CRITICAL APPRAISAL

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ORIGINAL PAPER

Distinguishing acute from chronic aortic dissections using CT imaging features

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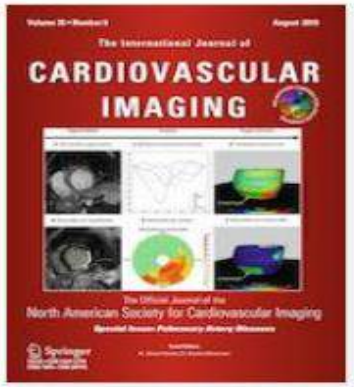

Impact Factor	Available
1.860	1985 - 2019
Volumes	Issues
35	236
Articles	Open Access
3,944	356 Articles

- Title is short and sweet, yet comprehensive.
- Published in relevant journal with IF 1.86, rank 104/328 on SJR.
- Recent research - a collaboration of Cardiac Surgery and Radiology.

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North American Society for Cardiovascular Imaging

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North American Society for Cardiovascular Imaging

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STUDY OBJECTIVE

1. To assess and compare a variety of CT imaging features in AAD and CAD.
2. To determine if some combination of imaging features was reliably predictive of the acute versus chronic nature of the disease in individual patients.

- Clearly stated
- Statistical analysis able to fulfil the objectives

METHODOLOGY

Problems :

1. Chest CT
2. CT Protocol
3. Non/ECG-gating

- CECT Thorax or CTA Aorta?
- Did not elaborate on CT Protocol. Not standardized.
- Non-ECG-gated scans more than ECG-gated scans.

STATISTICAL ANALYSIS

- Categorical data : χ^2 test or Fischer's exact test.
- Continuous data : Two-sample *t* test or Wilcoxon rank sums test.
- Multiple logistic regression : Firth's penalized maximum likelihood estimation.

- χ^2 is not suitable for small sample (<10), hence Fischer's better for smaller sample.
- Quantitative data – Two-sample t-test (independent variables)
- Qualitative data – Wilcoxon rank test
- Multiple logistic regression for sensitivity, odds ratio

RESULTS

- Too many imaging features were tested on.
- 5 imaging features with $P < 0.05$
- Pictures were provided for easier understanding.

Fig. 2 61 year-old male with an approximately 11 year-old chronic type B aortic dissection. CT scan at the level of the proximal descending thoracic aorta shows a straight flap (arrowhead), FL thrombus (star), and FL outer wall calcification (arrows)

Fig. 3 57 year-old male with a chronic, 105 day-old type B aortic dissection. CT scan at level of aortic arch shows peri-aortic soft tissue stranding (arrows)

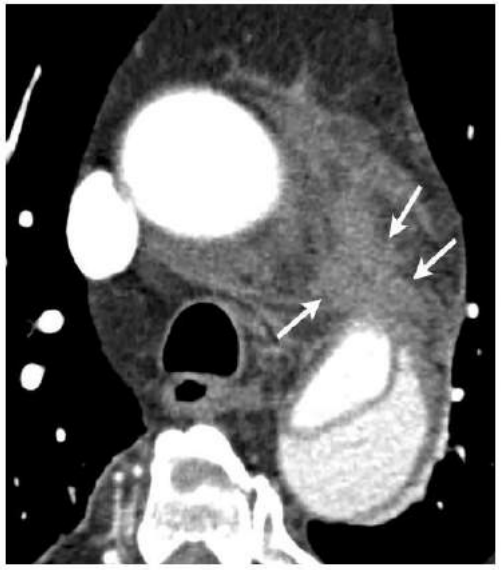


Fig. 4 68 year-old male with an acute type B aortic dissection. CT scan at the level of the aortic arch exhibits confluent soft tissue opacity (arrows)

