

The Role of Multi-Slice Computed Tomography Angiography in Evaluation of Aortic Artery Diseases

Doaa Hosny¹, Alhassan Bahaa Eldien Zaki Ahmed^{1*}, Mohamed Shawky Abdullah¹, Tamer Ghazy²

Departments of ¹Radio-diagnosis, Faculty of Medicine and ²Cardiology, Menofia University, Egypt

*Corresponding Author: Alhassan Bahaa Eldien Zaki Ahmed,

Email: alhassanbae@gmail.com, Mobile number: +201060551162

ABSTRACT

Background: Aortic diseases represent a significant reason of death and morbidity, requiring prompt diagnosis for appropriate management. Multi-slice computed tomography angiography (MSCTA) has emerged as a valuable noninvasive tool offering high spatial resolution and rapid image acquisition for comprehensive aortic evaluation.

Aim: To assess the role of MSCTA in diagnosing and differentiating various aortic artery diseases.

Patients and Methods: This research involved 100 cases clinically suspected of having aortic diseases, referred from the Vascular Surgery Department of Al-Ahrar Teaching Hospital for MSCT aortic examination. All patients underwent detailed CT angiographic evaluation with comprehensive documentation of aortic involvement, lesion characteristics, and associated findings.

Results: The ascending aorta was most frequently involved (42%), followed by abdominal aorta (36%), thoracic aorta (25%), and aortic arch (19%). Median diameters were 54 mm (ascending), 36 mm (arch), 33 mm (thoracic), and 42 mm (abdominal aorta). Aortic aneurysm was detected in 55% of patients, predominantly in the ascending aorta (50.9%). Dissection was observed in 34.8% of cases, classified as Stanford type A (47.8%), type B (17.4%), and type A+B (34.8%). Post-contrast findings revealed wall thickening (65%), mural plaques (71%), and stenotic lesions (19%). The most frequent diagnosis was uncomplicated thoracic aneurysm (20%). Less common findings included non-traumatic dissection (9%).

Conclusion: MSCTA is a highly reliable noninvasive imaging modality for evaluating aortic diseases, enabling accurate diagnosis, detailed anatomical assessment, and precise differentiation between various pathologies, thus guiding optimal clinical management.

Keywords: Aortic diseases, Multi-slice computed tomography angiography, Aortic aneurysm, Aortic dissection, Aorta, CTA

INTRODUCTION

The thoracic aorta consists of three different portions: the aortic arch, the aortic root, and the descending thoracic portion ⁽¹⁾. The abdominal aorta begins just prior to the appearance of the superior adrenal arteries. The abdominal aorta provides visceral and parietal arteries that originate from three vascular planes prior to bifurcating into the common iliac arteries at the L4 level ⁽²⁾.

Aortic illnesses are a significant etiology of morbidity and mortality, possibly leading to catastrophic clinical outcomes if identification is delayed. Consequently, prompt and accurate assessment is essential for giving safe patient care and appropriate clinical results ⁽³⁾.

Acute Aortic Syndrome (AAS) related emergencies are infrequent nevertheless regarded as life-threatening and potentially fatal conditions. Various forms of aortic emergencies/AAS are frequently clinically indiscernible. The prompt and accurate diagnosis of these entities significantly influences prognosis and guides treatment ⁽⁴⁾.

Contrast-enhanced computed tomography angiography is the preferred modality for identifying aortic illnesses and is essential in the diagnosis and treatment of patients with suspected acute aortic pathologic, that present a life-threatening emergency ^(5,6). Rapid acquisition of volumetric datasets via

computed tomography has become essential for surveillance, diagnosis, and intervention planning ^(7,8).

This study aimed to assess the role of multi-slice computerized tomography angiography in diagnosis and differentiation of variable aortic diseases.

PATIENTS AND METHODS

Patients: This research has been done on 100 cases who were clinically suspected for aortic artery disease. They have been referred to the Radio-diagnosis and Medical Imaging Department from Vascular Surgery Department of Alahrar teaching hospital for multi-slice computerized tomography (MSCT) aortic examination.

Inclusion criteria: Male and female patients clinically suspected to have aortic artery disease based on clinical data or other investigations have been involved in the research. These included cases with bilateral chronic lower limb ischemia, patients with duplex studies indicating aortic disease, and those presenting with pulsating intra-abdominal masses suspected to be abdominal aortic aneurysm.

Exclusion criteria included pregnant females, patients with chronic kidney disease having a serum creatinine concentration above 1.5 milligrams per deciliter, and those with a known allergy to contrast agents.

