Original Article

MSCT Imaging Of Ascending Aorta – Special Emphasis On Post-Operative Imaging

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Abstract: Background: MSCT is an excellent modality for noninvasive imaging of ascending aorta pathologies and post-operative status. Techniques for repair of the aorta currently include open and endovascular methods, hybrid approaches, minimally-invasive techniques, and aortic branch vessel reimplantation or bypass. Hence collaboration among radiologists and cardiothoracic vascular surgeons is essential. An awareness of the various surgical techniques, expected postoperative appearance, and potential complications is essential for radiologists. Methods: We studied a total of 100 patients on MSCT during the period 2014 to 2018. Results: This study is aimed at detail MSCT imaging appearances of Ascending Aorta abnormalities and special emphasis on appearances of post-operative Ascending Aorta – Normal findings as well as complications. The value of three-dimensional image evaluation will also be emphasized. Conclusions: Advances in MSCT scanners and ECG gating techniques have resulted in superior image quality of the ascending aorta and increased the use of CT angiography for evaluating the postoperative ascending aorta. Familiarity with these procedures and their imaging features are required to identify normal postoperative appearances and complications.[Rana Y Natl J Integr Res Med, 2019; 10(2):35-40]

Key Words: MSCT, Post-operative imaging, Ascending aorta

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Introduction: After studying this article, the radiologists should be able to enumerate various surgical and interventional techniques for ascending aorta repair; Identify postsurgical changes and complications resulting from aortic surgery on imaging; describe the role of imaging in postoperative evaluation; Apply computed tomography (CT) protocols for post operative evaluation of the aorta.

Diagnostic radiologists are essential members of a multidisciplinary team comprising vascular surgeons, cardiothoracic surgeons, and interventional radiologists. The postoperative evaluation of these patients can be challenging given the complexity ofthe surgical and endovascular procedures currently being performed. Therefore, our objective is to review the normal appearance and potential complications after repair of the ascending aorta and how to minimize potential interpretive pitfalls.

Materials and Methods: We studied a total of 100 post operative patients during the period 2014 to 2018.We performed CT scan on 128 slice SOMATOM Definition AS+ ;(Siemens Healthcare, Germany) with non-ionic contrast medium, dosage of 1 – 1.5 ml/kg → followed by saline chaser (half that of contrast amount). The flow rate was 4-4.5 ml/sec, with bolus tracking technique, Scan triggered at 100 HU; kV of 100 and effective mAs ~120.

Post processing techniques: All image data were evaluated using Syngovia software (Siemens Healthcare). Various image reformatting techniques including curved planar reconstruction, maximum intensity projection (MIP), shaded surface display and 3D volume-rendering technique (VRT) were used to get all the clinically relevant information.

Results : MSCT angiography findings were as described in Table 1, Table 2 and Table 3 below and figure 1 to 13

Table 1: Numbers of various pathologies evaluated on MSCT

Ascending aorta pathology	No./%
Aortic dissection type A	50
Aneurysm	40
Intramural hematoma	8
Arterial tortuosity syndrome	2

Table 2: Numbers of various surgeries evaluated on MSCT

Surgical techniques	No./%
1.Bentall/Modified Bentall	70
2. Yacoub	14
3. T. David–V technique	5
4. Elephant trunk technique	10
5. Open book technique	1

Table 3: Numbers of various complications observed

Type of complication	No.
1. Abnormal Low-Attenuation Perigraft Material	10
2. Contrast Material Extravasation	2
3. Perigraft Gas Collections/ Fistula formation	3
4. Aneurysm or dissection of native aorta proximal to graft- in supracoronary graft.	3
5. Pseudoaneurysm at coronary artery anastomosis.	0
6. Coronary graft insufficiency from kinking or intimal hyperplasia.	2
7. Acute coronary graft thrombosis.	0
8. Rare complication of elephant trunk technique: Early aortic rupture at distal anastomosis. Air embolism or Recurrent laryngeal nerve injury on left side.	0

