Imaging ascending and root

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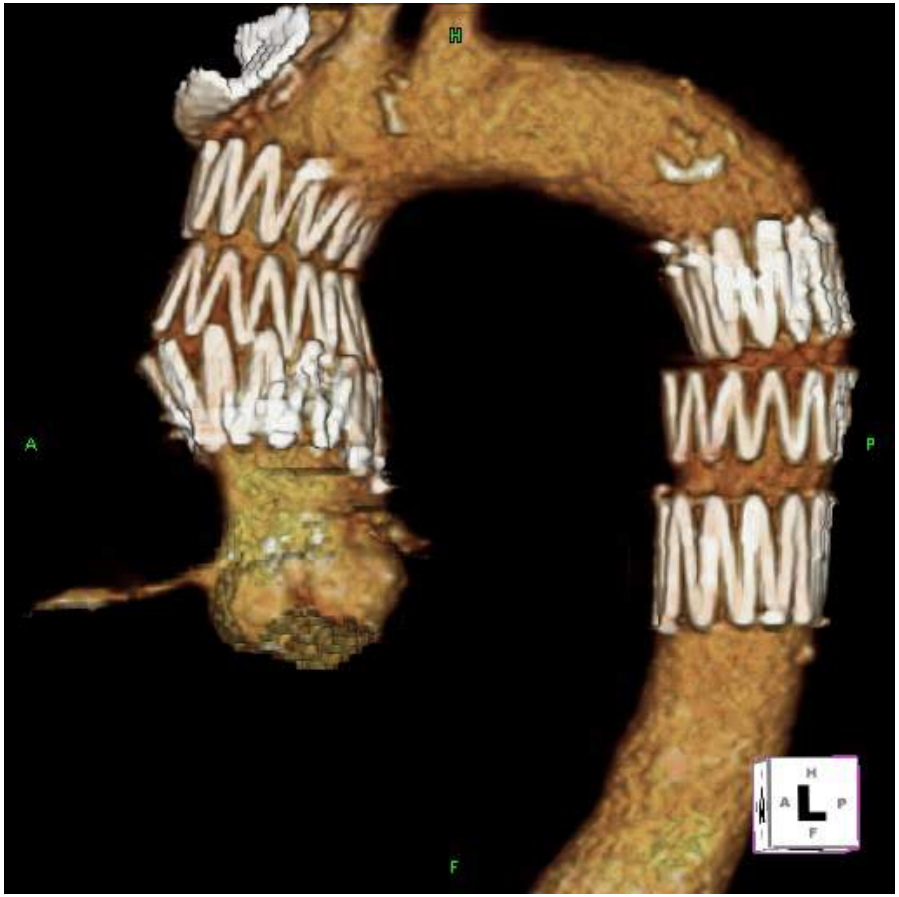
