



Motion-compensated cone-beam CT for 3D imaging of prosthetic devices implanted using transcatheter techniques

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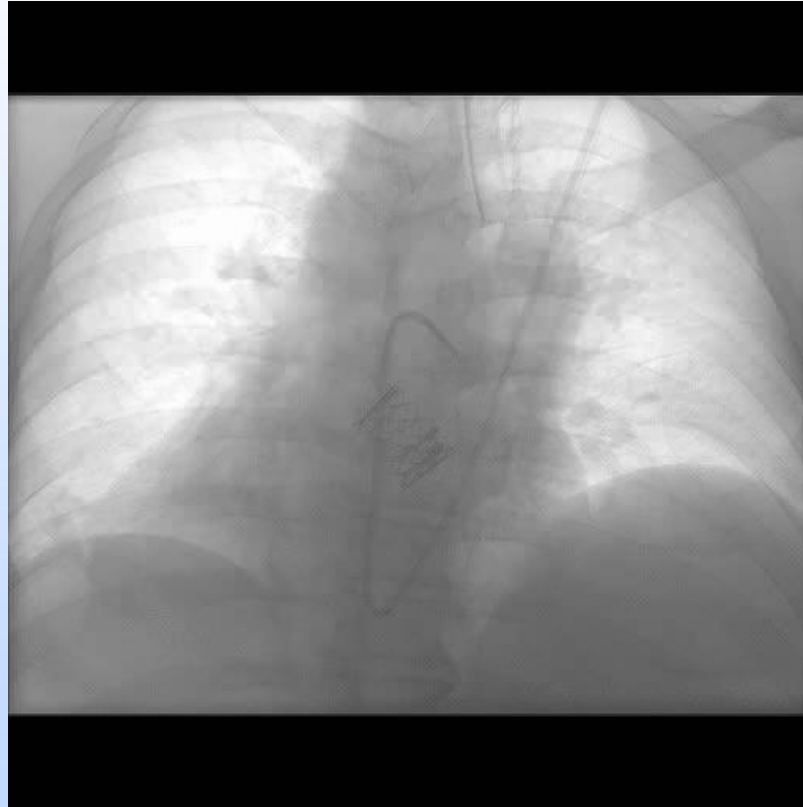
Donald Hagler, M.D. - Cardiology, Mayo Clinic

Verghese Mathew, M.D. - Cardiology, Mayo Clinic

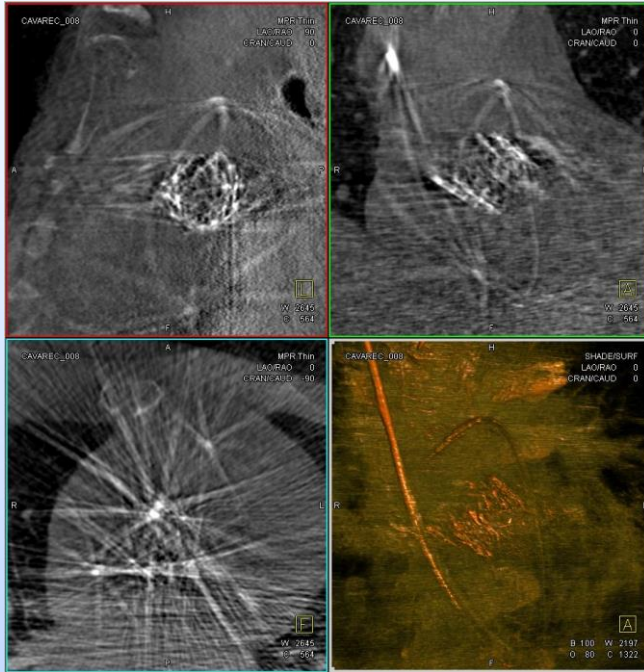
Disclosures

- This work was supported by Siemens Medical Systems.
- Dr. Guenter Lauritsch is an employee of Siemens Healthcare GmbH.
- The concepts and information presented in this paper are based on research and are not commercially available.
- IRB approved study.

Adverse consequences of motion



Adverse consequences of motion

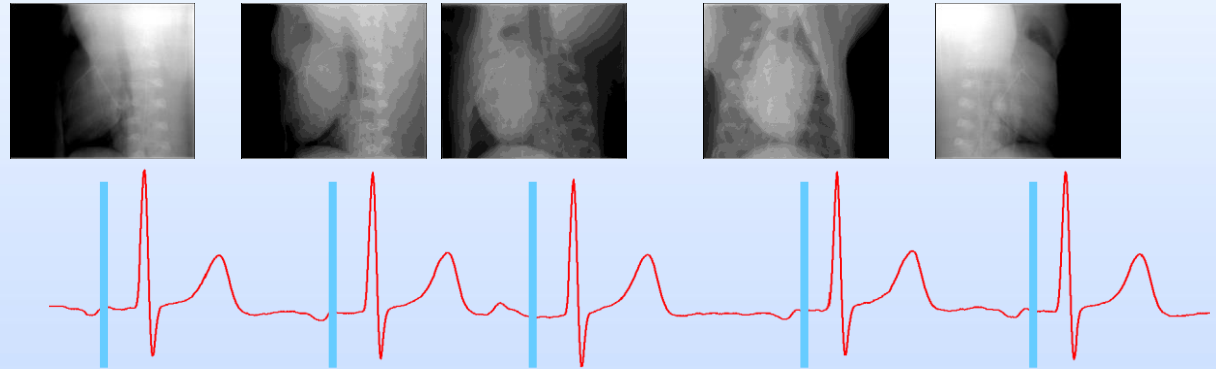
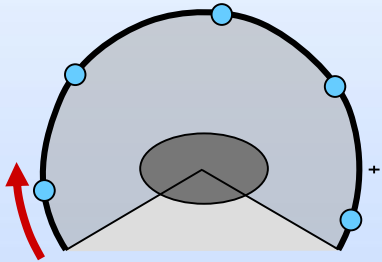