Figure 1: Ascending aorta– Normal Imaging Appearance

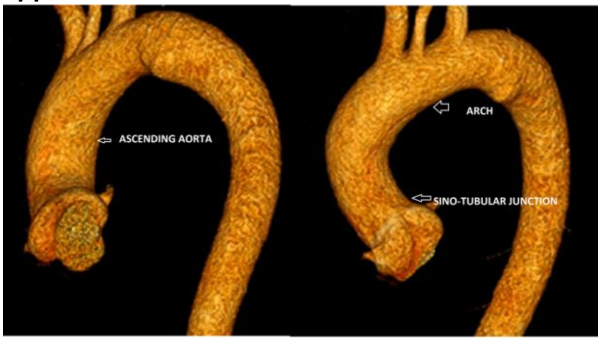


Figure 2:Schematic representation of various surgical techniques. Red colour indicate native aorta, green colour indicate prosthetic graft, blue colour indicate prosthetic valve: A Wheat procedure, B Modified Bentall procedure, C Yacoub procedure, D1 Elephant stage I technique, D2 Elephant stage II technique, D3 Hybrid Elephant stage technique[13]

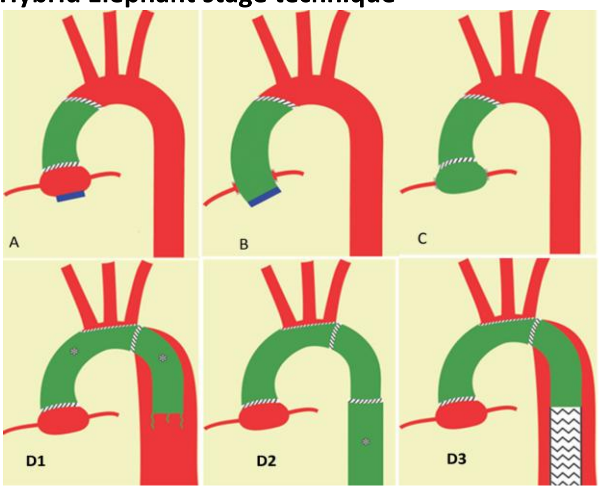


Figure 3: Various ascending aorta pathologies: 3A Ascending aorta aneurysm, 3B Stanford type A aortic dissection, 3C Stanford type A dissecting aneurysm

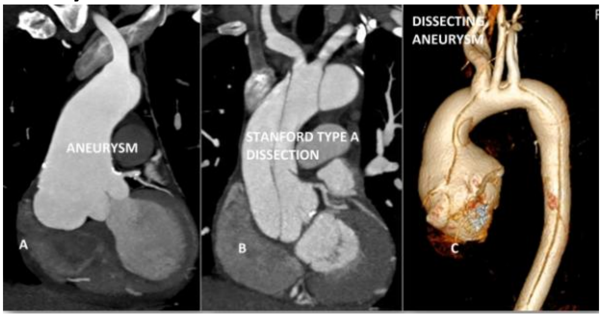


Figure 4:VRT and curved MPR images showing arterial tortuosity syndrome with dilated aortic root and ascending aorta

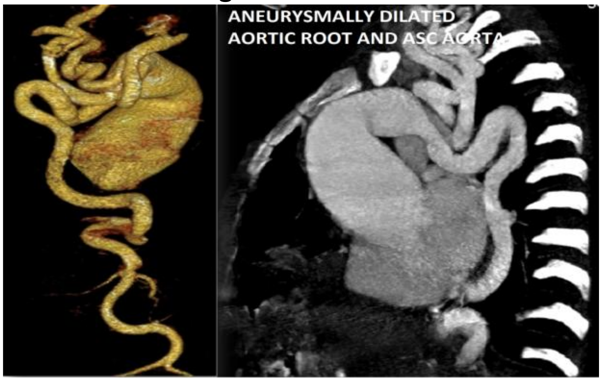


Figure 5: MPR & VRT images of a patient undergone modified Bentall procedure

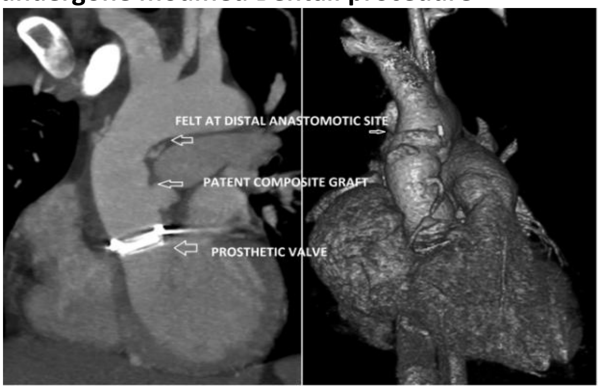


Figure 6: MPR & VRT images in a patient with Bentall Procedure for Stanford type A dissection. Repair of ascending aorta and arch is performed; residual dissection flap is seen in descending aorta.