METHODS

All patients underwent demographic data recording, including age, sex, and occupation. A full history was taken, covering clinical manifestations such as chest pain, pulsating abdominal pain, or symptoms of peripheral vascular disease like claudication pain. Past medical history was reviewed with emphasis on any history associated with aortic illness and associated risk factors like hypertension, diabetes mellitus, heart disease, hyperlipidemia, and smoking. Additionally, results of previous laboratory and radiological investigations were reviewed.

Computed tomography (CT) examination

CTA Protocol and Technical Considerations: A multi-slice CT scanner was used for all examinations.

Patient Preparation: Patients were instructed to fast for 3–4 hours prior to the examination. Adequate hydration was ensured to protect renal function and facilitate venous access.

Patient Positioning: Each case has been positioned supine on the examination table with arms raised above the head.

Technique: An anteroposterior (AP) scanogram was first acquired, and the volume scan covered the entire aorta. Patients were instructed to remain motionless and hold their breath during image acquisition. The imaging protocol began with a non-contrast (pre-contrast) phase, followed by contrast-enhanced imaging. For the arterial phase, fifty to sixty milliliters of high-iodine concentration contrast medium were administered at a rate of four to seven milliliters per second utilizing an automatic injector. Bolus tracking with or without automatic triggering (threshold typically 130–150 HU) or the timing bolus technique was employed to optimize arterial enhancement and minimize the volume of intravenous contrast material.

Parameters of CT protocol: KV= 120, mA= 500, mAs =111 and slice thickness 1 mm.

Image reconstruction: Throughout data acquisition for aorto-iliac diseases, the console automatically generated axial images of the anatomical area under investigation, typically at one-millimeter intervals. Multiplanar

reformatting (MPR) was then performed using three-dimensional reconstruction software, providing direct access to images in the axial, sagittal, and coronal planes. Curved planar reconstruction (curved MPR) was also applied to follow the course and location of the aorto-iliac arteries point by point along their path. Additionally, volume rendering was utilized to project data within a three-dimensional slab, where the intensity of all voxels was averaged to produce a detailed and high-quality 3D image.

Image analysis: Image analysis included both non-contrast and post-contrast studies. The non-contrast study was performed to detect calcifications and plaques, allowing clear distinction from contrast media. The post-contrast study was used to evaluate occlusions, stenotic lesions, and distal runoff. In patients with aortic dissection, it enabled assessment of leakage, differentiation between true and false lumens, evaluation of dissection extension into visceral branches, determination of the lesion level (suprarenal or infrarenal), and assessment of the degree of visceral involvement.

Ethical Approval:

Informed written agreement has been attained from all participants, and the protocol of the research received approval from the institutional ethics committee. The research has been registered with the local ethics committee of Menoufia University, Faculty of Medicine. The research adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

The collected data were coded, entered, and analyzed using IBM SPSS version 23.0 for Windows (SPSS Inc., Chicago, IL, USA). For qualitative data, the number (n) and percentage (%) of observations in each category were calculated. For quantitative data, descriptive statistics included the mean $\pm$ standard deviation (SD), range, median and the interquartile range (IQR).

RESULTS

Age of most of the male patients (78%) were more than 60 years, while age of most of the female patients (61.1%) were ranging from 40 to 60 years (Table 1).

Table 1: Age and sex distribution of the examined patients

Age (years)	Sex				Total	
	Male		Female			
	No.	%	No.	%	No.	%
18 – 40	5	6.1	2	11.1	7	7
40 – 60	13	15.9	11	61.1	24	24
> 60	64	78	5	27.8	67	69
Total	82	100	18	100	100	100
Min – Max			18 – 80			
Mean ± SD			58.6 ± 10.95			
Median (IQR)			61 (8)			

IQR: Interquartile Range.

The most frequent site of involvement detected was ascending aorta lesion, which was detected among (42%) of the patients, followed by abdominal aorta lesion among (36%) of the patients (Table 2).

Table 2: Site of involvement among examined patients

Variable		All patients (n=100)
Ascending aorta lesion (N. %)	Absent	58 (58%)
	Present	42 (42%)
Aortic arch lesion (N. %)	Absent	81 (81%)
	Present	19 (19%)
Thoracic aorta lesion (N. %)	Absent	75 (75%)
	Present	25 (25%)
Abdominal aorta lesion (N. %)	Absent	64 (64%)
	Present	36 (36%)
Renal artery stenosis (N. %)	Absent	98 (98%)
	Present	2 (2%)

The abdominal aorta demonstrated the widest variation among other aortic parts, with a median (IQR) diameter of 42 (34) mm and a range of 17 to 118 mm (Table 3).

