Aortic Vessel Wall Imaging Using 3D Phase Sensitive Inversion Recovery in Children and Young Adults

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Atherosclerosis Imaging

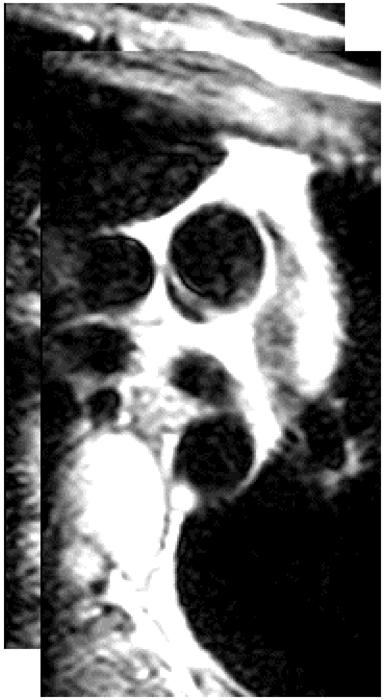
- Imaging subclinical atherosclerosis has clinical benefits in general and in familial hypercholesterolemia (FH)[1-3]
- Currently, T2-weighted, free-breathing, EKG-triggered, TSE black blood zoom imaging (T2Z) allows complete coverage of the thoracic aorta in a timely fashion[4]

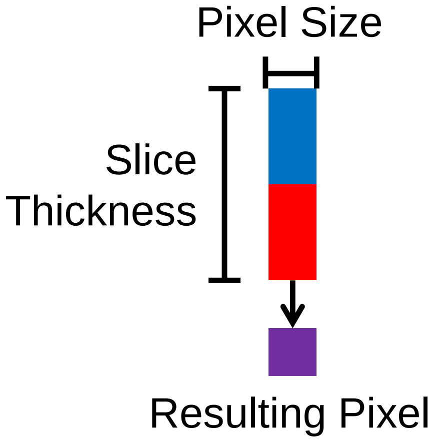
Can 3D Methods Improve It?

- Volumetric datasets with high resolution should to improve visualization of aortic atherosclerosis

- This would also avoid slice mis-registration

- 3D datasets would also decrease partial volume effects from thick slices

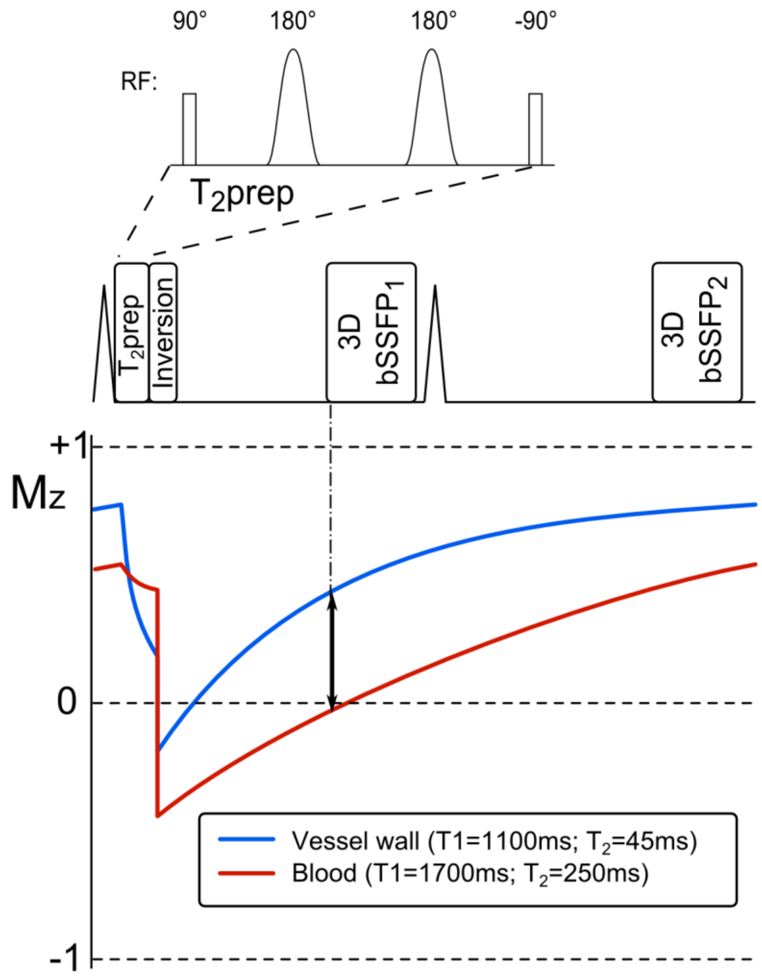




Objectives

- Compare the T2Z method to a novel 3D, balanced steady state free precession (bSSFP), respiratory navigated, phase-sensitive inversion recovery black blood imaging sequence (3D PSIR) in children and young adults to potentially improve vessel wall imaging in patients with familial hypercholesterolemia (FH)

