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Original article

The utility of computed tomographic angiography for final diagnosis of aortic dissection

Karun Sereeborwornthanasak, Somjai Wangsuphachart
Department of Radiology, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand

Background: Aortic dissection is a common cause of vascular emergency. For examination of the entire aorta, multi-slice computed tomographic (CT) scanning is now used as the modality of choice instead of aortography. However, it was questionable whehter CT angiography (CTA) can be used for management decisions regarding aortic dissection.
***Objective*:** To prove that CTA can be used as the modality of choice for final diagnosis of and management decision of aortic dissection, and also to analyze CTA appearances of the aortic dissection.
Methods: Aortic CTA images of 145 patients between Sept 1, 2003-Aug 31, 2005 at King Chulalongkorn Memorial Hospital (KCMH) were reviewed by two consensus radiologists. These patients' history of management decisions and results of treatment were also reviewed. The incidence of aortic dissection and the image appearances were also analyzed.
Results: The incidence of aortic dissection at KCMH was 31 cases in two years of wich 11 cases were classified as type A (35 %), while 20 cases into type B (65 %). No patient required another investigative modality after CTA diagnosis of aortic dissection. True/false lumens, intimal tear, peri-aortic fluid, pleural effusion, pericardial effusion, intramural hematoma and contrast leakage were imaging findings obtained in that order.
Conclusion: CTA can replace theconventional invasive aortography and can be used as the modality of choice for management decision of aortic dissection.

Keywords: Aortic dissection, computed tomographic angiography (CTA), multidetector computed tomographic scanner.

Aortic dissection is a common vasccular cause of aortic emergency, and its outcome is still frequently fatal. The incidence of aortic dissection ranges from 5-30 cases/million people/year, depending on the prevalence of risk factors in the study population [1, 2].

Current imaging modalities are helpful in management decision-making. Aortography has long been considered the procedure of choice but now it is rarely used for the initial diagnosis [2]. Multi-slice computed tomographic (CT) scanning now appears to be the modality of choice for complete examination of the entire aorta, and is often used in diagnosis of aortic dissection [1, 3, 4]. Knowledge of the morphological characteristics of dissection is very important. The most important features of dissection disclosed by CT are the presence of dissection of intima and two lumens (true and false). Never-theless, the CT features of dissection do not always appear like these patterns, and sometimes the two lumens are identifiable only by their different rates of opacification with contrast materials [3-5].

King Chulalongkorn Memorial Hospital (KCMH) installed a multidetector computed tomographic scanner (MDCT) in 2003. During the two years at KCMH, CT angiography (CTA) has frequently been requested for evaluation of aortic dissection because it is a more rapid and non-invasive procedure compared with the gold-standard invasive conventional aortography. It is still questionable whether aortic CTA can be used as the modality of choice for diagnosis of and management decision of aortic dissection at KCMH. The purpose of the current study is to examine whether or not CTA is absolutely useful for making a final diagnosis of aortic dissection or not.

***Correspondence to*:** Dr. Somjai Wangsuphachart, Department of Radiology, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand; E-mail: fmedsws@yahoo.co.th

Material and methods

From Sept 1, 2003-Aug 31, 2005, patients who were clinically suspected of aortic dissection at KCMH, for whom a CTA of aorta was requested, were reviewed via the picture archiving communication system (PACS). All patients underwent MDCT (Somatom Sensation 16 or 4, Siemens Medical Solution, Germany) according to the KCMH aortic CTA protocol. Images were interpreted by two consensus radiologists. All findings of aortic dissection, its complications and other abnormal findings of the aorta were analyzed.

Selected cases

All patients who underwent CTA of the aorta at KCMH.

All cases on which the discharge summary was recorded as aortic dissection (ICD10 code=I 71.0).