- Blur
 - Compromises device detail
- Ghost image of devices
- Enhances streak artifacts
 - Compromises detail in surrounding tissues and devices

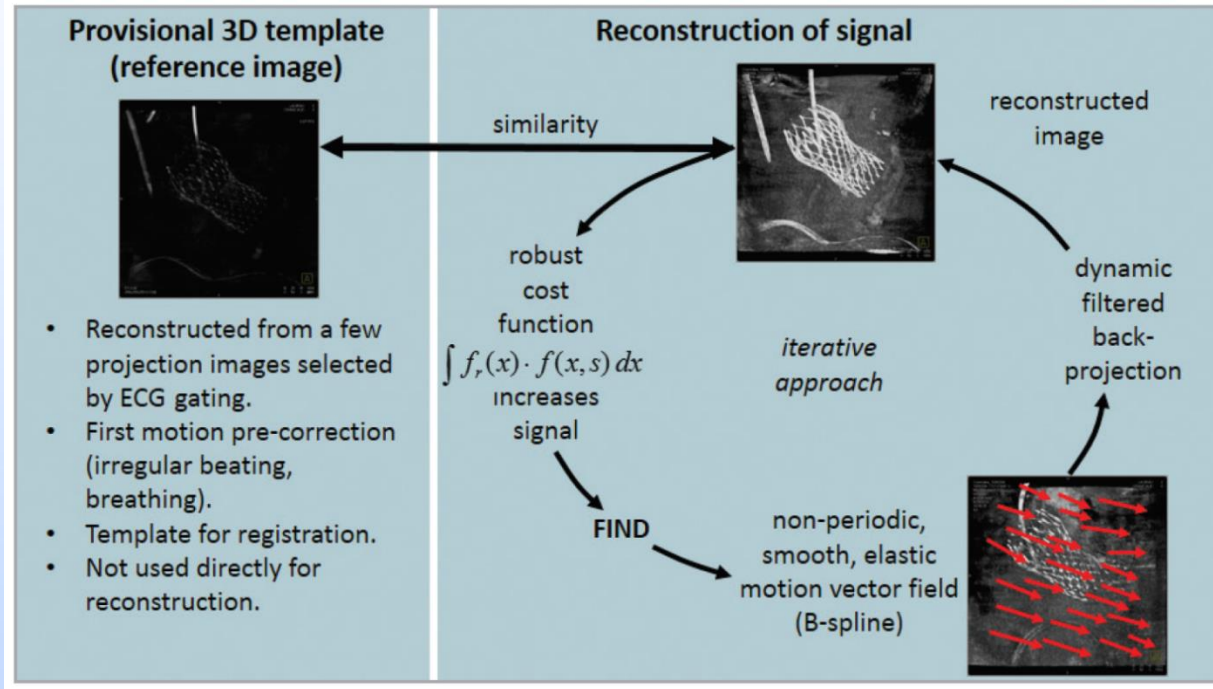
Motivation

- Investigate the potential for a motion-compensated (MoCo) reconstruction algorithm to improve CBCT quality for cardiovascular devices.

ECG gating to guide reconstruction



Motion-compensated reconstruction



Schultz CJ et al, EuroInterventions, 2015;11.

Methods

- Inclusion criteria
 - Adult patients
 - Scheduled for transcatheter valve, great artery stent, or paravalvular leak closure device.
- Exclusion criteria
 - Enrollment in a clinical trial

Methods

- Acquire rotational projection images of prosthetic devices.
 - Native rhythm
 - Intubated breath hold
 - Hybrid OR – Zeego
 - 200° rotational range, 1.5° per frame (133 frames)
 - Cath Lab – Artis Zee
 - 200° rotational range, 0.8° per frame (248 frames)