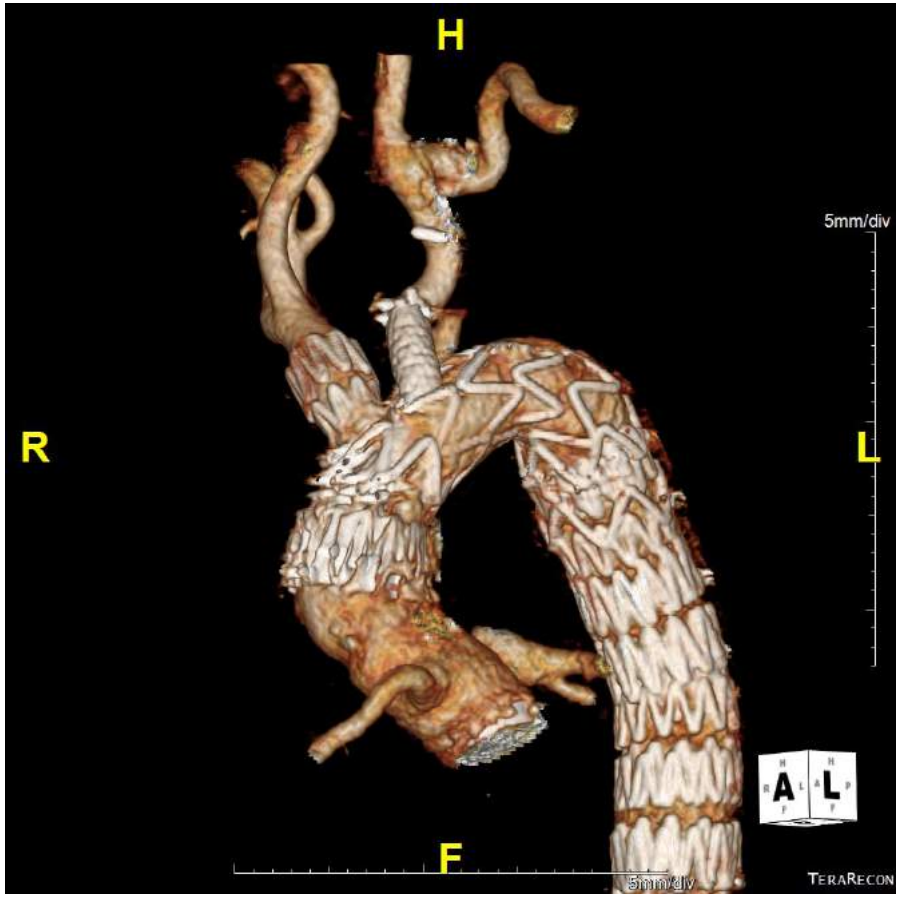
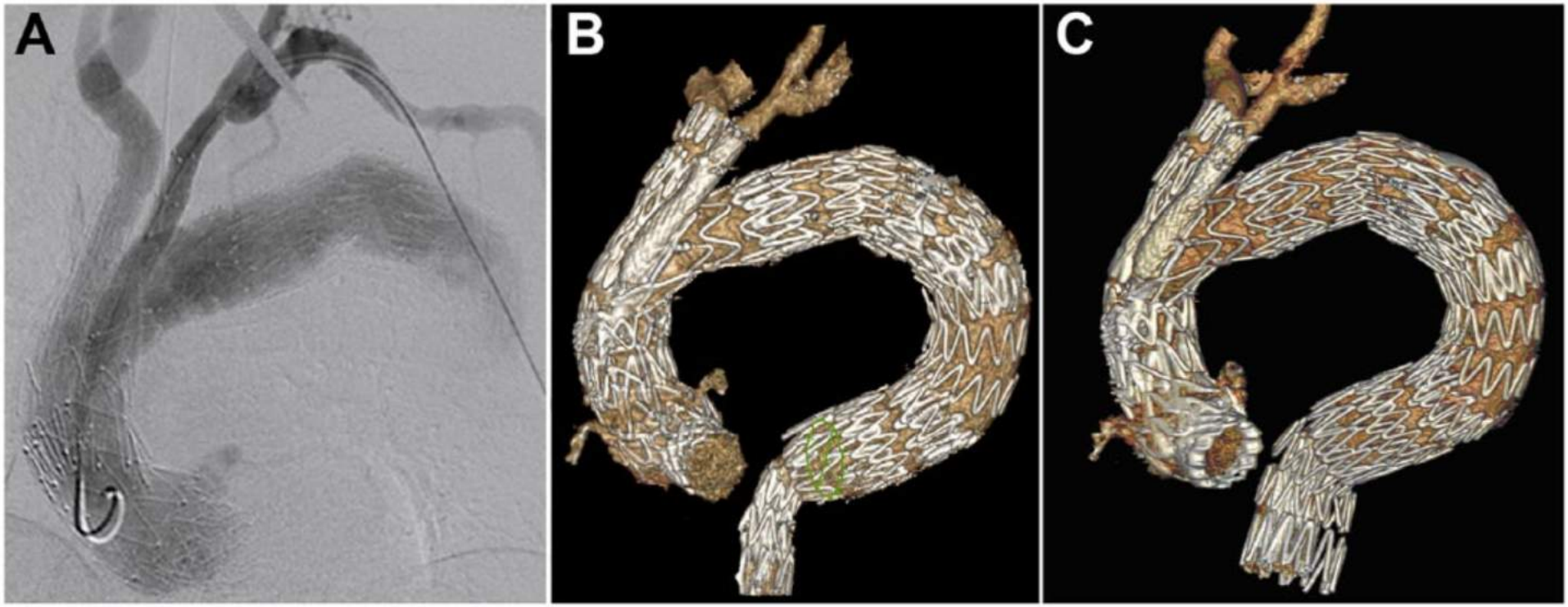
The arch and ascending aorta





