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## CH3 – CHEST

## Imaging in Aortic Dissection

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Aortic dissection (AD) is a catastrophic aortic disease. Imaging techniques play an invaluable role in the diagnostic evaluation and management of patients with AD. Major signs of AD with different imaging modalities are described in this article with a pertinent discussion on guidelines for the optimized approach of imaging study.

## 1. Incidence of AD

AD is a worldwide and relatively common aortic disease. In western countries it is estimated to be 5-10 cases per million population per annum for acute AD,<sup>1</sup> 0.1% - 1% in collected series of autopsy cases<sup>2</sup> and at least 2000 new cases per year occur in the United States.

AD has been considered an uncommon aortic disease in China in the past decades. Its inci-

dence, however, has been increasing in recent years. In 120 cases with AD studied at FuWai Hospital during a period of 1961 – June 1990, 46 and 74 cases being observed in a period of 1961 – 1984 and 1985 – June 1990 respectively.

## 2. Classification and causative factors of AD

2.1 AD has been classified into 3 major types by DeBakey et al,<sup>4</sup> based on the location of intimal tear and extent of dissecting hematoma. Type I, intimal tear located at ascending aorta and the dissection extended from ascending aorta to descending aorta, Type II only ascending aorta involved, and Type III only descending aorta involved, and both Type I and III abdominal aorta may be involved. This classification system has been simplified into Type A and B by Daily et al,<sup>5</sup> i.e. Type I and II as Type A which has poor prognosis and for acute cases usually surgical management is needed; Type III as Type B which has much better prognosis.

It is well-known hypertension and Marfan's syndrome are the most important causative factors, and the types of AD and causative factors in 120 cases of FuWai Hospital series are shown on Table 1.

Table 1  
Types of AD and causative factors (120 cases)

DeBakey's	N of cases (%)	Hypertension	Marfan's
		N of cases (%)	
Type I	25 (20.8)	11 (44)	8 (32)
Type II	12 (10)	3 (11)	7 (58.3)
Type III	80 (66.6)	42 (52.8)	14 (17.5)
Abd. Aorta	3 ( 2.5)	1	1

\* Hypertension + Marfan's 3

\*\*Miscellaneous factors, aortic stenosis, pregnancy, trauma etc 8(6.67), unknown 22(10.3).

As shown on the above Table, Type III is the commonest AD in China accounting for 2/3 of the total 120 cases.

2.2 According to the clinical course, in 120 cases of the present series acute, subacute and chronic AD was observed in 6 (5.0%), 20 (16.7%) and 94 (78.3%) respectively. Chronic AD was much commoner than that of acute and subacute AD in China. This figure is different from that reported abroad, i.e. acute and subacute AD making up 90% of the cases. In addition, Type I is the commonest type of AD accounting for 2/3 of the reported cases abroad.

### 3. Imaging Study

3.1 *Radiography.* The major signs for AD with different types in 110 cases of our series are shown in Table 2.

According to the original reports the accuracy of radiographic interpretation of AD in cases of our series was 67.5%. In addition, with reference to the extent of aortic dilation with or without cardiac/left ventricular enlargement and pleural effusion etc on chest films type of AD and extent of dissection may be roughly assessed. In our experience not a few patients with chronic AD the diagnosis was suggested first on chest film findings.

In general radiography is a useful screening procedure for AD as well as for follow-up examination.

3.2 Two-dimensional echocardiography (2DE) and Doppler technique may clearly demonstrate the major morphologic and hemodynamic changes of AD, such as 1. intimal flap, 2. double aortic lumen and differentiation of true and false lumen, 3. thrombi in false lumen, 4. intimal tear et. M-mode technique is helpful in showing the luminal dilation of the aorta and the oscillating of intimal flap. The transesophageal echocardiography (TEE), though invasive or less-invasive, has increased the detection rate of AD involving descending aorta.

Tottle et al<sup>6</sup> in a study of 23 patients with or suspected having acute AD, compared the sensitivity and specificity of combined 2DE+Doppler, CT and angiography, and the results made as follows: sensitivity and specificity of 2DE+Doppler was 77-80% and 93-96%; CT 88-100% and 92-100%, and angiography 88-98% and 94-100% respectively Erbel et al<sup>7</sup> reported a sensitivity and specificity of combined standard 2DE+TEE of 99% and 98% respectively. Echocardiography is particularly suited for the emergency study, and also useful in dem-

Table 2  
Major Radiographic Signs for AD with Different Types\*

Radiographic Signs	DeBakey's		
	Type I	II	III
Diffuse dilation of Ascend A, Arch, Descend A	19	5	17
D.D. of distal arch & Descend A	0	0	33
D.D. of descending A with cystic protrusion	7	2	3
Massive dilation of ascending A	7	2	3
Calcification of distal arch/Descend A	1	0	5

DD – diffuse dilatation

onstrating complications of AD such as aortic regurgitation, pericardial as well as pleural effusion et. The method, however, has only limited value in the study and assessment of aortic branch vessels and longitudinal extent of dissection.

3.3 CT an important non-invasive technique in the study of AD. Plain CT scanning is sensitive in detecting aortic wall calcification and its inner displacement >5-7 mm is a significant sign for AD. However, its positive rate is quite low.

The major signs of AD on contrast enhanced CT are double aortic lumen and intimal flap, the latter manifested as a linear negative shadow in between the two lumens. Zhou et al<sup>8</sup> reported a positive rate of these two signs as 100% and 82.3% respectively in a study of 17 patients with AD. Dynamic CT scanning, based on contrast filling, density difference and delayed washing-out of contrast medium etc may further aid differentiation of true and false lumen. In 7 (52.9%) out of 17 patients of the above stated series intraluminal thrombus was detected.