Methods

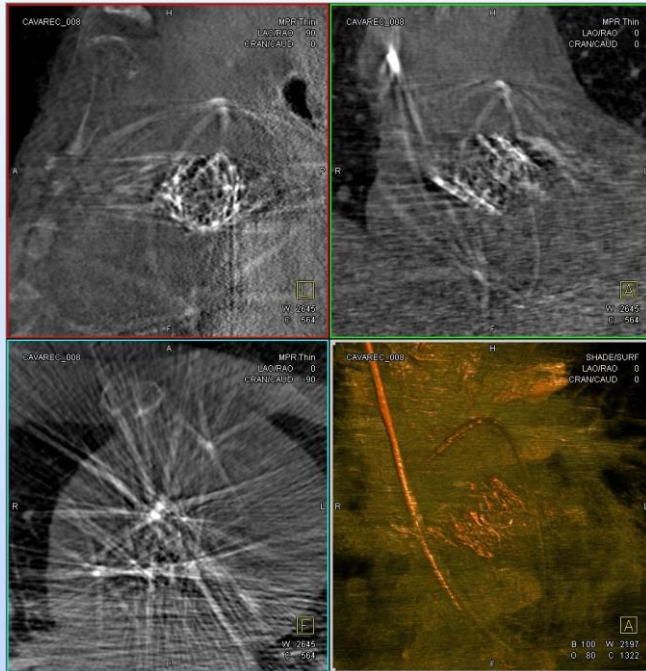
- Projection images reconstructed using
 - standard filtered back-projection cone-beam CT (CBCT, DynaCT)
 - research motion-compensated CT (MoCo)
- Images manipulated and displayed using Siemens 3D surface rendering tools (xWorkplace)

Methods

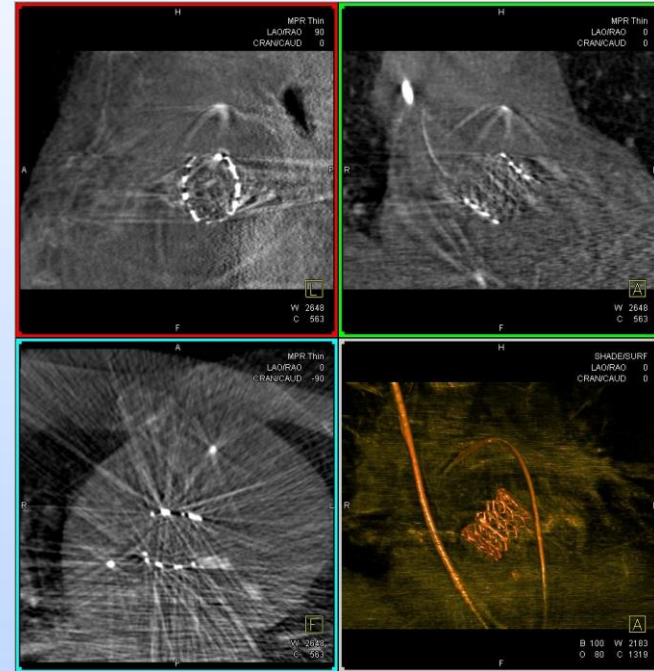
- Expert observers (2) consensus rating of details of the prosthetic
 - Assessed appearance of 3D surface rendering of devices
- 5 point rating Scale
 - 0 – Device not identifiable
 - 1 – Device barely visible
 - 2 – Shape well defined, most joints visible
 - 3 – All strut intersections visible
 - 4 – All struts visible