Table 3: Aortic diameter among studied patients

Variable		All patients (n=100)
Ascending aorta diameter (mm)	Median (IQR)	54 (12)
	Range	(35 – 107)
Aortic arch diameter (mm)	Median (IQR)	36 (8.5)
	Range	(20 – 53)
Thoracic aorta diameter (mm)	Median (IQR)	33 (18)
	Range	(7.5 – 93)
Abdominal aorta diameter (mm)	Median (IQR)	42 (34)
	Range	(17 – 118)

IQR: Interquartile Range.

Among the total studied 100 patients, there were 55 patients (55%) had aortic aneurysm (Table 4).

The most frequent site of aneurysm detected was the ascending aorta, which was detected among (50.9%) of the patients with aneurysm and the least frequent detected site was the aortic arch which was detected among (3.6%) of those patients (Table 4).

Table 4: Aneurysm characteristics among studied patients

Variable (N. %)		Aneurysm patients (n=55)
Aneurysm site	Aortic arch	2 (3.6%)
	Ascending aorta	28 (50.9%)
	Ascending and arch of aorta	4 (7.3%)
	Descending abdominal aorta	14 (25.5%)
	Descending thoracic aorta	4 (7.3%)
	Thoracic and abdominal aorta	3 (5.5%)
Size (mm)	Mean $\pm$ SD	42.1 $\pm$ 31.3
Shape	Saccular	4 (7.3%)
	Fusiform	51 (92.7%)
	Pseudo-aneurysm	0 (0%)
Complication	Frank rupture	3 (5.5%)
	Impending rupture	6 (10.9%)
	Uncomplicated	46 (83.6%)
Associated dissection		13 (23.6%)
Associated intramural hematoma		1 (1.8%)
Associated Thrombosis		23 (41.8%)

The most frequent site of dissection detected was at the ascending, descending and arch of the aorta, which was detected among (34.8%) of the patients. As regard dissection class; (47.8%) of the patients were Stanford A. As regard false lumen dissection; (21.7%) of the patients were partially thrombosed and (21.7%) were totally thrombosed (Table 5).

Table 5: Dissection characteristics among studied patients

Variable (N. %)		Dissection Patients (n=23)
Dissection site	Aortic arch	1 (4.3%)
	Ascending aorta	5 (21.7%)
	Descending aorta	1 (4.3%)
	Ascending and arch of aorta	5 (21.7%)
	Descending and arch of aorta	3 (13%)
	Ascending, descending and arch of aorta	8 (34.8%)
	Stanford A	11 (47.8%)
Dissection classification	Stanford B	4 (17.4%)
	Stanford A+B	8 (34.8%)
True lumen thrombosis	Present	0 (0%)
False lumen thrombosis	Partially thrombosed	5 (21.7%)
	Totally thrombosed	5 (21.7%)

57% of the patients showed calcified plaques at the non-contrast phase, while (63 %) of the patients showed mural calcification (Table 6).

Table 6: Non contrast phase findings among studied patients

Variable (N. %)		All patients (n=100)
Calcified Plaques	Absent	43 (43%)
	Present	57 (57%)
Mural Calcification	Absent	37 (37%)
	Present	63 (63%)
Intramural hematoma	Absent	98 (98%)
	Present	2 (2%)

5% of the patients showed wall thickening and 71 % showed mural plaques (Table 7).

Table 7: Contrast phase findings among studied patients

Variable (N. %)		All patients (n=100)
Stenotic lesions	Absent	81 (81%)
	Present	19 (19%)
Contrast leakage	Absent	97 (97%)
	Present	3 (3%)
Wall thickening	Absent	35 (35 %)
	Present	65 (60 %)
Mural Plaques	Absent	29 (35 %)
	Present	71 (65%)

As regards grading of diagnosis, <50% luminal stenosis was the most frequent grade in 8 patients (Table 8).

Table 8: Grading of stenosis among studied patients

Variable (N. %)	All patients (n=100)
<50% Luminal stenosis	8 (8%)
>50% Luminal stenosis	6 (6%)
Complete occlusion	5 (5%)

Among the studied patients, the uncomplicated thoracic aneurysm represented the most frequent diagnosis (20%), followed by dissecting aneurysm (13%) and atherosclerosis (14%).

Less common findings included non-traumatic dissection (9%), uncomplicated abdominal aneurysm (10%), and other rare aortic pathologies (Table 9).