The diagnostic goals [1, 6] were: 1) Confirm diagnosis; 2) Delineate the extent of the dissection; 3) Localize the intimal tear; 4) Differentiate true and false lumens; 5) Detect thoracic complication (pericardial and pleural effusion); 6) Assess involvement of branches: coronary arteries, aortic arch branches (innominate, left common carotid and left subclavian arteries), visceral arteries (celiac, superior mesenteric, inferior mesenteric and bilateral renal arteries) and iliac arteries.

Aortic CTA protocol and technique

1) Craniocaudal scan. Thoracic: from chest apex to lower border of diaphragm; Abdomen: from dome of diaphragm to symphysis pubis; Whole aorta: from chest apex to symphysis pubis.

2) Pre-contrast, post contrast and delayed image.

3) One hundred ml of nonionic contrast medium (300mg %I/ml) venous infusion 3-3.5 ml/sec, with 50 ml of normal saline chasing.

4) Region of bolus tracking. Thoracic: proximal ascending aorta; Abdomen: distal thoracic aorta at diaphragmatic dome level; Whole aorta: proximal descending aorta.

The CT parameters

Table 1 shows aortic CTA parameters of Samatom Sensation 16 or Sensation 14 in MSCT installed at KCMH.

Results

There were 31 out of 145 aortic CTA studies diagnosed as aortic dissection (23 %), in all of which management decisions were made without conventional angiography (in 100 %, CTA was the final modality for diagnosis). In one case that CTA showed negative for aortic dissection, subsequent transesophageal echocardiography (TEE) was undertaken, and also the negative CTA diagnosis was confirmed **(Fig. 1)**.

Of the 31 cases diagnosed as aortic dissection, 11 cases were classified into type A (35 %), and 20 cases into type B (65 %), according to the Stanford classification [6].

The most frequent CTA feature of typical aortic dissection (**Fig. 2**) was true/false lumen, which was found in 27 cases (87 %) (**Fig. 3**).The following findings found, in order, were intimal tear (**Fig. 4**), periaortic fluid, pleural effusion, pericardial effusion, and leakage of contrast medium. The other four cases were atypical forms i.e. intramural hematoma (**Fig. 5**). There was no evidence of penetrating atherosclerotic ulcer.

As for branch involvement of the dissection, the highest frequency of branch involvement in the Stanford type A was left subclavian artery (36 %), while in type B it was left renal artery (20 %). The dissection could extend to bilateral common iliac arteries, more frequently on the left. There was no involvement of right coronary, left coronary or inferior mesenteric arteries.

All of these findings were well seen on the arterial phase study. In the identified intramural hematoma, however, the pre-contrast study was considered to be better than post-contrast study (**Fig. 5**). There was no significant information gained from delayed images.

Table 1. MDCTA parameters for Somatom Sensation 16 and Sensation 4..

	Sensation 16	**Sensation 4**
kV	120	120
mAs	140	100
Collimation	16x0.75 mm	4x2.5 mm
Slice width	5 mm	5 mm
Feed/rotation	18 mm	15 mm