SAPIEN XT, Aortic valve

CBCT



MoCo



SAPIEN XT, Aortic valve

CBCT

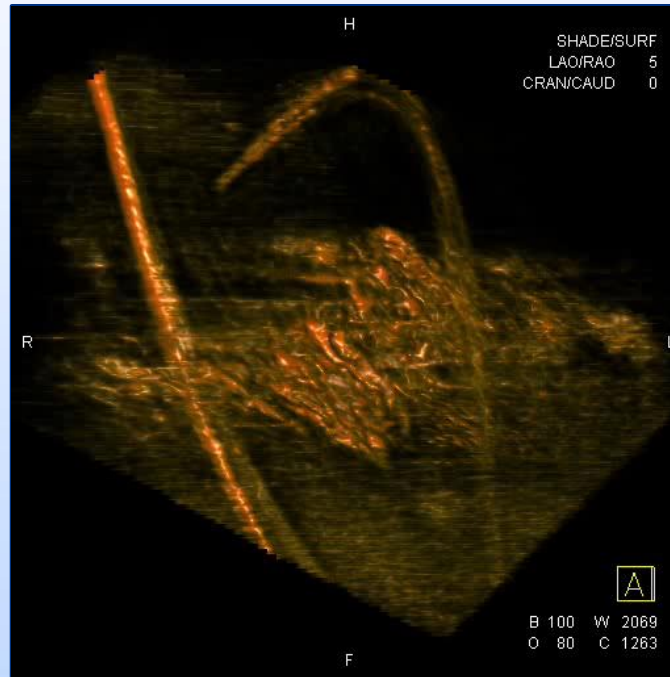
Age (yrs): 52

Sex: M

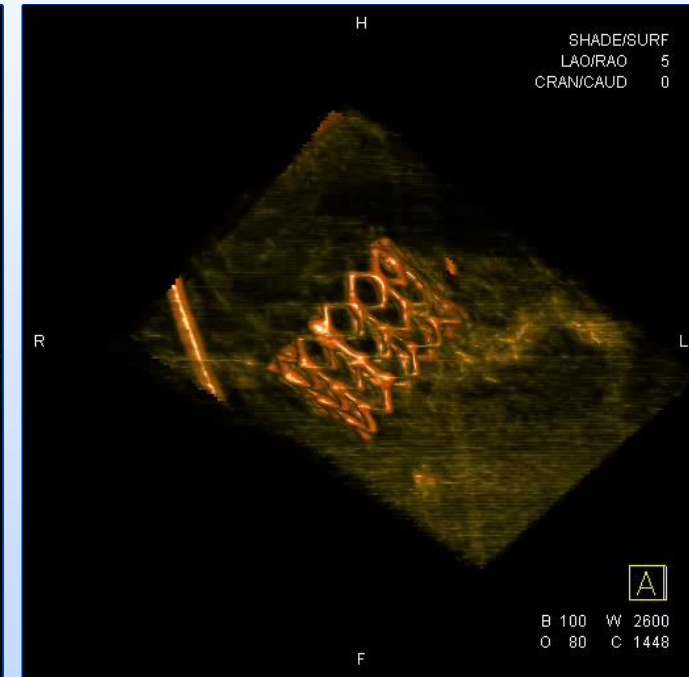
Weight (kg): 99

Heart rate (bpm): 96

ECG: Regular



MoCo



Consensus rating: 1

4

CoreValve[®] in CoreValve[®], Aortic valve

CBCT

MoCo

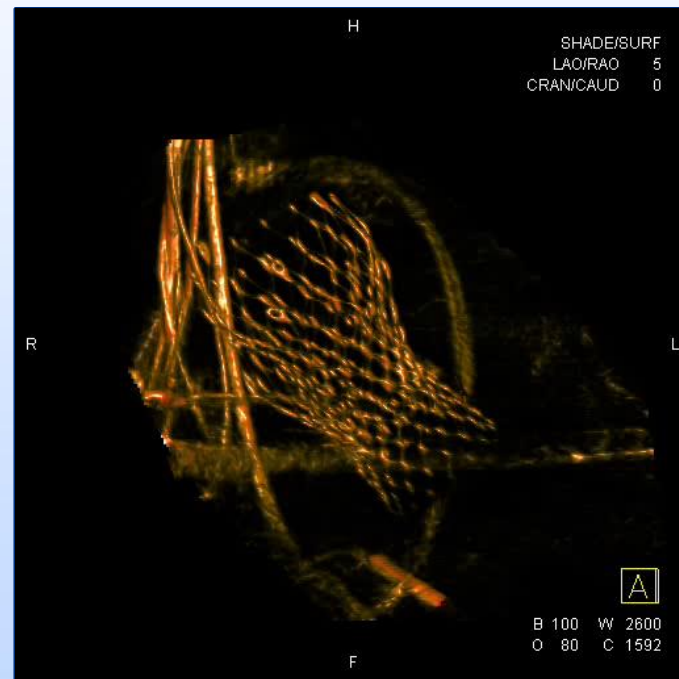
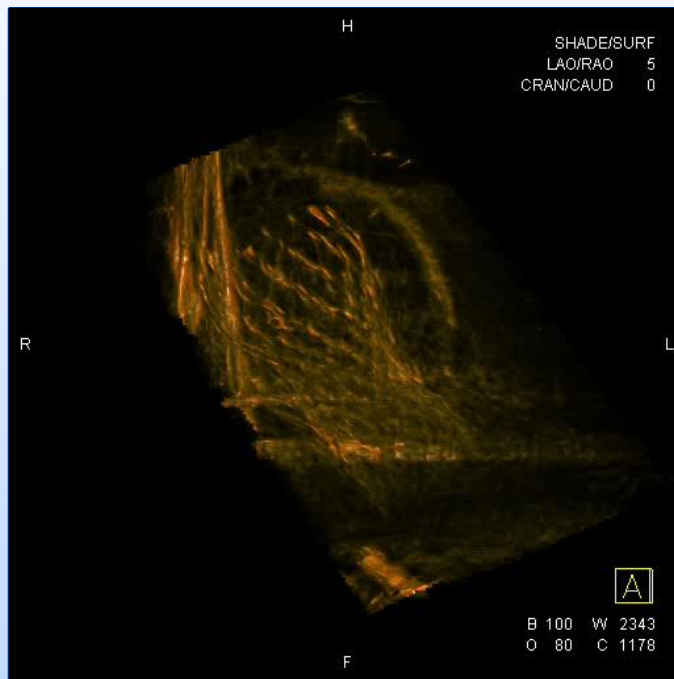
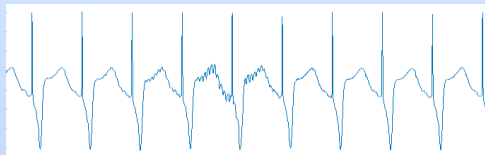
Age (yrs): 70