Courtesy: Roy Greenberg

Arch, ascending and TAVI



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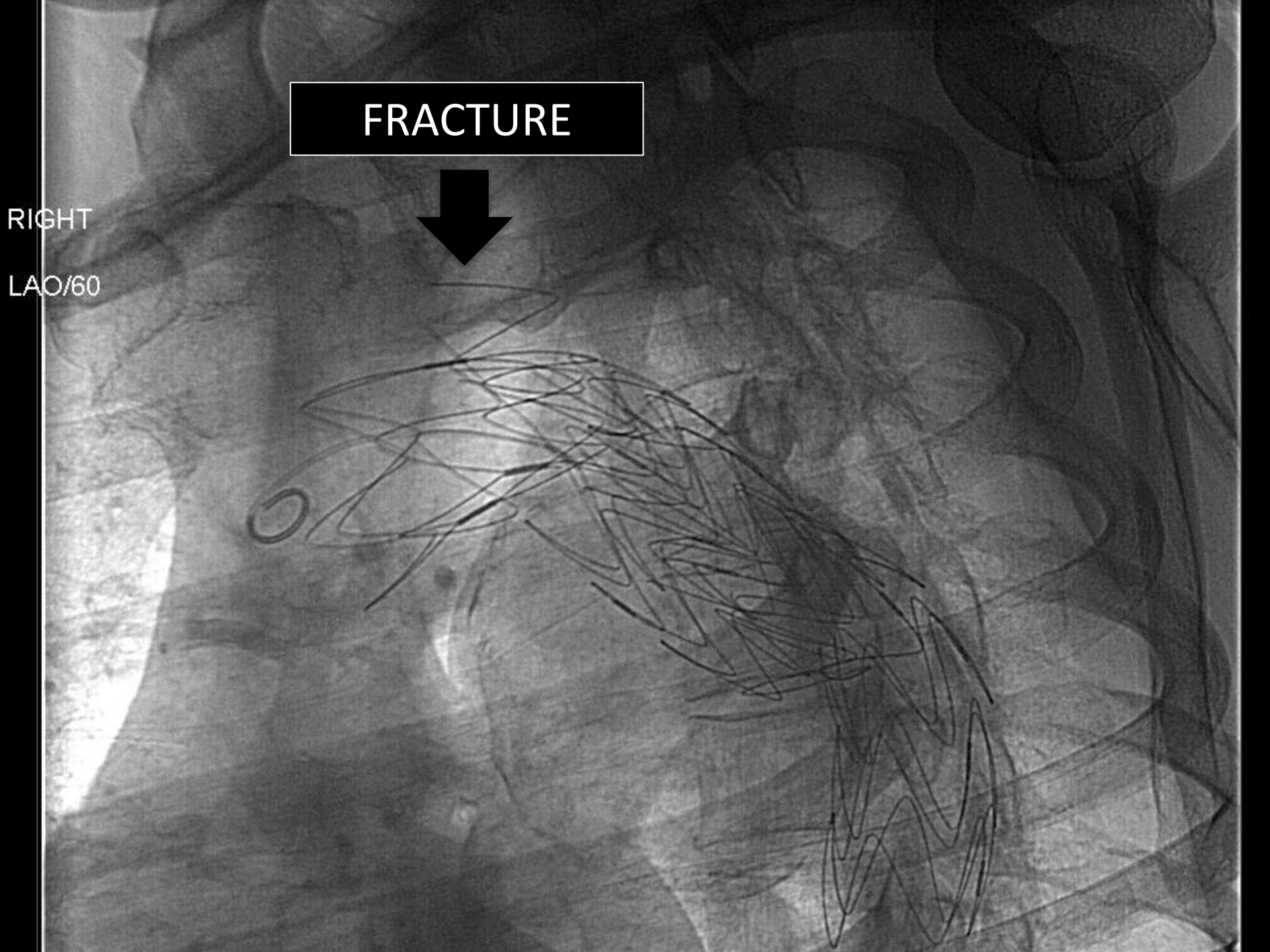

FRACTURE
RIGHT
LAO/60


GHT
AO/60
KINK


COMPONENT
SEPARATION

Endovascular stent grafting for ascending aorta repair in high-risk patients

Eric E. Roselli, MD, Jahanzaib Idrees, MD, Roy K. Greenberg, MD, Douglas R. Johnston, MD, and Bruce W. Lytle, MD (J Thorac Cardiovasc Surg 2014;■:1-11)