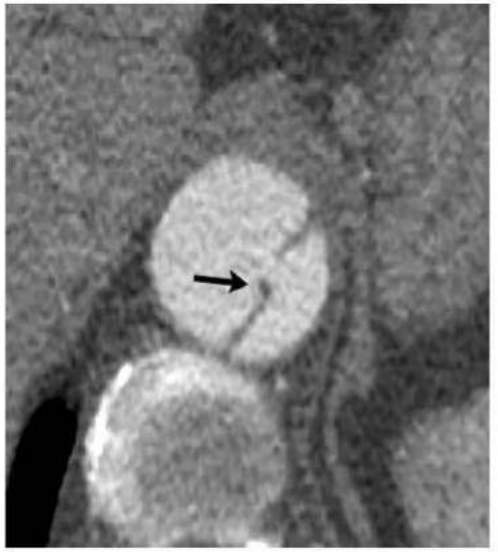
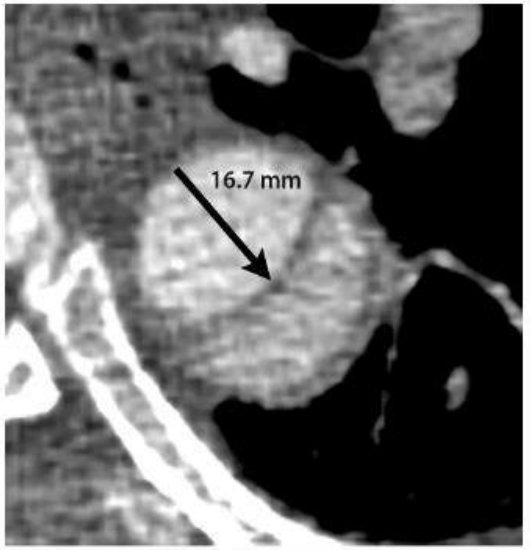


Fig. 5 57 year-old male with a chronic, 100 day-old type B aortic dissection. CT scan near the level of the diaphragm shows a dissection flap tear edge (arrow) that is thickened and curled into the FL



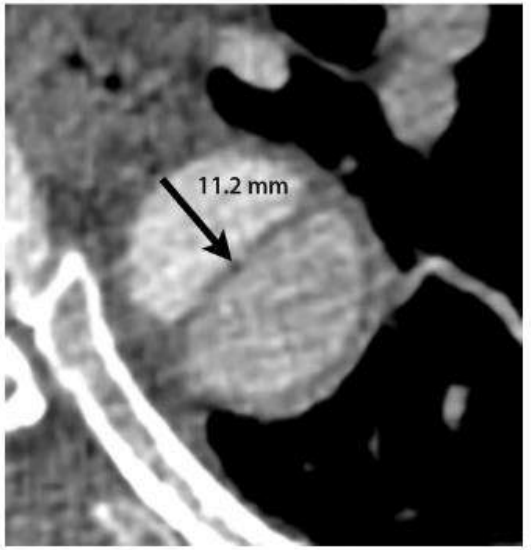


Fig. 6 A 45 year-old male with an acute type A dissection. Retrospectively-gated CT scan at the level of the proximal descending aorta demonstrates flap movement (arrows) of 5.5 mm in amplitude during different phases of the cardiac cycle