Weight (kg): 79

Sex: M

Heart rate (bpm): 106

ECG: Regular



Consensus rating: 1

3

CoreValve[®], Aortic valve

CBCT

MoCo

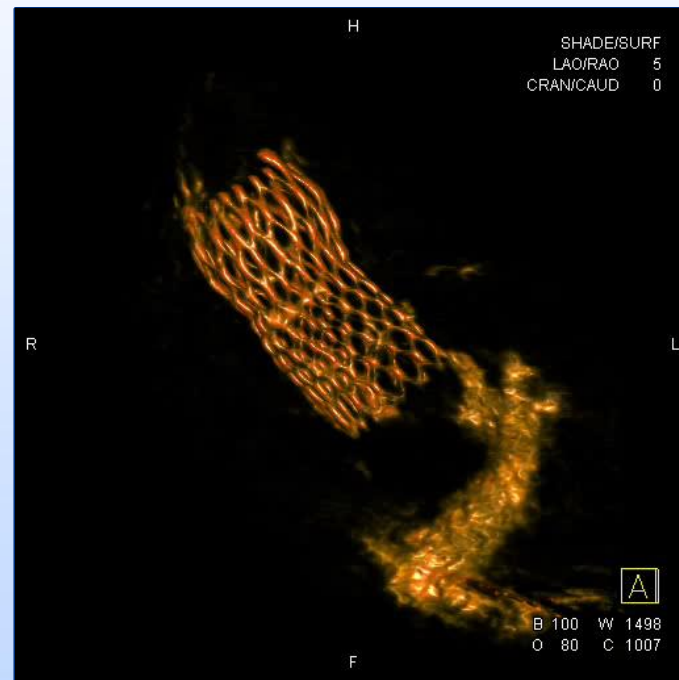
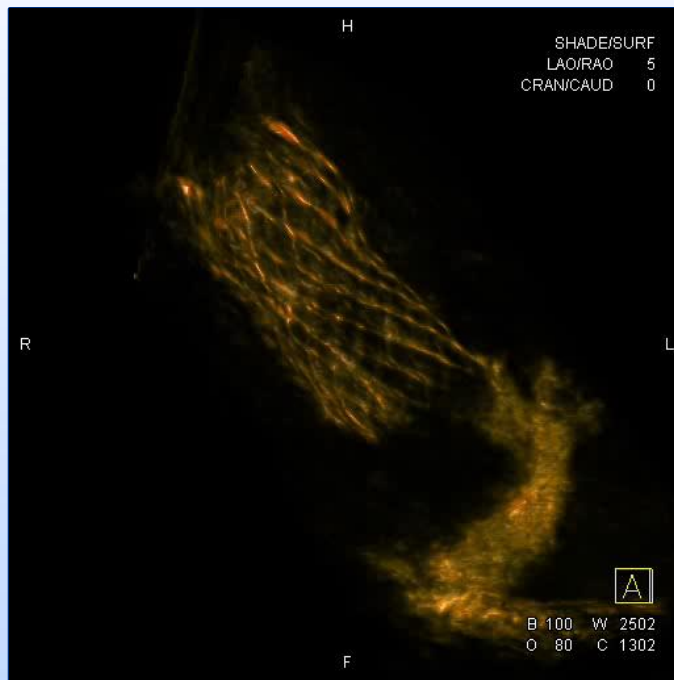
Age (yrs): 81

Sex: F

Weight (kg): 57

Heart rate (bpm): 64

ECG: Regular



Consensus rating: 2

4

IntraStent® Max™, Descending aortic coarctation

CBCT

MoCo

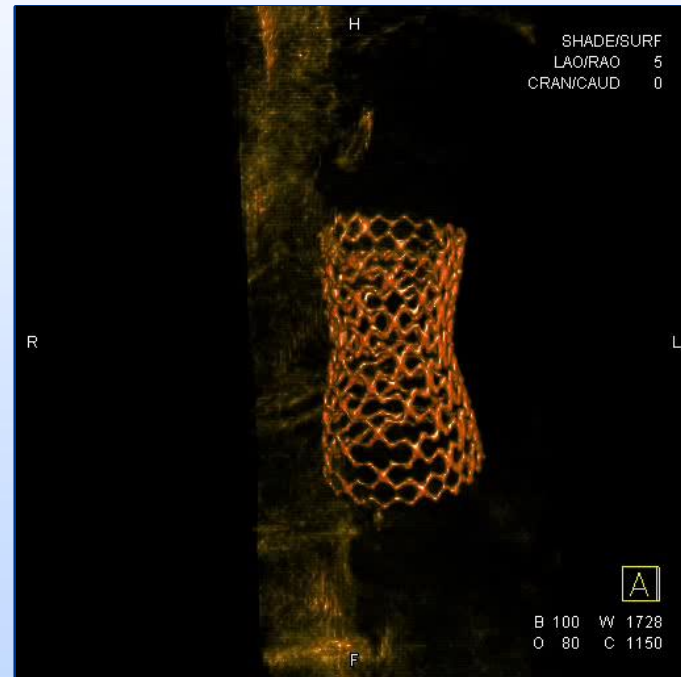
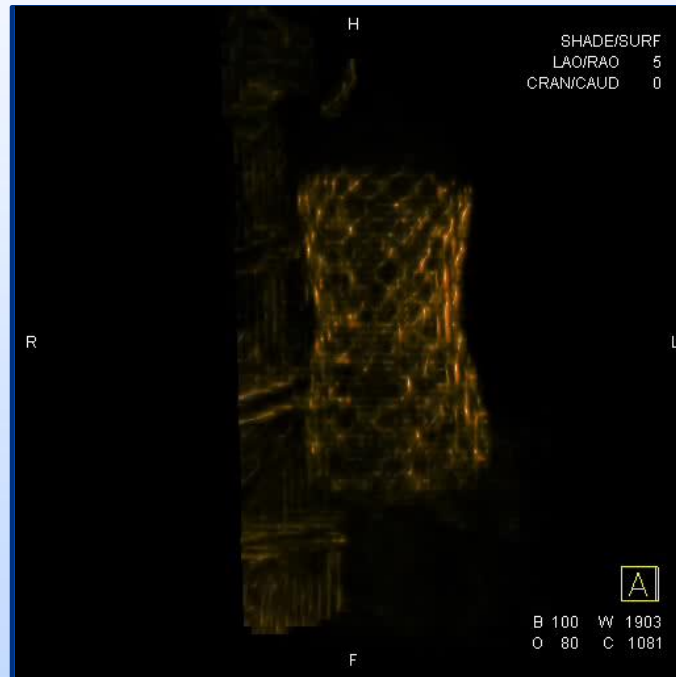
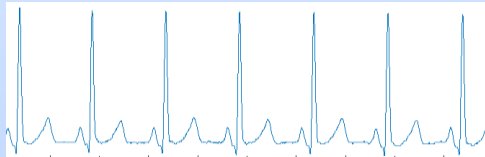
Age (yrs): 46