TABLE 3. Operative details

Patient	Age	Gender	Indication	Appr.	Device(s)	Outcome	Details/events
1	91	M	Type A	TA	Gore, Medtronic	Late death	COD: unknown
2	56	F	Type A	TA	Cook	Endo Reintv	Type 1 endoleak→TEVAR extension with talent
						Late death	COD: pneumonia
3	79	M	Type A	TF	Cook	Late death	COD: Lung cancer
4	75	F	Type A	TF	Gore	Acute death	Endoleak, rupture
5	82	F	Type A	TF	Cook	Acute death	LM coverage→open conversion, COD: multi-organ failure
6	51	F	Type A	TA	Cook	Alive	Early endoleak
7	84	M	Type A	TA	Cook	Acute death	COD: bleeding
8	83	F	Type A	TA	Cook	Alive	Type 1 endole
9	79	M	Type A	TF	Gore	Endo, open reintv	TEVAR treate later open re
10	69	F	IMH	TA	Cook	Alive	Definitive repa
11	81	F	IMH	TF	Gore	Alive	Definitive repa
12	38	M	PseudoA	TAx	ASD + BMS	Open Reintv	PseudoA—Pul repair→ope Definitive repa
13	84	M	PseudoA	TF	Medtronic	Alive	Definitive repa
14	63	F	PseudoA	TF	Cook	Alive	Definitive repa
15	55	M	PseudoA	TAx	Cook	Open Reintv	PseudoA resol retrieval
16	73	M	PseudoA	TF	Cook	Alive	Definitive repa
17	63	M	PseudoA	TAx	Cook	Endo Reintv	Definitive repa definitive repair
18	64	M	PseudoA	TA	Cook	Alive	Definitive repair
19	88	M	PseudoA	TAx	Gore	Alive	Definitive repair
20	61	F	PseudoA	TF	Cook	Alive	Small endoleak, monitored
21	64	M	C.Dissection	TAx	Cook	Open Reintv	1. Retained delivery system→open conversion direct device fixation 2. Late left ventricular apex pseudoaneurysm repair, definitive repair
22	74	F	C.Dissection	TF	Cook	Alive	Definitive repair

Appr., Approach for device delivery; *M*, male; *Type A*, acute type A dissection; *TA*, transapical; *COD*, cause of death; *F*, female; *Endo*, endovascular; *Reintv*, reintervention; *TEVAR*, thoracic endovascular aortic repair; *IMH*, intramural hematoma; *TF*, transfemoral; *LM*, left main coronary artery; *TAx*, transaxillary; *ASD*, atrial septal defect closure device; *BMS*, bare metal stent; *PseudoA*, pseudoaneurysm; *CT*, computed tomography; *C.Dissection*, chronic dissection.

22 patients

Type I endoleak: 6 (27%)

Distal migration: 1 (5%)

Re-intervention: 6 (32%)

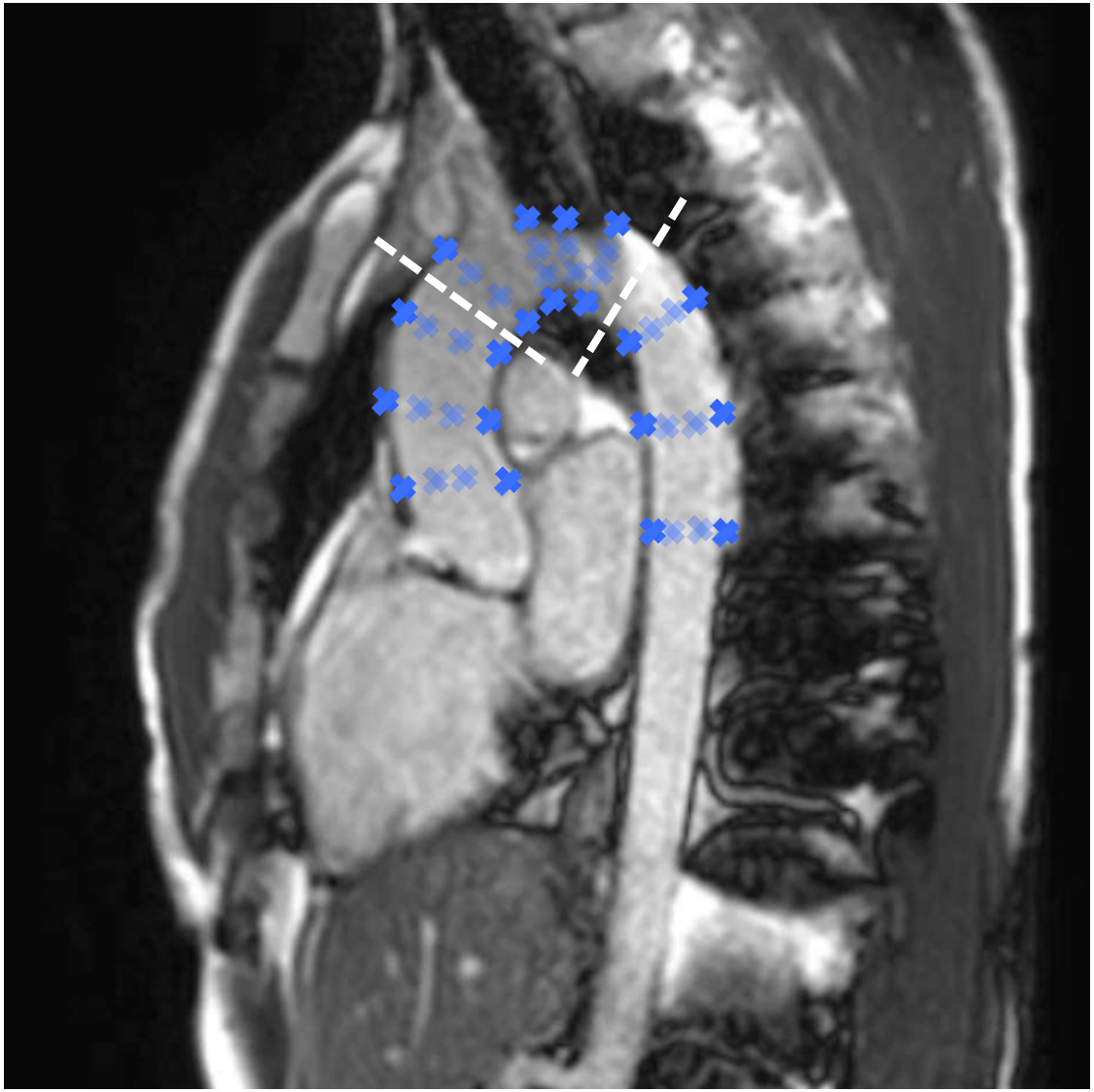
J Thorac Cardiovasc Surg. 2015;149:144-51