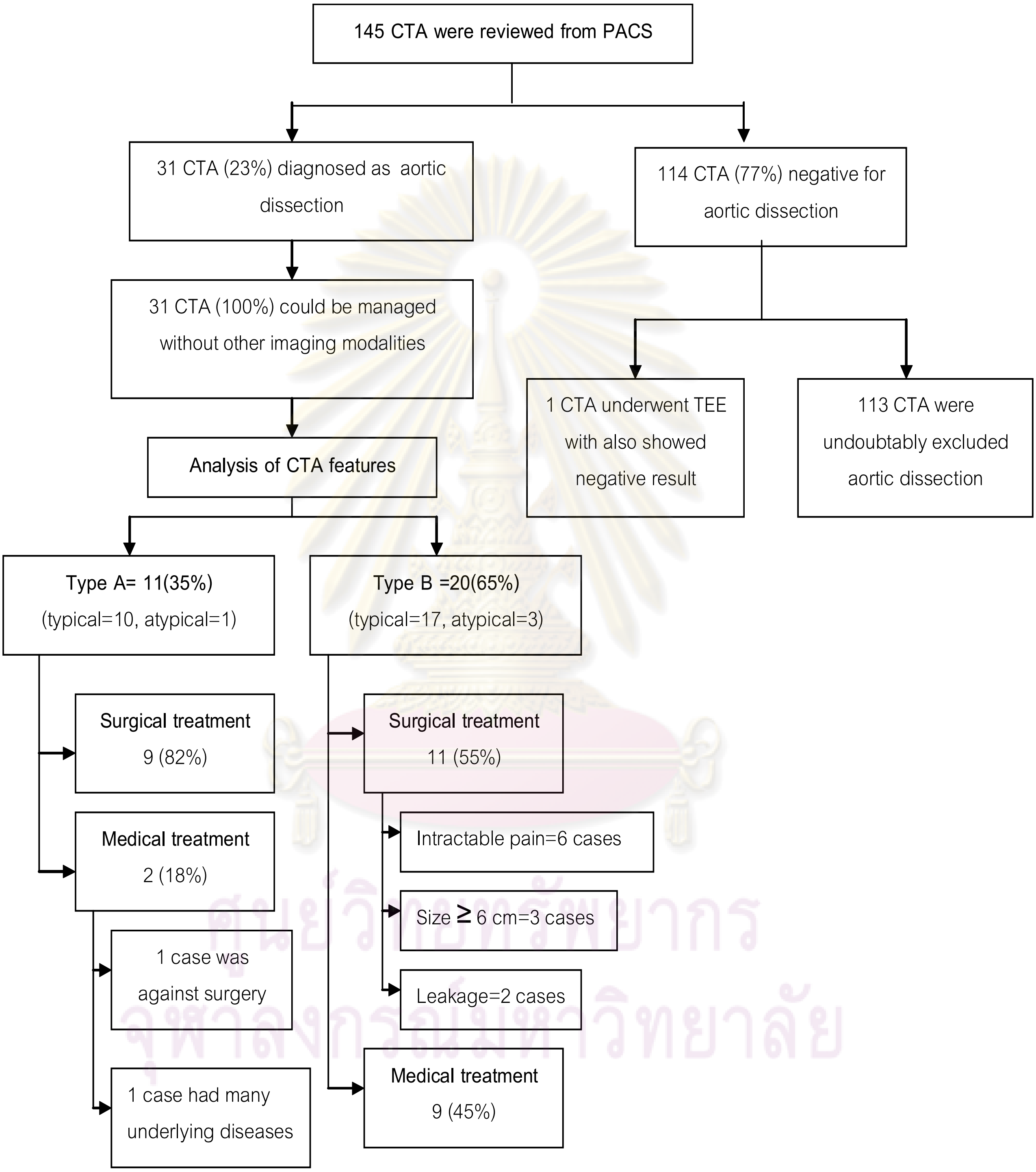
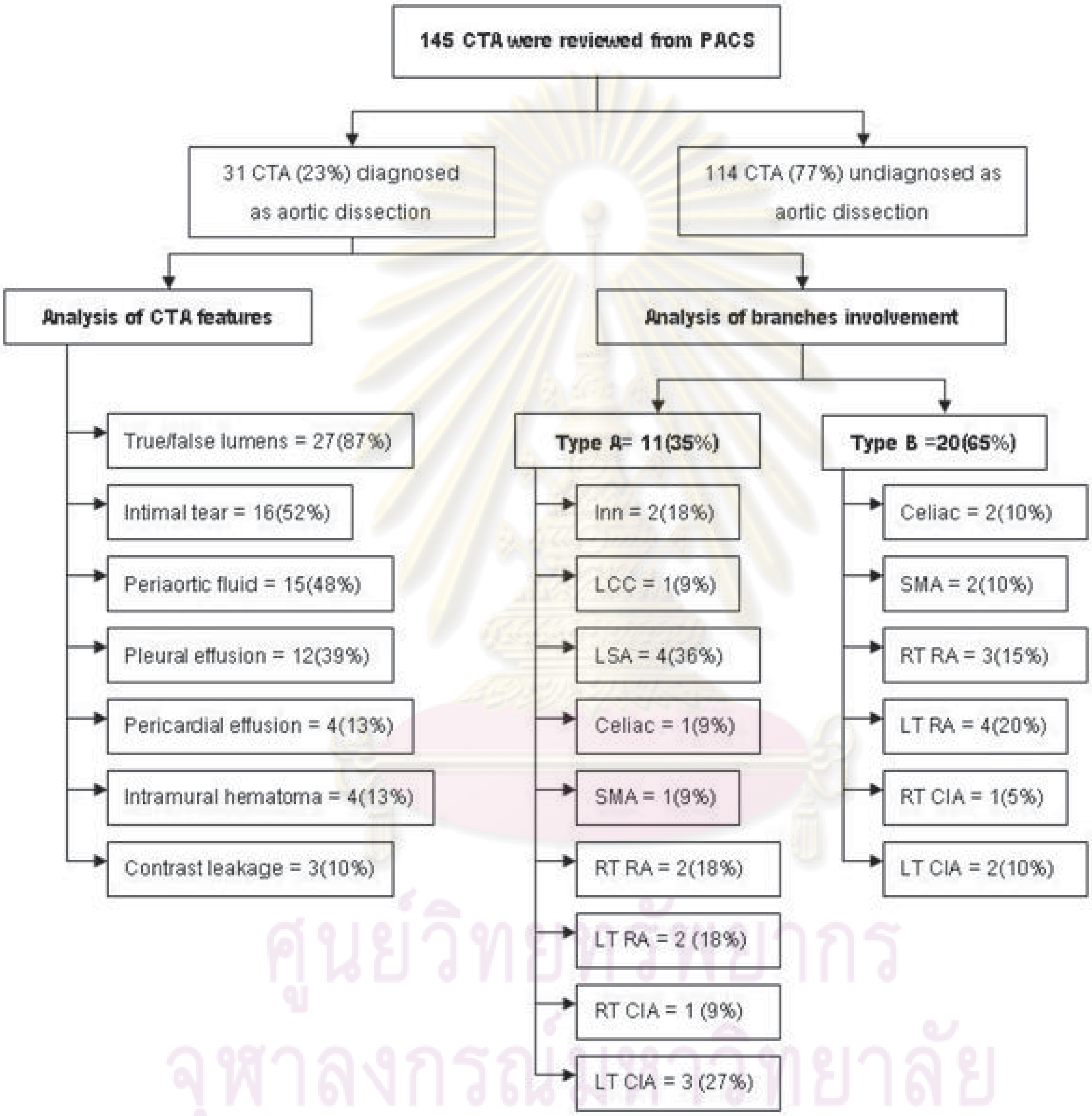