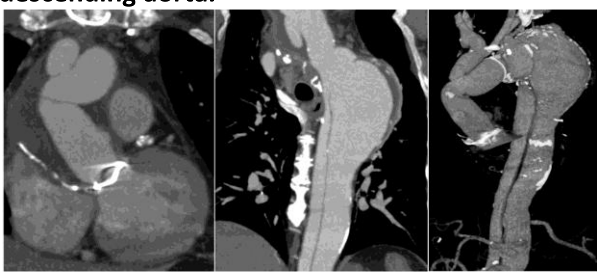


Figure 7: MPR & VRT images showing Post balloon dilatation of co-arctation, Post AVR, ventral aortic aneurysm repair with reimplanted right and left coronary buttons (Modified bentall procedure).

Figure 8: MPR& VRT images showing Aortic valve sparing – Yacoub's Procedure (done for ascending aortic aneurysm) with extension graft to DTA to bypass associated co-arctation.

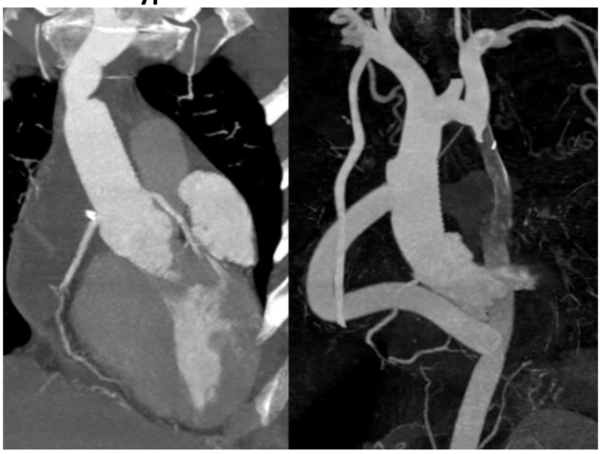


Figure 9: MPR images of another patient showing aortic root replacement with valve sparing.

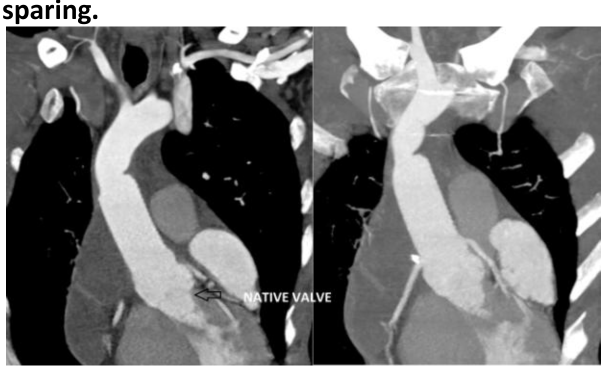


Figure 10: VRT and axial images showing Elephant trunk stage I Technique – Ascending aorta & Arch repair.

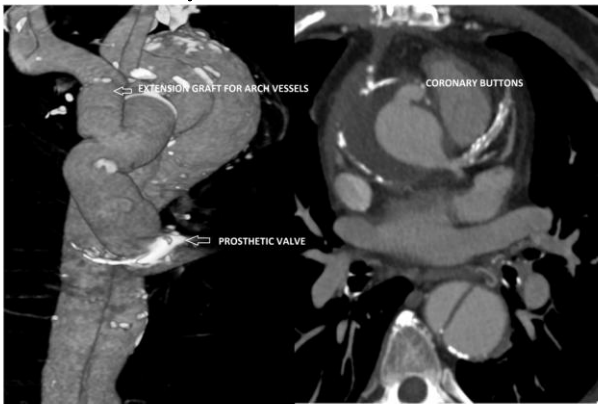


Figure 11: MPR, axial and VRT images of another patient with Elephant trunk stage I technique - Ascending aorta and proximal arch aneurysmal repair with interposition graft, surrounding thrombosed native aorta.

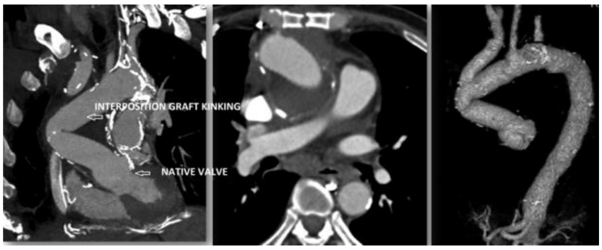


Figure 12: MPR & VRT images showing ascending aorta aneurysm repair in a patient of arterial tortuosity syndrome with ascending aortic aneurysm:open book technique graft anastomosis.

