography in the evaluation of peripheral vasculature using MSCT—our initial experience. Indian J Radiol Imaging 2004;14:309–15.

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