Sex : F

Weight (kg): 80

Heart rate (bpm): 71

ECG: Regular



Consensus rating: 2

4

IntraStent® Max™, Descending aortic coarctation

CBCT

MoCo

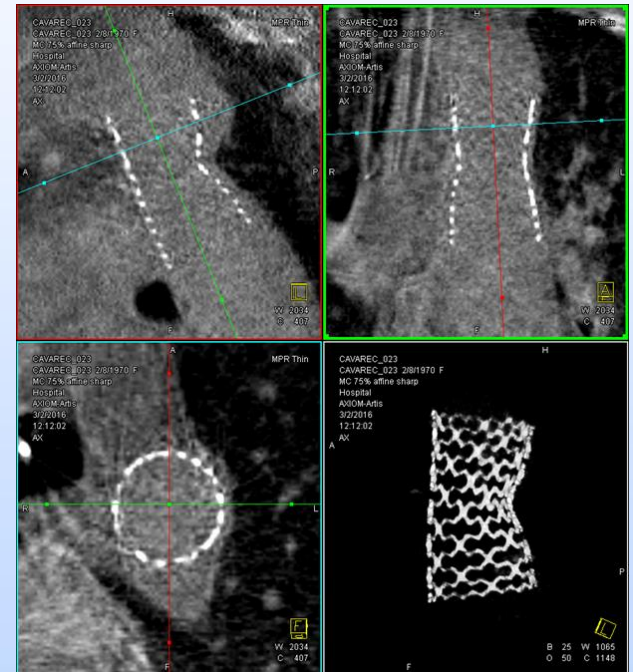
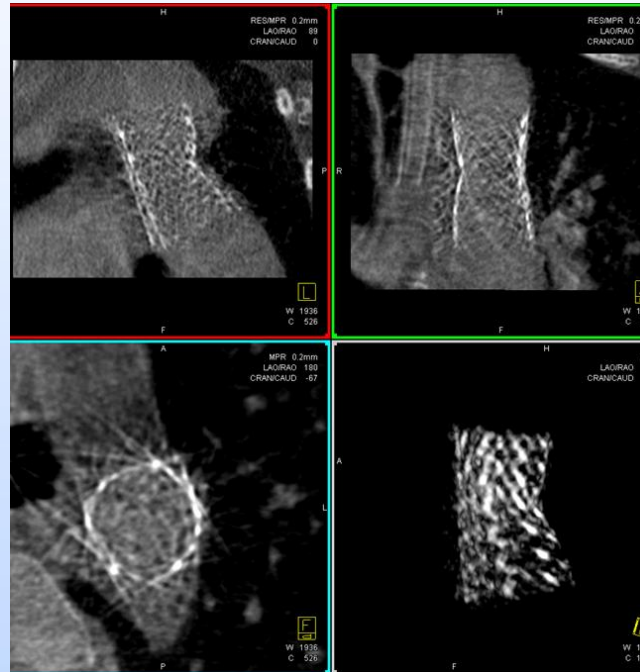
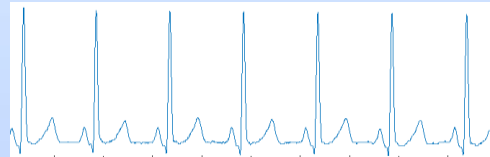
Age (yrs): 46