Sequence Design



Patient Recruitment

- Children and young adults with familial hypercholesterolemia (FH)
- Already enrolled in a study of vascular health

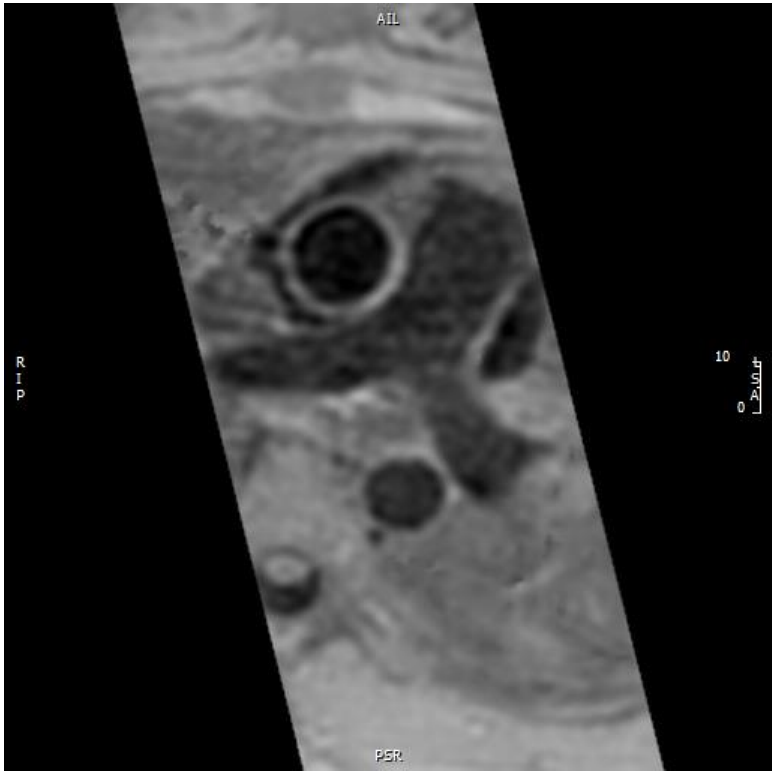
Imaging Parameters

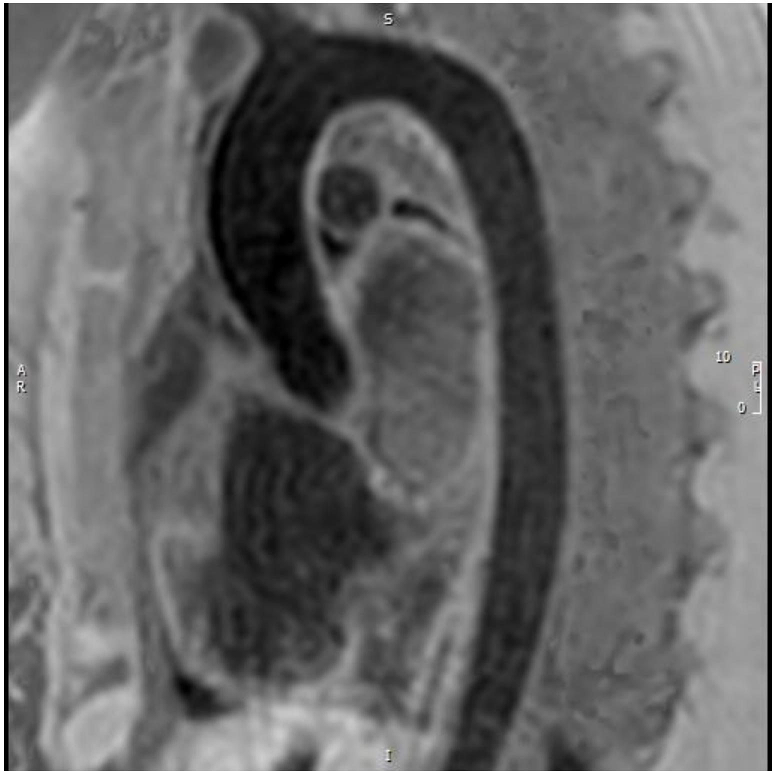
- Philips 1.5T Ingenia scanner
- No sedation or breath-holding
- T2Z imaging parameters (2D, axial slices):
  - Voxel size=1.0 x 1.2 x 5 mm^3
  - FOV 260 x 55 mm^2
  - TR=2 cardiac cycles
  - TE=50 ms
  - echo train length=10
  - 2 signal averages
  - Trigger delay longest

