Prediction of the location at risk for intimal dissection

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Key question

Is there a spatial correlation between focal aortic 3D growth, transmural wall stress and the location of intimal tearing?
Background

• **Dissection** often occurs in a non-aneurysmal aorta, making identification of patients at risk of dissection challenging.\(^1\)

• Rather than static diameter measurement, **growth of the aorta may better predict dissection.**\(^2,3\)

• **Aortic growth** can be subtle and should be perceived in **multiple directions;** transversal (classic fusiform or saccular aneurysm) or longitudinal (elongation).\(^4\)

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Which patients?

• Dynamic information is useful in all patients.
  • Blood pressure at the time of scanning
  • *Routine* ECG gated scans

• Prediction of dissection risk factors using dynamic information is important and applicable in *connective tissue disease* patients.
Routine CTA = ECG-gated CTA!

The **upsides:**
- Accurate imaging.
- Information on cardiac cycle.
- Software already available on every CT scanner.
- No extra costs.
- No extra radiation, especially not when prospectively gated.
- Only takes one minute to attach the ECG-leads.

There are **no downsides**! It is already available, all centers should use it.
Routine CTA = ECG-gated CTA!
New surveillance method

Vascular deformation mapping (VDM) is a technique for mapping 3D aortic growth in a multi-directional manner from *routine* CT angiography (CTA).

Growth assessment (Vascular Deformation Mapping)\(^5\)

- Baseline CT
- Growth mapped on baseline CT segmentation surface
- Diastolic
- Follow-up CT
- DICOM overlay for registration
- 3-Dimensional growth

A. 3D Growth (J/yr) and Transmural wall stress (MPa)

- Max growth (J/yr) at Δ: 0.29 (CT1 → CT2)
- Max stress (MPa) at σ: 0.35 (CT1 diastole → systole)

B. CT1, CT2, CT3

- CT1: 39.6
- CT2: 43.7
- CT3: Dissection

1.8 mm/year increase

Time (years):
0 1 2 3

B. 3D Growth (J/yr) and Transmural wall stress (MPa)

- Max growth (J/yr) at Δ: 0.08 (CT1 → CT2)
- Max stress (MPa) at σ: 0.16 (CT1 diastole → systole)

B. CT1, CT2, CT3

- CT1: 32.8
- CT2: 35.8
- CT3: Dissection

1.0 mm/year increase

Time (years):
0 2 4 6
Key findings

Focal aortic growth and peak cyclic transmural wall stress co-localized with intimal tear location in all cases.
Take home message

• Localized 3-D aortic growth is a dynamic process best monitored by routine ECG-gating CTA in all cases.

• The combination of aortic wall stress assessment and VDM using ECG-gated CTA data, may help in better understanding predicting risk factors for TBAD.

• Highly-precise and advanced VDM software is being developed at the U of M in collaboration with Imbio Inc. The latest improved results will be presented at the upcoming cardio-vascular meetings.