Sex : F

Weight (kg): 80

Heart rate (bpm): 71

ECG: Regular



CoreValve[®], in surgical aortic valve

CBCT

MoCo

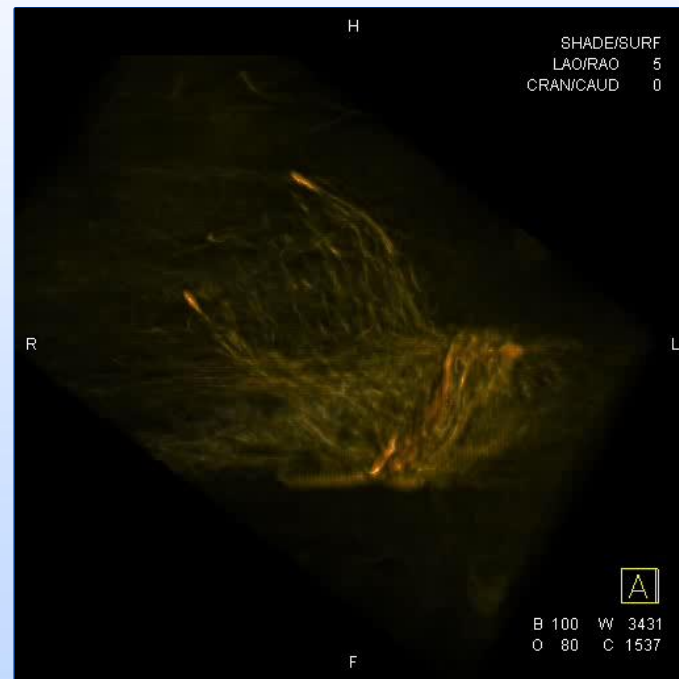
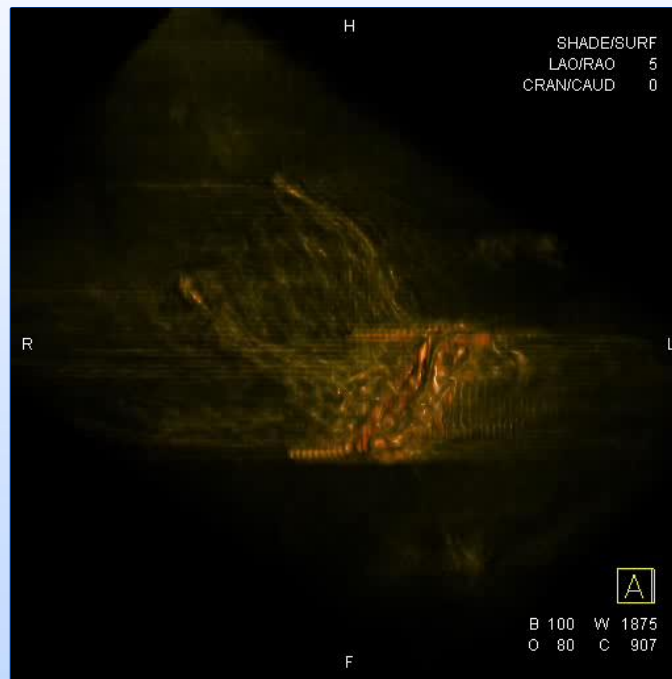
Age (yrs): 78

Sex : M

Weight (kg): 69

Heart rate (bpm): 67

ECG: No Signal



Consensus rating: 1

1

Amplatzer™ plug, mechanical mitral valve

CBCT

MoCo

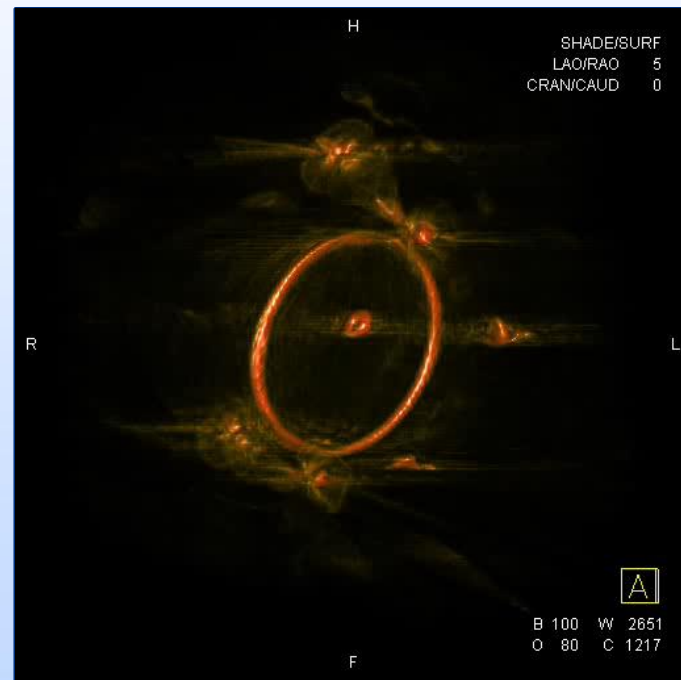
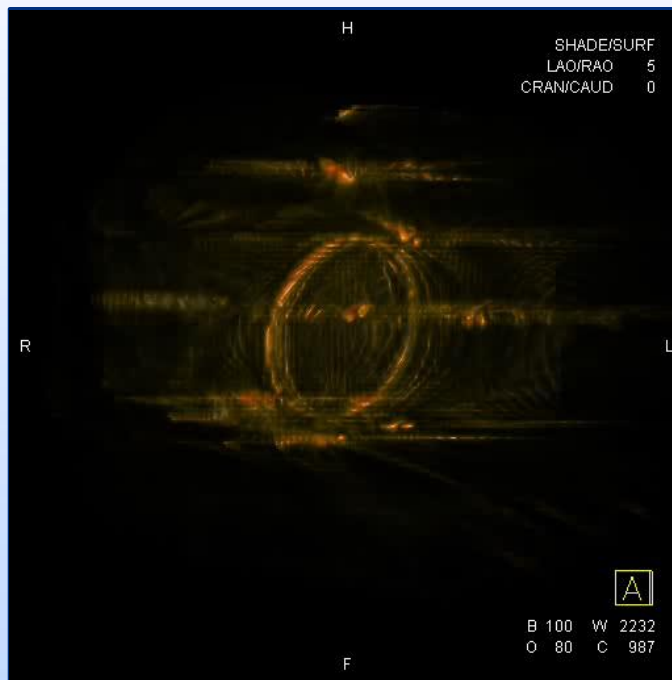
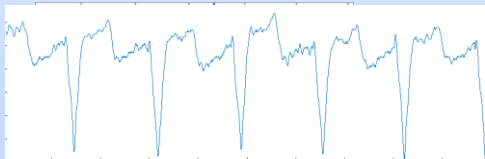
Age (yrs): 73