Table 1 Imaging features in acute and chronic aortic dissections

Variable	Acute (N = 60 patients[a])	Chronic (N = 60 patients[a])	P-value*
Flap thickness (mm)	2.90 ± 0.87	4.01 ± 1.15	<0.0001**[S]
FL maximum diameter (mm)	26.05 ± 9.89	32.07 ± 10.2	0.0005**[S]
FL/TL area ratio			
Mid ascending aorta	3.57 ± 3.93 (N = 26[b])	2.05 ± 1.31 (N = 5)	0.28**
Distal LSA	2.09 ± 1.25 (N = 55)	3.45 ± 2.44 (N = 45)	0.01**[S]
At celiac trunk	3.21 ± 3.78 (N = 51)	3.48 ± 4.87 (N = 50)	0.051**
Halfway between LSA and celiac trunk	2.61 ± 1.88 (N = 56)	3.93 ± 2.12 (N = 50)	0.0003**[S]
Pre-contrast scan available			0.09
Yes	18 (30%)	27 (45%)	
If yes, high attenuation in FL	3 (16.7%)	0	0.06**
No	42 (70%)	33 (55%)	
Pericardial effusion			0.51
Yes	6 (10%)	4 (6.7%)	
No	54 (90%)	56 (93.3%)	
Pleural effusion			0.75
Yes	5 (8.3%)	6 (10%)	
No	55 (91.7%)	54 (90%)	
FL-side flap calcification			0.36**
Yes	1 (1.7%)	4 (6.7%)	
No	59 (98.3%)	56 (93.3%)	
FL outer wall calcification			<0.0001**[S]
Yes	0	17 (28.3%)	
No	60 (100%)	43 (71.7%)	
FL thrombus			<0.0001[S]
Yes	6 (10%)	41 (68.3%)	
Indeterminate	21 (35%)	1 (1.7%)	
No	33 (55%)	18 (30%)	
Fat infiltration			0.0046**[S]
Soft tissue stranding	13 (21.7%)	5 (8.3%)	
Confluent soft tissue opacity	5 (8.3%)	0	
No	42 (70%)	55 (91.7%)	
Visible tear edges			<0.0001[S]
Yes	29 (48.3%)	53 (88.3%)	
If yes, tear edges curled into FL	6 (20.7%)	24 (45.3%)	0.03[S]
No	31 (51.7%)	7 (11.7%)	
Flap shape			<0.0001*[S]
Straight	4 (6.7%)	49 (81.7%)	
Curved	56 (93.3%)	11 (18.3%)	
Flap motion (mm)	6.62 ± 4.94 (n = 53)	1.69 ± 1.84 (n = 52)	<0.0001**[S]

Effect	Odds ratio (95%CI)	P-value
FL maximum diameter	1.140 (1.032, 1.301)	0.0140
Visible tear edges	6.847 (1.345, 55.602)	0.0312
Straight flap shape	22.501 (4.589, 200.968)	0.0004
Flap motion	0.774 (0.602, 0.936)	0.0162
FL thrombus: present versus indeterminate/absent	7.967 (1.479, 58.544)	0.0199

DISCUSSION

- Algorithm to determine chronicity of dissection
  - Did not clearly mention how was this formulated.
  - Need to figure out by the reader.
- Basically formulated using odds ratio
- In order to get P < 0 (=acute dissection), tear edge, straight curve, FL thrombus must be absent. Thus, a smaller FL maximal diameter with larger flap motion are required to get P < 0.
- P > 3 = definitely chronic dissection.

$$P = \{\log(1.140) \times D\} + \{\log(6.847) \times V\} + \{\log(22.501) \times S\} + \{\log(0.774) \times M\} + \{\log(7.967) \times T\}$$

where P > 0 corresponds to chronic and P < 0 to acute

- Confusing
- Did not explain why P > 0 corresponds to chronic dissection
- New algorithm, not cited by any other article yet.

CONCLUSION

- Acute and chronic aortic dissections showed significantly different CT imaging features.
- Acute dissections:
  - periaortic confluent soft tissue opacity.
  - curved dissection flap.
  - highly mobile dissection flap.
- Chronic dissections:
  - thick dissection flap.
  - FL outer wall calcification.
  - FL thrombus.
  - dilated FL.
  - visible tear edges curling into the FL.

- Clear summarize the salient points of the study.