Table 9: Clinical diagnosis among studied patients

Variable (N. %)		All patients (n=100)
Diagnosis	Aortitis	4 (4%)
	Atherosclerosis	14 (14%)
	Coarctation	8 (8%)
	Le Rich syndrome	5 (5%)
	Ascending aortic dilatation	6 (6%)
	uncomplicated thoracic aneurysm	20 (20%)
	Complicated thoracic aneurysm	2 (2%)
	Uncomplicated abdominal aneurysm	10 (10%)
	Complicated abdominal aneurysm	4 (4%)
	Uncomplicated thoraco-abdominal aneurysm	1 (1%)
	Complicated thoraco-abdominal aneurysm	2 (2%)
	Non-traumatic dissection	9 (9%)
	Dissecting aneurysm	13 (13%)
	Traumatic dissection	1 (1%)
	Traumatic floating thrombus	1 (1%)

The provided CT angiographic images demonstrate a spectrum of major aortic pathologies. **Figure (1)** illustrates a classic *coarctation of the descending thoracic aorta* with prominent *post-stenotic aneurysmal dilatation* and mural thrombus formation, along with well-developed collateral circulation. **Figure (2)** shows features of *inflammatory aortitis*, evidenced by *enhanced circumferential mural thickening* of the descending aorta and extending to the origins of the common iliac arteries, associated with peri-aortic fat stranding. **Figure (3)** depicts a marked *ascending aortic aneurysm* with a concomitant *moderate pericardial effusion*, raising concern for possible impending complications. **Figure (4)** demonstrates *Leriche syndrome*, characterized by *complete infrarenal aortic occlusion* with absent contrast opacification in the affected segment.

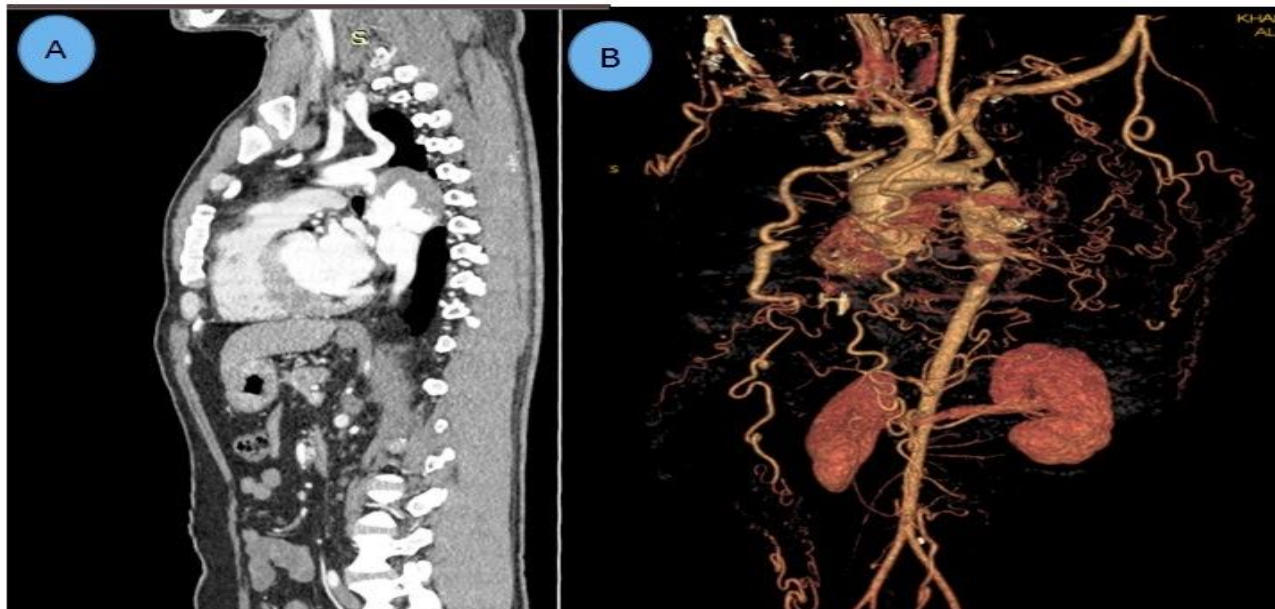


Figure (1): Coarctation of descending thoracic aorta **(A)** Sagittal CT angiogram illustrates coarctation of the descending thoracic aorta with post stenotic aneurysmal dilatation showing mural thrombus and **(B)** CT angiogram volume rendered image shows abundant collateral pathway.

