Multidimensional aneurysmal growth

A novel technique derived from biomedical engineering principles to help refine assessment of aortic growth

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Outline

1. Background
2. Motivations
3. Growth measure
4. Results
5. Conclusions
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Background

Thoracic Aortic Aneurysms

Carries about 90% overall mortality rate

Surgery carries morbidity/mortality risks

Current clinical practice:
- Maximum transverse TAA diameter
- TAA expansion rate

Strong challenge
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Motivations

TAA diameter challenge

mean = 5.31 cm

59%

Pape et al. Circulation 2007

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Motivations
Can we challenge TAA expansion rate?

How does a TAA grow?
Where does TAA grow fast?

Local wall weakening

April 31, 2007

April 12, 2007
July 3, 2008

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Growth measure

Descending aorta geometry acquisition

Image segmentation  3D model  Surrogate model
Growth measure
Multidimensional growth estimation

Non linear growth measure

\[ g_d^i = \frac{1}{t} \log \left( \frac{D_i^{\text{follow-up}}}{D_i^{\text{post operation}}} \right) \]

Baseline

1 year follow-up

100 observations


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Representative case

Growth rate (mm/y)

Outer diameter (mm)

Maximum growth

Maximum diameter

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Results

Entire cohort of descending aortas

0.9 mm/y → 3.1 mm/y

↑ 3 times

p < 0.001

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Results

Stable descending aortas

Is it stable?

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Results

Growing descending aortas

1.8 mm/y -> 4 mm/y

Axial growth

2 times

p < 0.001

1.3 mm/y

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Results

Stable descending aortas

- Axial growth

0.23 mm/y → 1.64 mm/y

7 times

p < 0.001

0.02 mm/y

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Conclusions

The aortic wall grows at random locations along its length.
Conventional measure cannot predict maximum growth.
Location of maximum diameter is different than the location of maximum growth.

Multidimensional measurement:
- Spots of fast diameter growth
- Shrinking of some sites of the descending aorta
- Longitudinal growth

Accuracy and reliability in aneurysm surveillance

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