AORTIC DISSECTION

WHAT WE ALREADY KNEW

- Acute aortic syndrome – ACUTE EMERGENCY
- Starts in fusiform aneurysms (28%)
- Does not occur in aneurysms <5cm in diameter
- Hypertension (60-90%) is the main predisposing factor, followed by atherosclerosis of aorta (42%), Marfan syndrome (16%), pregnancy (50%), bicuspid aorta and other congenital cardiovascular abnormalities.
- Stanford and DeBakey classifications
- Acute : symptoms < 14 days
- Chronic : symptoms >14 days
- True lumen : smaller, oval, in continuity with undissected portion of aorta, higher contrast concentration, ribbon-like
- False lumen : "cobweb" sign – residual ribbon of contrast media, "beak" sign, rewinding around true lumen, may be thrombosed
- Mural calcification of FL in chronic dissection
- Mercedes-Benz sign = 2 false channels secondary to dissection of one channel => multibarreled dissection = poorer survival!

Radiology Review Manual, 8th Edition - Wolfgang F. Dahnert

- NECT : high attenuation within aortic wall (slow flow/thrombosis/intramural hematoma), intimal flap
- CECT :
  - False negative : inadequate contrast opacification, thrombosed lumen misinterpreted as aortic aneurysm with mural thrombus
  - False positive : perivenous streaks caused by beam hardening + motion artifacts, cardiac/aortic motion artifacts, opacified normal sinus of Valsalva, normal pericardial recess mistaken for thrombus, mural thrombus in fusiform aortic aneurysm, periaortic fibrosis, anemia with apparent high attenuation of aortic wall.
- Surgery is indicated in dissections involving the ascending aorta, because of the high risk of life-threatening complications.
- Medical management or endovascular stent/graft implantation is reserved for dissections without ascending aorta involvement.

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AORTIC DISSECTION

WHAT WE NEED TO KNOW

- Chronic aortic dissection has not been thoroughly explained.
- About 1/3 of patients fall into this category.
- Increasing burden due to progressive ageing of the population and the increased survival of patients with conditions such as hypertension and atherosclerosis.
- Unfortunately, despite advancements in diagnostic and therapeutic modalities, morbidity and mortality are still high.
- Symptoms can be vague, nonspecific, and may even be absent – related to mass effect :-
  - ✓ Hoarseness of voice
  - ✓ Non-productive cough
  - ✓ Hemoptysis
  - ✓ Dysphagia
  - ✓ Symptoms of aortic insufficiency
- Important complication :
  - Higher risk of rupture
  - Gradual impairment of distal perfusion which can lead to ischemic syndrome.

AORTIC DISSECTION

WHAT WE NEED TO KNOW

Chronic dissection treatment and prognosis

- Stanford A : Open surgery
  - Higher risk of complications with surgical intervention.
  - However operative mortality rate is <10%, serious complication is rare with ascending aortic dissection (due to no major arterial branches).
- Stanford B : Medical management vs endovascular stent grafting
  - Medical vs surgery mortality risk is 10% vs 30%.
  - Beta-blockers/CCB & statins.
  - Endovascular stent-grafts : enlarges true lumen.
  - Prophylactic stent-grafting does not appear to be justified in asymptomatic medically controlled patients with chronic type B aortic dissection.

AORTIC DISSECTION

WHAT WE NEED TO KNOW

GOAL OF MANAGEMENT

- To detect aortic wall weakness to completely restore blood flow in true aortic lumen and prevent rupture
- BP < 130/80mmHg

HOW TO FOLLOW UP?

- Regular assessment of the aorta - 1, 3, 6, 9 and 12 months after the acute event, and every 6-12 months thereafter depending on aortic size and stability of the lesion3
- 6 monthly physical examination, chest radiograph, CTA Aorta.