Imaging Parameters

- 3D PSIR imaging parameters:
  - Voxel size=0.8 x 0.8 x 1.6 mm^3 overcontiguous, reconstructed to 0.8 x 0.8 x 0.8 mm^3
  - Flip angle 70°
  - TR=3.48 ms
  - TE=1.74 ms
  - TI=400 ms
  - Echo train length=45
  - Respiratory navigation with 5 mm gating window
  - Trigger delay longest

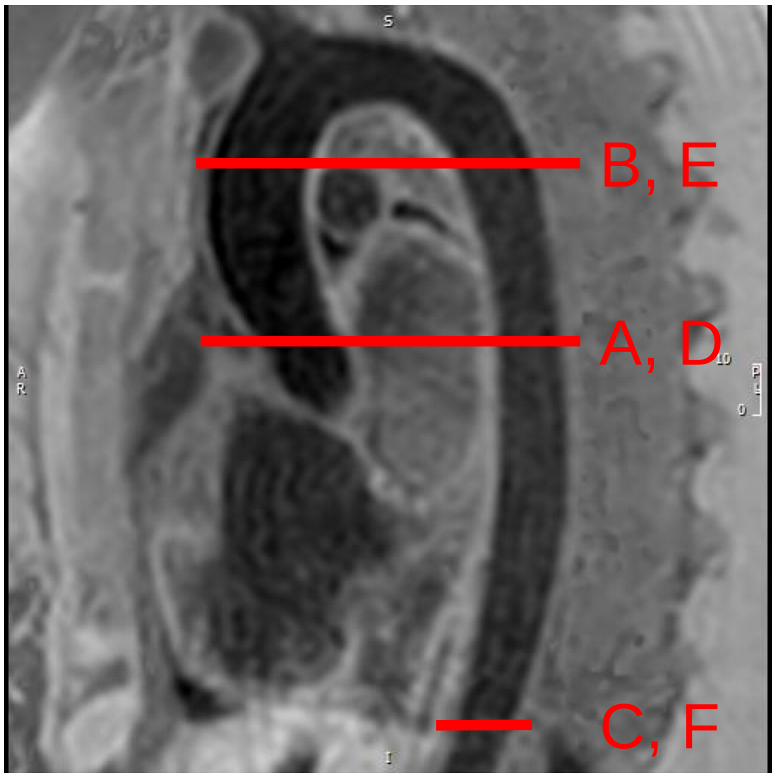
Image Plane

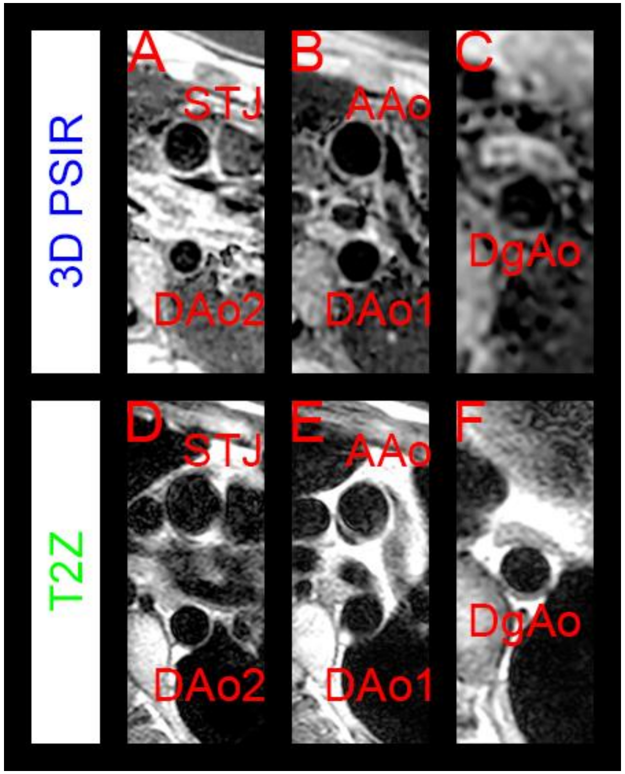




Para-sagittal imaging plane

Analysis Planes





3 axial slices used for both 3D PSIR and T2Z

Analysis Planes

- 3 axial slices used for both 3D PSIR and T2Z:
  - –Aortic sinotubular junction (STJ),
  - –Ascending aorta just above RPA (AAo)
  - –Aorta at the diaphragm (DgAo)
  - –Descending aorta at the level of the AAo and STJ (DAo1 and DAo2, respectively)
- 3D localization tool used to find closest T2Z axial slice
- Aortic luminal sharpness was measured using SoapBubble 5.0

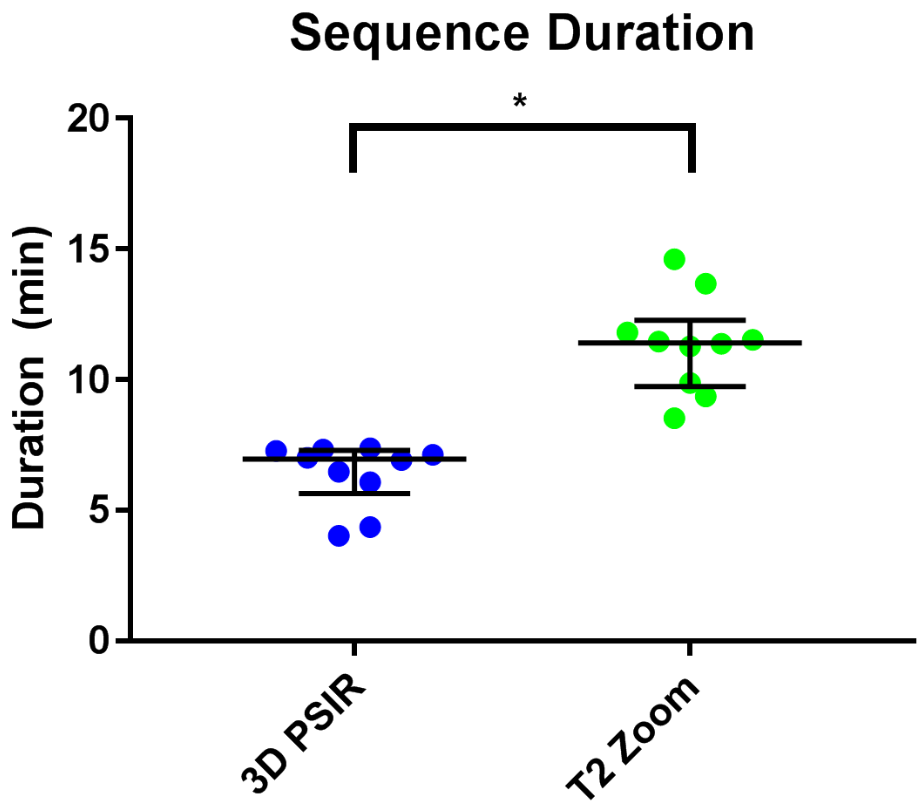
Statistics

- Paired luminal sharpness and duration data were tested using Wilcoxon signed-rank test
- Statistical analysis was performed using GraphPad Prism 7.0.