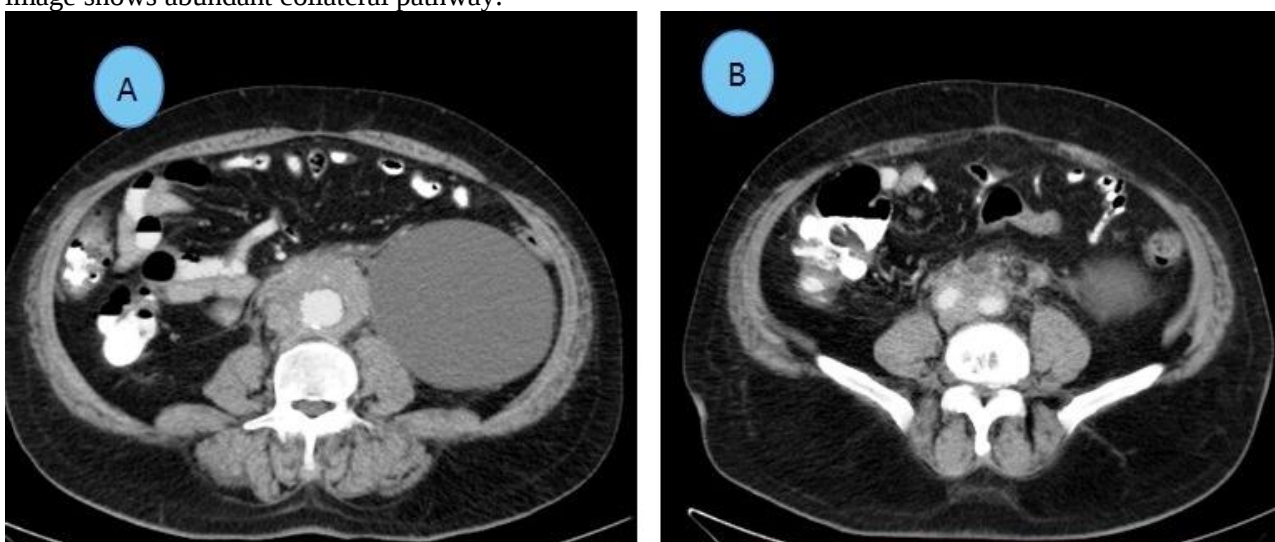


Figure (2): Aortitis of descending aorta, **(A)** axial CT angiogram illustrates enhanced circumferential mural thickening of descending aorta. **(B)** axial CTA image shows enhanced circumferential mural thickening of beginning of common iliac arteries with smudging peri-aortic fat.

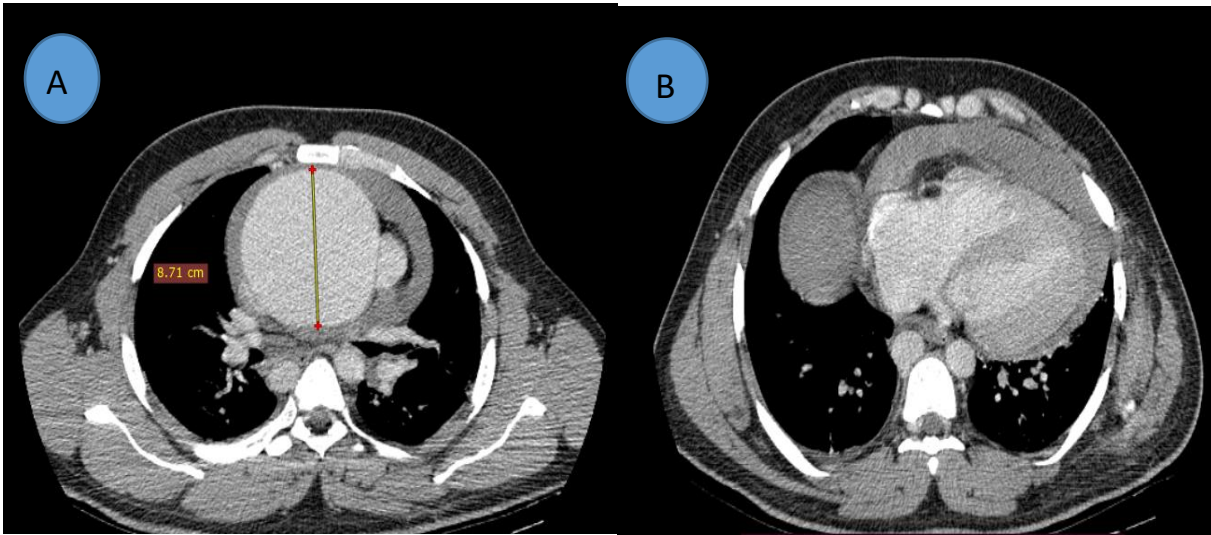


Figure (3): Aneurysm of ascending aorta **(A)** axial CTA image illustrates marked aneurysmal dilatation of the ascending aorta. **(B)** axial CT angiogram shows moderate pericardial effusion.