Aortic motion

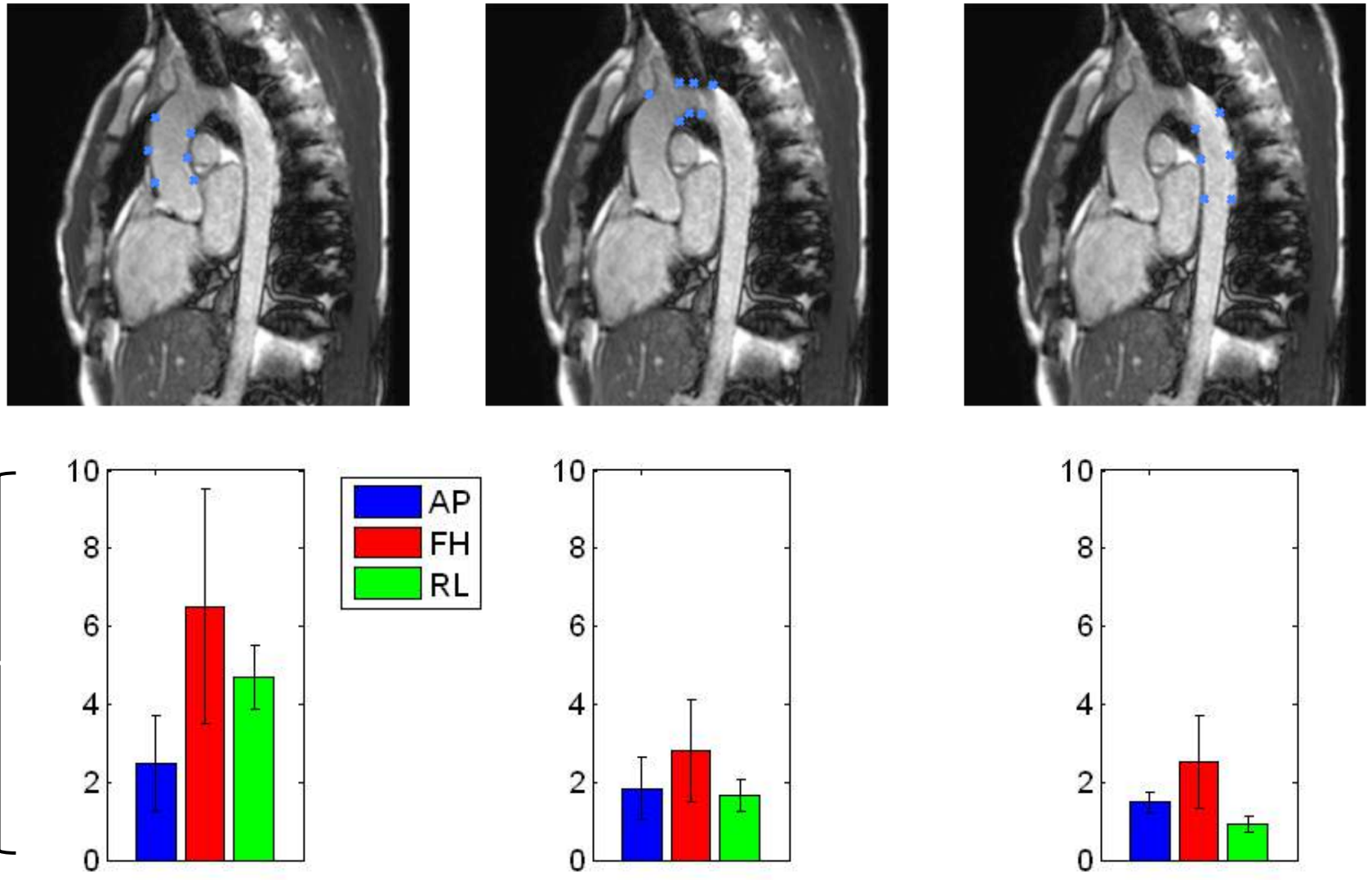
Cardiac

Respiratory

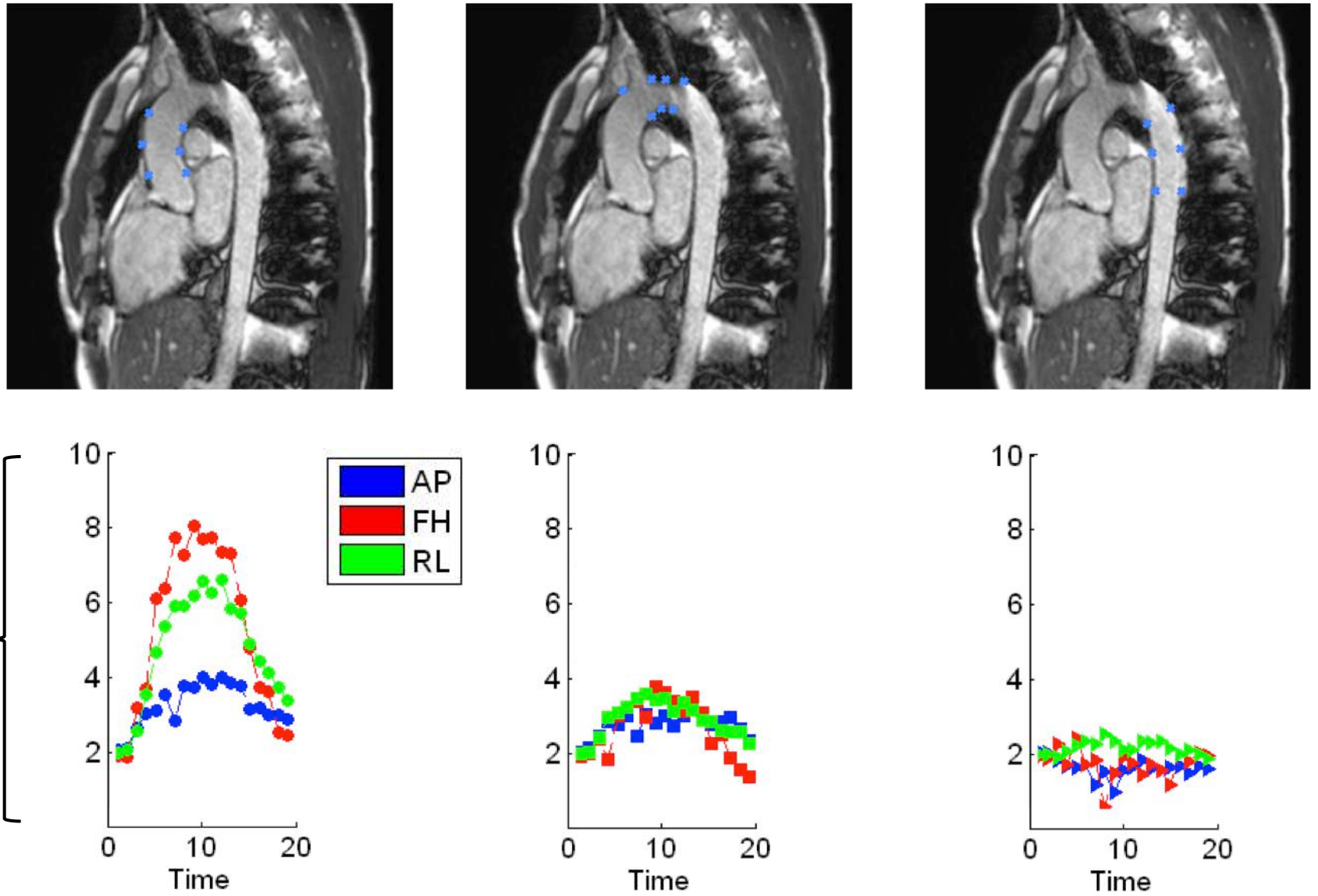
Quantification