Fig. 1 Diagramatic flow of management decision.



Inn=innominate artery, LCC=left common carotid artery, LSA=left subclavian artery, SMA=superior mesenteric artery, RA=renal artery, CIA=common iliac artery

Fig. 2 Diagramatic flow of the aortic dissection appearances.

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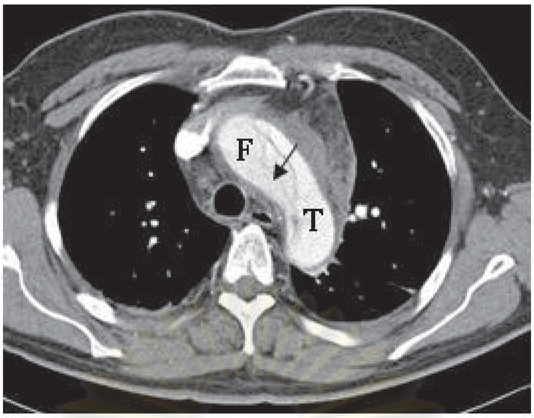

Fig. 3 Axial CTA image at aortic arch showing the intimal flap (*arrow*). Differential density of contrast is seen in better enhanced true lumen (**T**) and less enhanced false lumen (**F**). Visualization of aortic cobweb in false lumen is noted.