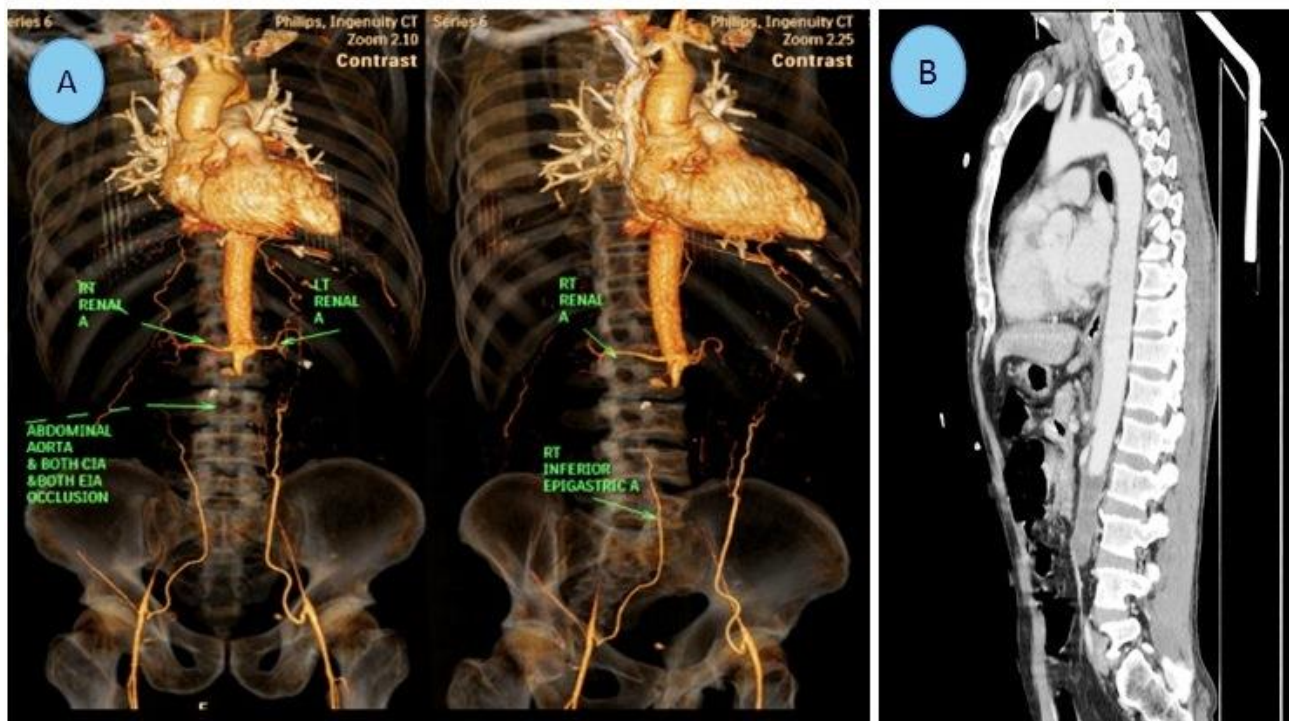


Figure (4): **(A)** CT angiogram volume rendered images of the aorta shows infra-renal complete occlusion of the aorta (Leriche syndrome). **(B)** Sagittal reconstructed CTA image shows non-opacified infra-renal aorta.

DISCUSSION

The anatomical distribution revealed that the ascending aorta was the most frequently involved site of disease (42%), followed by the abdominal aorta (36%), thoracic aorta (25%), and aortic arch (19%). This pattern is consistent with previous studies indicating that the ascending aorta is a common site for both aneurysm formation and dissection initiation ⁽⁹⁾.

However, abdominal aortic aneurysm (AAA) is considered the most prevalent aneurysmal disease globally, particularly among smokers and hypertensive individuals ⁽¹⁰⁾, reflecting possible differences in our study population and inclusion criteria.

The median ascending aorta diameter was 54 mm (IQR 12), ranging from 35 to 107 mm, demonstrating the wide spectrum of aortic dimensions encountered. These findings are consistent with current guidelines that define ascending aortic aneurysms as diameters >40–45 mm ⁽¹¹⁾. According to the 2022 AHA guidelines, ascending aortic aneurysms exceeding 45 mm in Marfan patients or 50–55 mm in the general population are considered for elective surgical repair ⁽¹²⁾.

The abdominal aortic diameter measurements (median 42 mm, range 17–118 mm) align with **Moxon et al.** ⁽¹³⁾ defining abdominal aortic aneurysm as exceeding 30 mm in diameter, with surgical intervention typically recommended for aneurysms >55 mm.

The most frequent aneurysm site was the ascending aorta (50.9%), followed by descending abdominal aorta (25.5%). This reflects epidemiological trends where thoracic aortic aneurysms are increasingly recognized due to improved imaging capabilities ⁽¹⁴⁾. The 55% aortic aneurysms prevalence in our study is significantly higher than population-based screening studies (1.5%–1.7%) ⁽¹⁵⁾, but consistent with hospital-based high-risk cohorts showing 30%–60% prevalence ⁽¹⁰⁾.