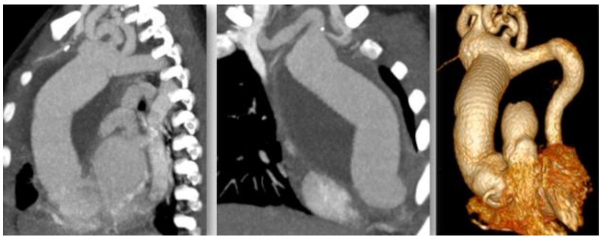
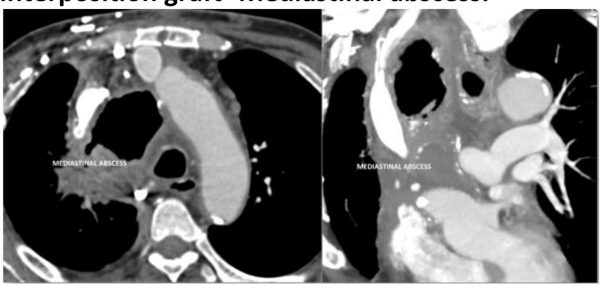


Figure 13: Axial and coronal images showing Post operative complication of aortic interposition graft- Mediastinal abscess.



Discussion: <u>Anatomy Of Ascending Aorta</u>*:* The ascending aorta extends from the aortic valve to the origin of the innominate artery, with its proximal portion referred to as the "aortic root." It normally has only two branches, the right coronary artery and the left coronary artery. These arise from the right and left aortic sinuses (of Valsalva) respectively, which are out-pouchings of the aortic wall above each cusp of the aortic valve. Immediately above the three aortic sinuses, the normal tubular configuration of the aorta is attained - at the sinotubular junction

Various Ascending Aorta Pathologies: Thoracic Aortic Aneurysm : An aneurysm is defined as a permanent dilatation of the aorta exceeding the normal measurements by more than 2 SDs at a given anatomic level. For example, an ascending aortic diameter greater than 3.91 cm (mean + 2 SDs) and a descending aorta diameter greater than 3.13 (mean + 2 SDs) have been determined as an upper threshold for normality by two independent studies. As a rule, an ascending aortic diameter equal to or greater than 4 cm (in individuals younger than 60 years old) and a descending aortic diameter larger than 3 cm is considered to indicate dilatation and a diameter equaling or exceeding 1.5 times the expected normal diameter is considered an aneurysm.

Although atherosclerosis is, overall, the most frequent cause of thoracic aneurysm, cystic median necrosis is the most common cause of an aneurysm isolated to the ascending aorta, especially when annuloaorticectasia is present. It is most frequently caused by Marfan syndrome, but in one third of the cases, it is idiopathic. In Marfan syndrome, the classic imaging features include a pear-shaped aneurysmal ascending aorta with smooth tapering to a normal aortic arch. In addition to these risk factors, a genetic predisposition to develop thoracic aortic aneurysm has been shown by Coadyet al[1].

Thoracic aortic aneurysms are divided into two main categories: true and false, according to their pathologic features. In true aneurysms, all three layers of the aortic wall (intima, media, and adventitia) are involved in aneurysm formation without disruption of any layers[2]. In false aneurysms (also referred to as pseudoaneurysms), the intima is disrupted (and often, the media as well), and blood is contained by the adventitia and periadventitial tissues. When resulting from trauma, pseudoaneurysms are usually seen in the aortic isthmus, whereas penetrating aortic ulcer occurs in the descending aorta in most cases[2].

True aortic aneurysms are usually fusiform in shape, involving the entire circumference of the aorta, and often extend over a significant length of the vessel. Pseudoaneurysms are usually saccular, with a narrow neck at the origin in the aorta. The presence of a wide neck in a saccular aneurysm suggests a mycotic origin. These aneurysms have a tendency to involve the ascending aorta, likely because of its proximity to regions affected by endocarditis.