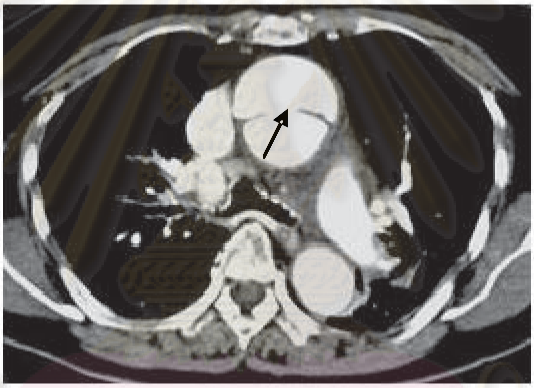

Fig. 4 CTA at level of ascending aorta shows type-A dissection with discontinuous dissection flap representing "intimal tear" (*arrow*).

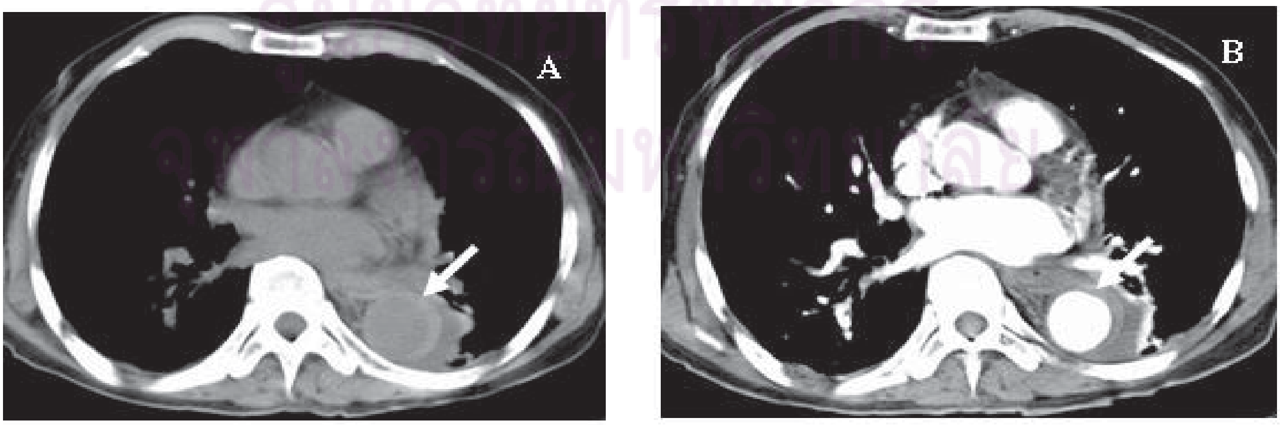

Fig. 5 Imaging of intramural hematoma (IMH). **A**: Unenhanced CT scan depicts crescent-shaped area with high attenuation (*arrow*) extending along wall of descending aorta. Periaortic fluid is visible. **B**: CTA shows no enhancement of crescent-shaped areas (*arrow*). IMH is less apparent, compared to the unenhanced CT scan in **A**.

For type A dissection, 9 patients (82 %) underwent surgery while the other two patients (18 %) were treated medically. For type B dissection, 9 patients (45 %) were treated medically while the other 11 patients (55 %) underwent surgery.