The overwhelming predominance of fusiform aneurysms (92.7%) over saccular aneurysms (7.3%) is consistent with **Ozawa et al.** ⁽¹⁶⁾, where fusiform aneurysms represent the most common morphological pattern. Among aneurysm cases, complications occurred in 16.4% (5.5% frank rupture, 10.9% impending rupture), consistent with natural history studies by **Elefteriades** ⁽⁹⁾. Associated dissection was noted in 23.6% and thrombosis in 41.8%, consistent with findings from **Fillinger et al.** ⁽¹⁷⁾, who demonstrated that mural thrombus is commonly present in aortic aneurysms.

The incidence of aortic dissection has increased significantly, rising from 5 to 26 cases per 100,000 individuals ⁽¹⁸⁾. The most common dissection affected site was concurrent involvement of ascending, descending, and arch segments (34.8%), consistent with the IRAD database findings ⁽¹⁹⁾.

According to Stanford classification, cases were categorized as type A (47.8%), type B (17.4%), and concomitant type A+B (34.8%). This demonstrates the complexity of dissection patterns, with extensive dissections associated with higher morbidity and mortality ⁽²⁰⁾. **Sayed et al.** ⁽²¹⁾ emphasized that aortic dissection carries extremely high mortality rates, making rapid and accurate diagnosis crucial.

The presence of false lumen thrombosis (21.7% partially thrombosed, 21.7% totally thrombosed) is consistent with literature on natural history and impact on long-term outcomes. **Evangelista et al.** ⁽¹⁹⁾ noted that aortic dissection with persistent patent false lumen carries high risk of complications.

Non-contrast phase findings showed calcified plaques (57%) and mural calcification (63%), reflecting predominantly atherosclerotic disease. The low prevalence of intramural hematoma (2%) is consistent with recent literature suggesting this represents a less common form of acute aortic syndrome. **Sueyoshi et al.** ⁽²²⁾ found that ulcer-like projections emerged in approximately one-third of intramural hematoma cases and many progressed to dissection.

Lovy et al. ⁽²³⁾ demonstrated that unenhanced CT was 89% sensitive and 100% specific for acute aortic syndrome, with contrast-enhanced CTA being 100% sensitive for isolated intramural hematoma. **Al-Qaisi et al.** ⁽²⁴⁾ stated that CT permits simultaneous angiographic and anatomical volume acquisition in seconds with high spatial resolution, showing both luminal and extra-luminal pathology simultaneously.

Kurabayashi et al. ⁽²⁵⁾ reported sensitivity and specificity of high-attenuation crescent findings were 61.2% and 99.1% respectively, with negative predictive value of 93.3%. **Sharma et al.** ⁽²⁶⁾ reported that CTA was an excellent imaging modality for comprehensive evaluation, combining advantages of conventional CT with 3D reformatted images. **Errington et al.** ⁽²⁷⁾ found CTA had 100% sensitivity and 94.4% specificity for detecting juxta/suprarenal extension in abdominal aortic aneurysm.

CONCLUSION

Our findings support the continued use of MSCT angiography as a primary diagnostic tool for aortic disease evaluation and highlight the importance of comprehensive imaging protocols in detecting the full spectrum of aortic pathology. The comprehensive nature of information provided by CT angiography, including anatomical, morphological, and functional assessment, makes it an invaluable tool in the modern management of aortic diseases. The high diagnostic yield and detailed characterization of pathology support the continued use of CT angiography as a primary imaging modality for patients with suspected aortic disease.

DECLARATIONS

Consent for publication: I certify that each author has granted permission for the work to be submitted.

Funding: No fund

Availability of data and material: Available

Conflicts of interest: None.

Competing interests: None.