Asymptomatic aneurysm – surgery when :

1. Diameter > 5.5cm
2. Propagation of dissection resulting in aortic diameter > 6.0cm
3. Aneurysm growth > 5.0mm annually
4. Enlarging hematoma compromising major aortic branches
5. Bleed into pleural cavity
6. Saccular aneurysm

USEFUL IMAGING FEATURES

Acute Aortic Dissection	Chronic Aortic Dissection
Periaortic fat stranding	*FL outer wall calcification*
Confluent soft tissue opacity	FL thrombus
Very mobile intimal flap (6.62 ± 4.94mm)	Less mobile intimal flap (1.69 ± 1.84mm)
Curved flap	Straight flap
Hyperdense (60-70HU) FL on plain scan	Tear edge (curls into FL)
Thin flap (2.9 ± 0.87mm)	Thick flap (4.01 ± 1.15mm)
Smaller FL diameter (26.05 ± 9.89mm)	Larger FL diameter (32.07 ± 10.2mm)
FL/TL area ratio L subclavian a. level (LSA) – 2.09 ± 1.25 Midway between LSA and celiac trunk – 2.61 ± 1.88	FL/TL area ratio LSA – 3.45 ± 2.44 Midway between LSA and celiac trunk – 3.93 ± 2.12

LEARNING POINTS

What's good?

- New knowledge to determine the age/chronicity of aortic dissection.
- Aid in treatment option : surgical intervention vs medical treatment.
- ECG gated study may eliminate motion artifacts.

What needs improvement?

- More studies to prove the accuracy of the equation.
- A standard CT protocol for better images : CTA suffices? Needs delayed scan? If delayed, how long?

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2. Beebeejaun, M. Y., Malec, A., & Gupta, R. (2013). Conservative Management of Chronic Aortic Dissection with Underlying Aortic Aneurysm. Heart International, 8(1). https://doi.org/10.4081/hi.2013.e4
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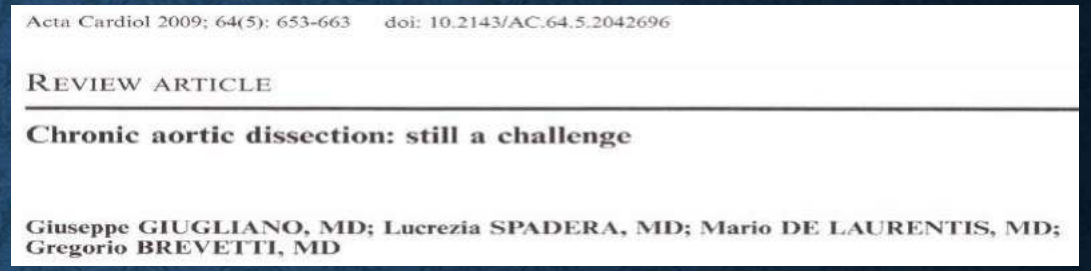
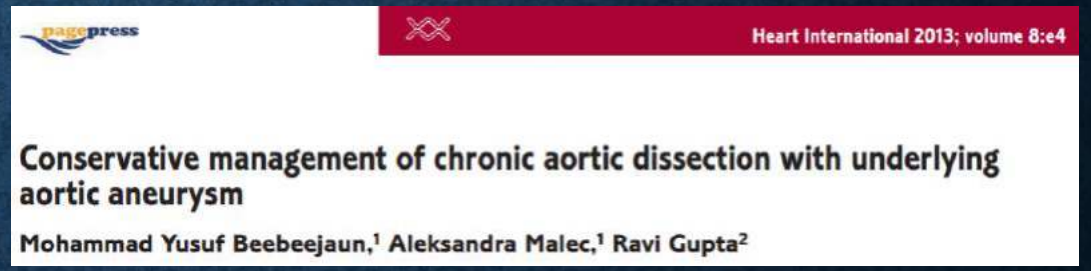

Acta Cardiol 2009; 64(5): 653-663 doi: 10.2143/AC.64.5.2042696

REVIEW ARTICLE

Chronic aortic dissection: still a challenge

Giuseppe GIUGLIANO, MD; Lucrezia SPADERA, MD; Mario DE LAURENTIS, MD; Gregorio BREVETTI, MD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Heart International 2013; volume 8:e4

Conservative management of chronic aortic dissection with underlying aortic aneurysm

Mohammad Yusuf Beebeejaun,[1] Aleksandra Malec,[1] Ravi Gupta[2]