Sex : M

Weight (kg): 66

Heart rate (bpm): 72

ECG: Regular



Consensus rating: 1

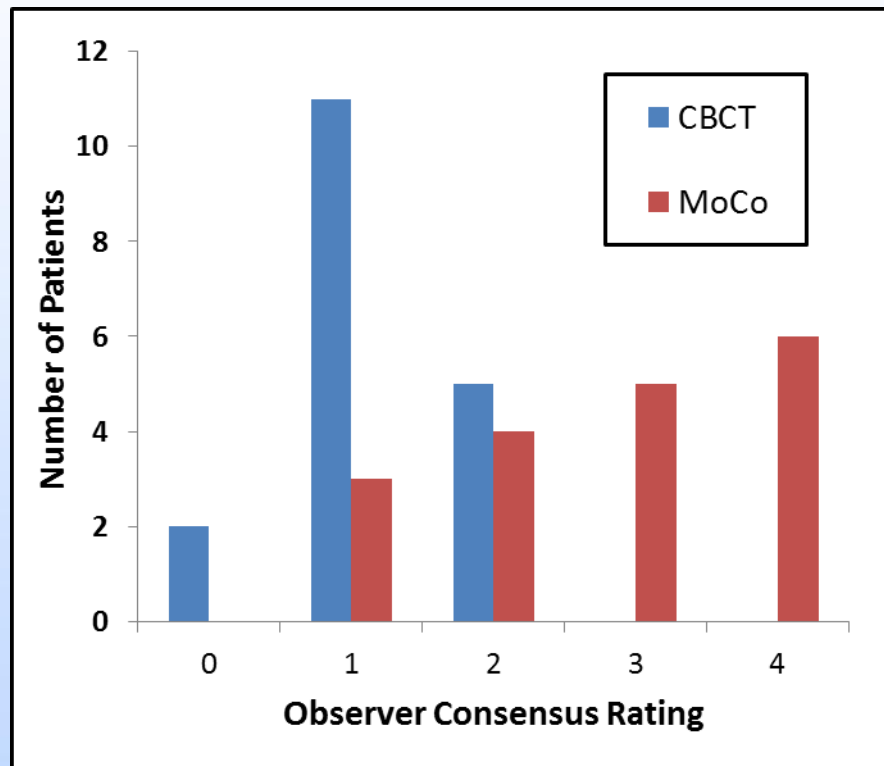
3

Patient summary

- Total Patients (18)
- ECG
 - Regular (11)
 - Partially regular (2)
 - Irregular (2)
 - None (3)
- TAVR (15)
 - CoreValve[®] (12)
 - Sapien XT (3)
- Paravalvular leak (2)
 - AV (1)
 - MV (1)
- Aortic Stent (1)

2 Observer consensus rating summary

	CBCT	MoCo
Mean:	1.2	2.8
Range:	0 to 2	1 to 4
Improvement:		+1.6 (0 to 3)



Limitations

- MoCo is research SW
 - Not approved for clinical use
 - Takes several minutes for reconstruction
 - Semi-automated
 - Requires workflow enhancements for clinical use

Concluding remarks

- MoCo reconstruction improves 3D assessment of implanted cardiovascular devices.
- Reduces streak artifacts; minimizes device ghosting.
- Image quality is dependent on
 - Patient size
 - Availability and regularity of ECG

Concluding remarks

- Potential application for immediate and long-term assessment of devices in and near the heart
 - Shape and size
 - Structural detail and integrity
 - Spatial relationship between multiple devices
 - Improved visualization of adjacent anatomy