Acute Aortic Diseases: In contrast to uncomplicated aneurysms, which are often detected in asymptomatic patients, acute aortic diseases, including aortic dissection, intramural hematoma, and penetrating aortic ulcer, are usually diagnosed in patients with acute chest pain. MSCT play a major role in detecting these complications, followed by MRI, conventional angiography and transesophageal echocardiography (TEE)[3].

Aortic dissection: Aortic dissection is the most common acute aortic disorder, with an incidence up to 0.2–0.8%, and also carries the highest mortality rate[4]. Thus, prompt diagnosis is critical. Aortic dissection is caused by an intimal tear within an abnormal, weakened vessel wall. This leads to blood entering the wall, with subsequent propagation in the media both proximally and distally, displacing the intima inward. The two well-known classification systems, De Bakey and Stanford, are based on two parameters: the origin of the intimal tear and the extent of involvement of the aorta. The Stanford system classifies aortic dissection into two types, A and B. Type A involves the ascending aorta. In contrast, type B affects only the descending aorta and generally requires only conservative medical treatment[5].

Intramural Hematoma (IMH): Intramural hematoma is defined as a bleeding of the vasa vasorum in the medial layer of the aorta[6]. The most frequent source of intramural hematoma is in the media itself, representing spontaneous hemorrhage from the vasa vasorum of the medial layer with subsequent formation of hematoma within the media causing focal, most often circumferential, wall thickening. Other potential causes include aortic trauma or a penetrating aortic ulcer that has bled into the aortic wall[7]. The importance of intramural hematoma is that it can be a precursor of aortic dissection, representing either an early stage or a variant of dissection[8].

Intramural hematoma most frequently involves the ascending or proximal descending aorta—up to 70% of cases. The clinical presentation is similar to dissection: severe chest pain radiating to the back. Because of the similarity between the two entities, intramural hematoma is classified in the same way as aortic dissection: type A when the ascending aorta is involved and type B when involvement is limited to the descending aorta.

Arterial Tortuosity Syndrome: Arterial tortuosity syndrome (ATS) is a rare hereditary, autosomal recessive connective tissue disorder characterized by dysmorphic facial features, skin and joint laxity, tortuosity, elongation of the major arteries, vascular dilatation, stenosis, formation of aneurysm, pulmonary artery stenosis, and bowel hernia and rupture. Large and medium-sized arteries are mostly affected. Cardiomegaly with ventricular hypertrophy is seen in most patients. Bony changes like scoliosis, arachnodactyly, and chest wall deformity are also well-known associations[8].

Complications :

1. Abnormal Low-Attenuation Perigraft Material[13]: CT scans occasionally show an abnormally large amount of low-attenuation material surrounding an aortic graft or increasing amounts of such material on serial scans. Such a finding causes suspicion for infection with perigraft abscess, correlation should be made with clinical indicators of infection.

2. Contrast Material Extravasation: Graft anastomotic dehiscence can be definitively diagnosed at CT when a collection of contrast material is seen outside the graft. Occasionally, however, small amounts of contrast material may pool between the graft and the surrounding native aortic wrap in patients with an inclusion root graft, is likely due to partial dehiscence at a coronary artery or proximal graft anastomosis and is probably of little or no clinical significance.

3. Perigraft Gas Collections/ Fistula formation: -may indicate infection with a gas-forming organism or a fistula with an airway or lung, the esophagus, or the skin. Fistulas may also be suspected if there is tethering of the adjacent structure.

4. Aneurysm or dissection of native aorta proximal to graft- in supracoronary graft.

5. Pseudoaneurysm at coronary artery anastomosis- less in modified bentall.

6. Coronary graft insufficiency from kinking or intimal hyperplasia.

7.Acute coronary graft thrombosis.

8.Rare complication of elephant trunk technique: Early aortic rupture at distal anastomosis. ir embolism. Recurrent laryngeal nerve injury on left side.

Conclusion: Advances in computed tomography (CT) scanners and electrocardio- graphic gating techniques have resulted in superior image quality of the ascending aorta and increased the use of CT angiography for evaluating the postoperative ascending aorta. Several abnormalities of the ascending aorta and aortic arch often require surgery, and various open techniques. Normal postoperative imaging findings, such as hyperattenuating felt pledgets, prosthetic conduits, and reanastomosis sites may mimic pathologic processes. Familiarity with these procedures and their imaging features are required to identify normal postoperative appearances and complications. Postoperative complications require further intervention include pseudoaneurysms, anastomotic stenoses, dissections, and aneurysms.

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