Results

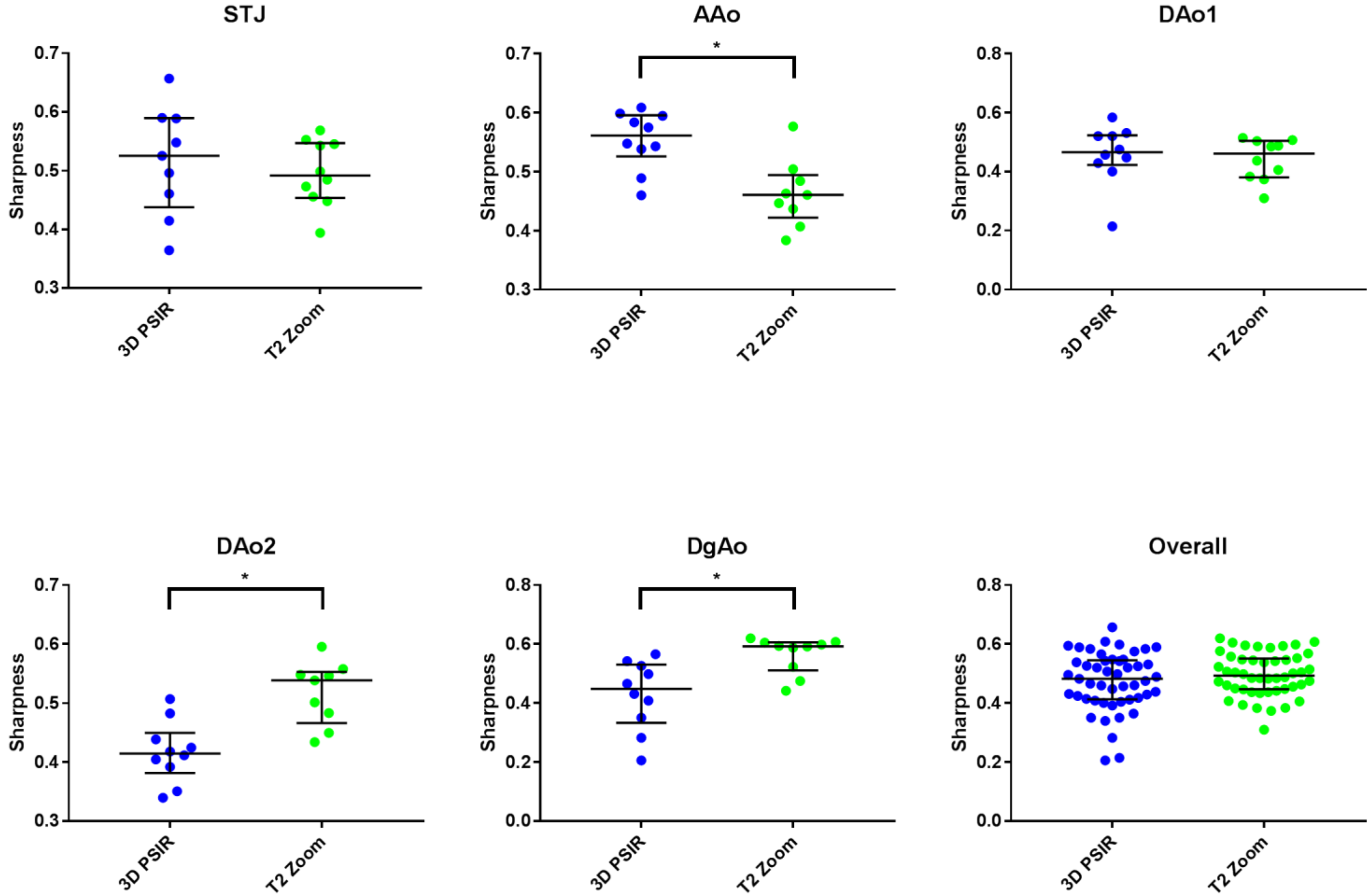
- Ten patients (median age 15.2 years, range 7.3-19.5) underwent the protocol
- Three vessel tracings (one 3D PSIR of the STJ, one T2Z of the AAo, and one T2Z of the DAo2) were unable to be analyzed

Sequence Duration



3D PSIR sequence was always faster than T2Z (median 39% faster)

Luminal Sharpness



Luminal sharpness:
Better on the 3D PSIR at the Aao
Better on T2Z at the DAo2 and DgAo
Overall, there was no significant difference

Discussion

- 3D PSIR allows volumetric depiction of the aorta with high isotropic resolution
- 3D PSIR has equivalent luminal sharpness to the standard T2Z sequence
- 3D PSIR has shorter sequence duration

Discussion

- Reduced slice thickness in the isotropic dataset may avoid partial volume effects, and thus allow for improved atheroma detection
- Atheroma burden in this group of young patients receiving statin therapy was low

Conclusion

- The development of the 3D PSIR sequence will enable a rapid and more detailed 3D vessel wall dataset
- This will allow improved exploration of vascular health in children and young adults
- This may yield further insights into patient risk stratification for diseases that cause vascular changes in children
  - Familial hypercholesterolemia
  - Obesity
  - Hypertension

References

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