Ultrafast CT with scanning time of milisecond order, the volume mode provides high-resolu-

tion images minimizing motion artifacts, and in flow mode sequences the contrast filling, peaking and washing-out of the scanned segments can be observed.

The limitation of CT are poorer visualization of aortic branch vessels, intimal tear and fail to demonstrate aortic regurgitation and longitudinal extent of dissection without reconstruction.

3.4 *Magnetic resonance imaging (MRI)*. As a non-invasive modality MRI has shown to be very effective in the diagnostic evaluation of AD. Spin echo (SE) sequence provides sectional images of excellent morphologic detail and gradient echo (GRE) depicts the flow dynamics of AD. MRI is superior to 2DE and CT in direct multi-positional imaging, no need of contrast enhancement and better contrast resolution etc.

Kersting-sommerhoff et al<sup>10</sup> reported a sensitivity and specificity of MRI of 95% and 90% respectively in the evaluation of AD. In 33 cases of our series<sup>11</sup> the rate of diagnostic accuracy was around 95%, and the major MR signs for AD with different types are shown on Table 3.

**Table 3**  
**Major MR Signs for AD with Different Types\***

Major Signs	DeBakey's			
	I (5)	II (2)	III (25)	Abd. A (1)
Intimal entry	1	2	8	
Intimal flag	5	2	24	1
Double lumen				
Th. A	4	2	23	
Abd. A	3	–	21	1
Mural thrombus in false lumen	2	1	11	
Branch vessel involvement**	3	1	1	

\* N. 33 cases

\*\* Brachiocephalic art. 3 renal art. 2

As shown on Table 3, intimal entry, intimal flap, aortic double lumen and mural thrombus in false lumen was identified in 11 cases (33.3%), 32(97%), 30(90.9%) and 14(42.2%) respectively. MR signs were correlated with surgical findings in 12 operated patients, and the results were as follows, 5/12 patients with MR identified intimal entry were operated on, MR signs confirmed to surgery in 4, double lumen and intimal flap in 12 operated patients, MR signs conformed to surgery in 11, in 5 operated patients mural thrombus revealed in false lumen, MR signs positive in 4 suspicious in one, and brachiocephalic artery involvement was found in 2 operated patients MR signs positive in one.

The application of cine-MRI with GRE sequence has improved the detection rate of intimal tear as well as the differentiation between thrombus and slow flow in false lumen, in visualization of branch vessel involvement cine-MRI is also superior to that of CT and echocardiography. It is also useful in detection and quantitation of aortic regurgitation.

3.5 Conventional angiography and DSA remain to be the “gold standard” in the diagnostic evaluation of AD, the accuracy rate up to 95-99%<sup>12</sup>. Conventional angiography currently has been replaced by DSA in most cases. The major DSA signs for AD, based on 71 patients (85 examinations) studied at FuWai Hospital, are shown in Table 4.

Generally the diagnostic accuracy of DSA is about 95%. In identifying intimal entry IA DSA was superior to IV method, and the multiple entries detected in 13 of the 14 patients were by IA DSA. Re-entry was revealed in 30% of patients of our series. IV DSA is suitable in demonstrating the overall situation of double lumen and intimal flap, and IA DSA may provide clearer images of anatomic detail. In delineation of branch vessels and their involvement as well as qualification of aortic regurgitation angiography is superior to that of other imaging modalities and IA DSA is superior to IV DSA.

However, in detecting mural thrombi of false lumen angiography is only of limited value depending on the indirect sign of wall thickening.

**Table 4**  
**Major DSA Signs for AD**

	DSA	
	IV (46 exams)	IA (39 exams)
Intimal entry	21 (46.0%)	33 ( 8.5%)
re-entry	1	12 (30.7%)
Intimal flap	18 (39.1%)	8 (21.0%)
Double aortic lumen	39 (84.7%)	34 (87.1%)
Mural thrombus in false lumen	6 (13.0%)	5 (12.8%)
Pseud-aneurysms	3	2
Aortic regurgitation	–	19 (48.7%)

\* Multiple entries found in 13, two in 11, three or more in 2

\*\* 89 branch vessels involved, iliac 25, renal 25, Rt innominate 14

#### 4. Discussion

4.1 Adequately managed medical and surgical treatment has resulted in excellent to good therapeutic effect in patients with AD. The 30 days and overall 5 years, 10 years survival rate were reported<sup>13</sup> to be 89%-90%, 57%-66% and 31%-40% respectively. Imaging evaluation of AD, therefore, must satisfy the need of different treatment options. For example patients suspected to have acute AD, the exact diagnosis of AD should be promptly established or excluded. In view point of therapeutic management, type, extent of dissection, intimal tear, status of aortic valve and branch vessel involvement etc should be accurately assessed.

4.2 Optimized approach of imaging techniques based on our experience as well as the documented data, it can be summarized as follows: 1) patients suspected having acute and sub-acute AD, particularly Type I and II, IA DSA or angiography may be the first modality in order to gain time for adequate surgical management, Echocardiography being able to be a bedside modality is one of the advantages; 2) patients with chronic AD, particularly Type II, MRI, CT, echocardiography (TEE included) and IV DSA are methods of choice, and also be used for follow-up study; 3) if there is evidence of medial treatment failure, progressive deletion of the aorta or extension of AD and branch vessel involvement etc. further aimed study of DSA, MRI or combined 2DE+TEE are needed.

Radiography is still routinely used as a screening and preliminary procedure.

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