REFERENCES

- Ciolina F (2020):** Vascular Diseases of the Thorax. In Thoracic Radiology. Springer, Cham., 133-158. https://doi.org/10.1007/978-3-030-35765-8_11.
- Ironi G, Brembilla G, Benedetti G et al. (2019):** Anatomical Overview and Imaging of the Aorta and Visceral Arteries. In Visceral Vessels and Aortic Repair. Springer, Cham., (pp 3-17). https://doi.org/10.1007/978-3-319-94761-7_1
- Abbasi M, Pathrose A, Serhal A et al. (2019):** Imaging approaches for aortic disease. In Vessel Based Imaging Techniques. Springer, Cham., pp. 173-208. https://doi.org/10.1007/978-3-030-25249-6_10.
- Baliyan V, Parakh A, Prabhakar A et al. (2018):** Acute aortic syndromes and aortic emergencies. Cardiovascular diagnosis and therapy, 8(1):S82-S96. doi:10.21037/cdt.2018.03.02.
- Kim T, Lee K, Choe Y et al. (2021):** Acute aortic diseases: evaluation with computed tomography and magnetic resonance imaging. Emergency Chest Radiology, (pp63-88). DOI:10.1007/978-981-33-4396-2_6
- Ko J, Goldstein J, Latson L et al. (2021):** Chest CT angiography for acute aortic pathologic conditions: pearls and pitfalls. Radiographics, 41(2): 399-424.
- Steinbrecher K, Marquis K, Bhalla S et al. (2022):** CT of the difficult acute aortic syndrome. RadioGraphics, 42(1): 69-86.
- Hahn L, Prabhakar A, Zucker E (2018):** Cross-sectional imaging of thoracic traumatic aortic injury. Vasa., 48(1):6-16.
- Eleftheriades J (2002):** Natural history of thoracic aortic aneurysms: indications for surgery, and surgical versus nonsurgical risks. Ann Thorac Surg., 74(5):S1877-S1898. doi:10.1016/s0003-4975(02)04147-4
- Chaikof E, Dalman R, Eskandari M et al. (2018):** The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm. Journal of Vascular Surgery, 67(1): 2-77.e2. <https://doi.org/10.1016/j.jvs.2017.10.044>
- Czerny M, Grabenwöger M, Berger T et al. (2024):** EACTS/STS guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ. Ann Thorac Surg., 118(01):5-115.
- Isselbacher E, Preventza O, Hamilton Black J et al. (2022):** 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. Circulation, 146(24):e334-e482.
- Moxon JV, Parr A, Emeto T et al. (2010):** Diagnosis and monitoring of abdominal aortic aneurysm: current status and future prospects. Curr Probl Cardiol., 35(10):512-548.
- Booher A, Eagle K (2011):** Diagnosis and management issues in thoracic aortic aneurysm. American Heart Journal, 162(1):38-46.
- Svensjö S, Björck M, Wanhainen A (2014):** Update on screening for abdominal aortic aneurysm: a topical review. European Journal of Vascular and Endovascular Surgery, 48(6): 659-667. <https://doi.org/10.1016/j.ejvs.2014.08.029>
- Ozawa H, Takahashi A, Bessho R et al. (2024):** Saccular and fusiform abdominal aortic aneurysms treated with endovascular repair differ in presentation and treatment threshold: Analyses using a national clinical database in Japan. J Am Heart Assoc., 13(11):e032715. doi:10.1161/JAHA.123.032715
- Fillinger M, Racusin J, Baker R et al. (2004):** Anatomic characteristics of ruptured abdominal aortic aneurysm on conventional CT scans: Implications for rupture risk. Journal of Vascular Surgery, 39(6): 1243-1252.
- Lodewyckx C, Prior H, Hiebert B et al. (2020):** A province-wide analysis of the epidemiology of thoracic aortic disease: Incidence is increasing in a sex-specific way. Can J Cardiol., 36(11):1729-1738
- Evangelista A, Isselbacher E, Bossone E et al. (2018):** Insights from the international registry of acute aortic dissection: A 20-year experience of collaborative clinical research. Circulation, 137(17):1846-1860.
- Macedo E, Ramoa Oliveira A, Vale M et al. (2024):** Extensive arterial dissection: A rare multivascular emergency. Cureus, 16(12):e76668. doi: 10.7759/cureus.76668.
- Sayed A, Munir M, Bahbah E et al. (2021):** Aortic dissection: A review of the pathophysiology, management and prospective advances. Curr Cardiol Rev., 17(4):e230421186875. doi: 10.2174/1573403X16666201014142930.
- Sueyoshi E, Matsuoka Y, Imada T et al. (2002):** New development of an ulcerlike projection in aortic intramural hematoma: CT evaluation. Radiology, 24(2):536-41.
- Lovy A, Rosenblum J, Levsky J et al. (2004):** Acute aortic syndromes: a second look at dual-phase CT. American Journal of Roentgenology, 200(4):805-11.
- Al-Qaisi M, Nott D, King D et al. (2009):** Imaging of peripheral vascular disease. Medical Imaging, 2: 25-34. DOI:10.2147/RMI.S4868
- Kurabayashi M, Okishige K, Ueshima D et al. (2014):** Diagnostic utility of unenhanced computed tomography for acute aortic syndrome. Circulation Journal, 78(8):1928-34.
- Sharma U, Gulati M, Mukhopadhyay S (2005):** Aortic aneurysm and dissection: evaluation with spiral CT angiography. Journal of the Nepal Medical Association, 44(157):8-12.
- Errington M, Ferguson J, Gillespie I et al. (1997):** Complete preoperative imaging assessment of abdominal aortic aneurysm with spiral CT angiography. Clinical Radiology, 52(5): 369-77.