In vivo assessment of abdominal aortic aneurysm wall strain using 2D and 3D B-mode ultrasound

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Abstract

Background, Motivation and Objective
Abdominal aortic aneurysm (AAA) rupture is associated with a high mortality. Because ultrasound (US) is recommended for the surveillance of small AAAs, adding biomechanical markers to the B-mode evaluation is of interest to improve rupture risk assessment. The objective of this study was to estimate AAA wall strains with B-mode ultrasound from 2D and 3D scans of patients.

Statement of Contribution/Methods
The abdominal aorta of 19 patients with AAA was scanned with a 3D US system equipped. Multiple 4D and 2D US B-mode scans were performed along the aorta to span the whole AAA. Motion tracking methods were applied to the 4D and 2D B-mode datasets to estimate strain fields.

Results/Discussion
Average systolic strain values of 1.8 ± 0.5 % and 7.6 ± 2.0 % were obtained for the 4D and 2D datasets, respectively. Average 3D and 2D systolic strains were correlated with a coefficient of 0.75 (p-value 0.002). Surveillance of small AAAs with US strain imaging is expected to be more accessible in a clinical setting when using widely available B-mode scans (2D or 4D – which is less often used).

Methodology

- 19 AAA patients. Age: 75 ±7 years. Written informed consent was obtained.
- Philips EPIQ7 US system, X6-1 3D probe.
- Multiple overlapping 4D US B-mode scans along the aorta spanning the AAA.
  - Temporal resolution: 4–7 Hz. Voxel size: 0.8 × 0.5 × 1 mm³
  - Multiple cross-sectional 2D B-mode scans spanning the AAA with an approximate 1-cm step between them.
  - Temporal resolution: 19-27 Hz. Pixel size: 0.2 × 0.2 mm² to 0.4 × 0.4 mm².

Discussion and conclusion

- Abdominal aortic aneurysm (AAA) is an enlargement of the aorta.
- AAA rupture is associated with high mortality.
- Surgery is recommended for large aneurysms, or in case of rapid growth.
- Ultrasound (US) imaging is recommended for surveillance of small AAAs.
- US-based biomechanical markers are of interest to improve rupture risk assessment.
- AAA wall strain is based on natural cardiovascular pulsations.
- Strain US elastography (SUE) is predominantly computed from radiofrequency US datasets.
- B-mode scans are widely available in a clinical setting compared to radiofrequency US.
- Objective of this study:
  - Estimate AAA wall strain from 2D and 3D B-mode scans.

References


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