Discussion

The most important steps for evaluation of suspected aortic dissection are: i) to confirm dissection and ii) to classify the dissection type (A or B). This information is most important for deciding whether surgical or conservative treatment is indicated. Additional information obtained by CTA is also useful for treatment planning such as extension of the dissection, intimal tear localization, true and false luminal differentiation, pericardial effusion, pleural effusion and branch involvement. MDCT allows us to diagnosis aortic dissection with a sensitivity and specificity of nearly 100 % [3]. In our study, there was no further modality required after CTA diagnosis of aortic dissection. This shows that CTA can replace invasive conventional aortography and can be used as the complete modality of choice for management decision of aortic dissection. A negative result was confirmed in one case by subsequent transthoracic echocardiography (TEE). This event probably supports the high negative predictive value of aortic CTA in diagnosing aortic dissection.

Christoph et al. [8] reported an incidence of 62 cases of aortic dissection over 5 years in two medical centers diagnosed with multiple noninvasive imaging modalities (TEE, contrast-enhanced CT and magnetic resonance imaging (MRI)). These patients were classified into the Stanford type A and type B as 52 % and 48 %, respectively.

Our study showed that a comparable incidence of aortic dissection was 31 cases during two years (Sept 1, 2003-Aug 31, 2005), in which 11 cases of type A (35 %) and 20 cases of type B (65 %).

The CTA provides high accuracy for identifying intimal tear and differentiation between true and false lumens, which is particularly important for planning endovascular treatment. In the current study, the most frequent findings were differentiation of true and false lumens (87 %). This is also one of the most important features of dissection on CTA. Differentiation between true and false lumens was not identified in 4 cases (13 %), which were classified as intramural hematoma. Christoph et al. [9] reported a vicinity incidence of intramural hematoma of 12.8 % diagnosed by multiple noninvasive imaging modalities (TEE, contrast-enhanced CT and MRI).

Another most important feature of aortic dissection is intimal tear. This feature was seen in 16 cases (52 %) of the current study. Kapoor et al. [10] reported a lower incidence of identifiable intimal tear of only 6 % on contrast enhanced MDCT.

Major branch involvement is an important complication of aortic dissection since it may develop ischemia as a result of branch obstruction [8]. The most common branch involvement of type A dissection is the left subclavian artery. The involvement is probably explained by turbulent flow at its origin where the arch and descending aorta form the acute bending. Yoshida et al. [11] reported a slightly higher frequency of aortic arch branch involvement (Inn=30 %, LCC=18 %, LSC=21 %). Our study shows no abnormal organ perfusion detected on CTA.

Surgical intervention is usually indicated in all patients with type A dissection [2, 12]. In the current study, 2 patients (18 %) diagnosed as type A aortic dissection were treated by medical treatment. The first patient had ischemic heart disease, rheumatic heart disease, acute arterial occlusion in both legs with post embolectomy and continuous heparinized infusion contraindicating surgery. The second patient's relatives were against surgery. Uncomplicated type B dissection without surgical indication was treated medically [8]. All surgical patients of type B dissection had individual surgical indications. Six cases had intractable pain despite aggressive medical therapy, 3 cases had interval progressive aortic dilatation reaching 6 cm and the other two cases were suspected of leakage of contrast medium [12].

All the noninvasive imaging modalities including CTA, TEE and MRI allowed high diagnostic accuracy of aortic dissection. But the choice of diagnostic modality also depended on the availability and expertise at the given institution. Aortic MDCTA is an imaging technique that is considered to be of around-the-clock availability, a rapid procedure and less operator-dependent. MDCTA also allows the information of the complication of the aortic dissection such as pericardial effusion, pleural effusion and poor organ perfusion which are also important in management decision. In clinical practice, aortic MDCTA should be the initially preferred diagnostic strategy for the assessment of patients with suspected acute aortic syndromes. Our study shows that MDCTA can be used as the modality of choice for diagnosis and management decision of aortic dissection, entirely replacing conventional aortography.

Conclusion

Aortic MDCTA can entirely replace conventional aortography for assessment of patients suspected with aortic dissection. The most characteristic feature with highest prevalent is the differentiation of true and false lumens with flap which is mostly recognized on the arterial phase.

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