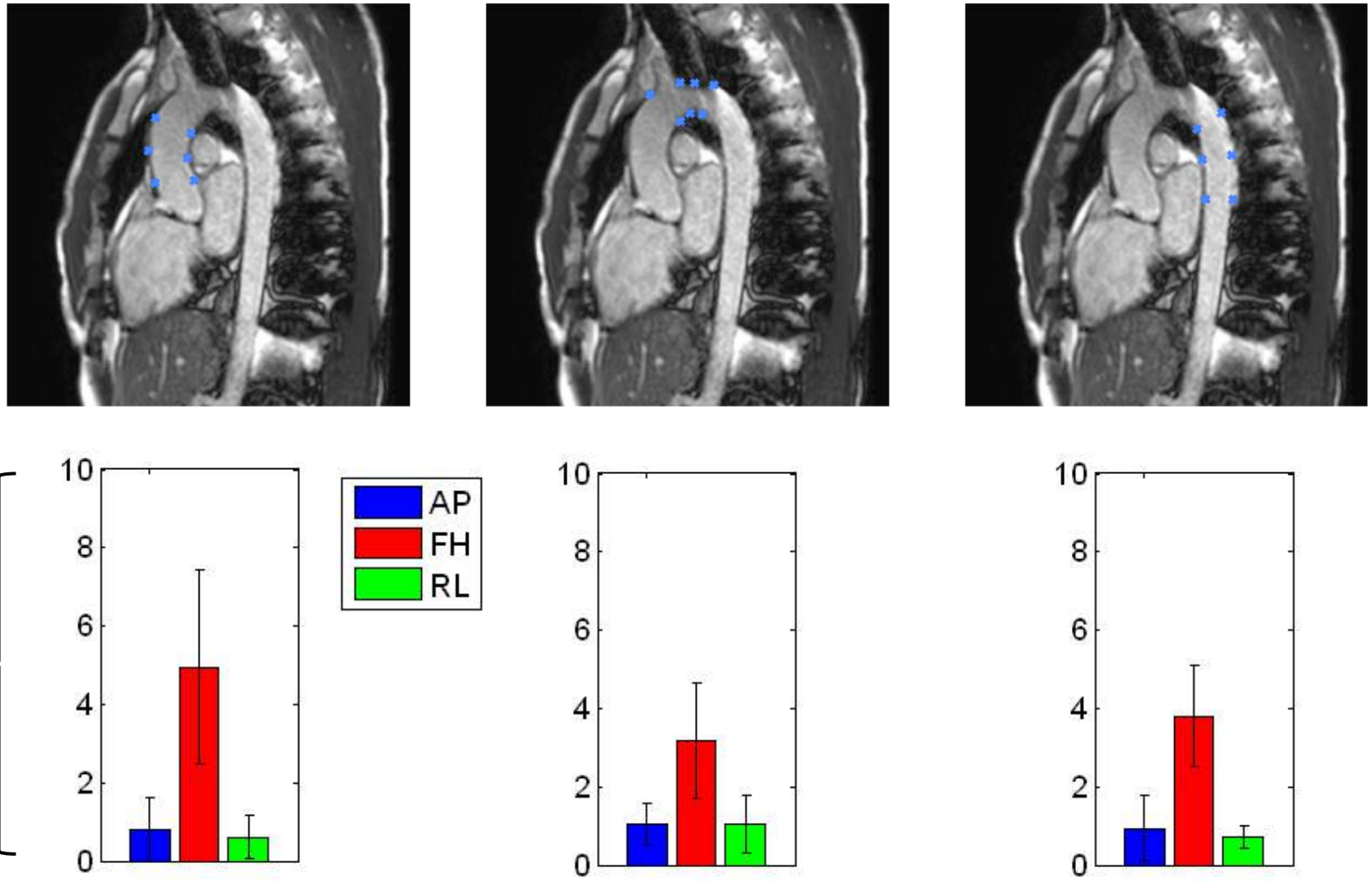
Aortic displacement – cardiac motion



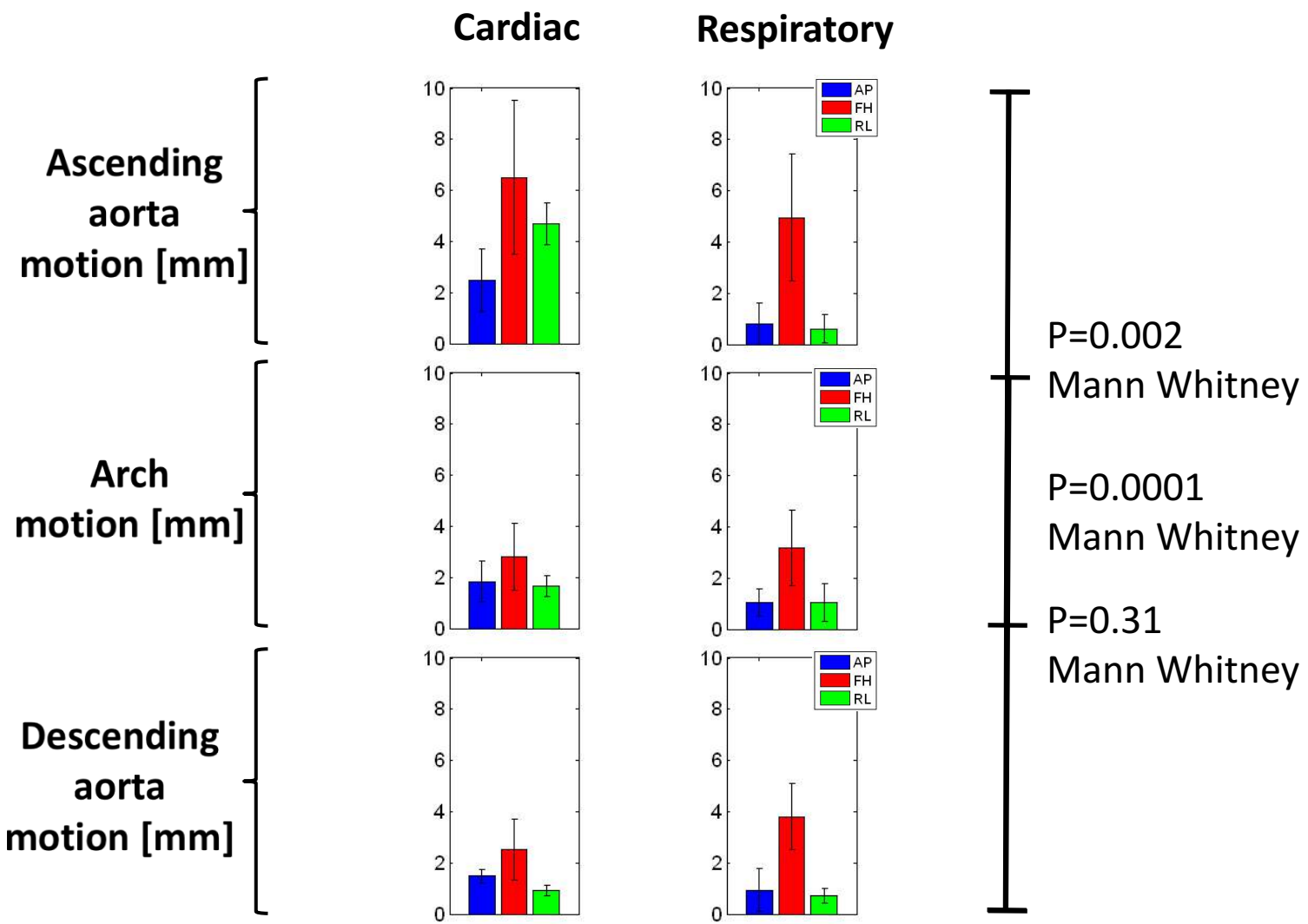
Aortic displacement – cardiac motion



Aortic displacement – respiratory motion



Comparison


Cardiac
Respiratory
Ascending aorta motion [mm]
Arch motion [mm]
Descending aorta motion [mm]
AP
FH
RL
0
2
4
6
8
10
P=0.002
Mann Whitney
P=0.0001
Mann Whitney
P=0.31
Mann Whitney

Positional stability

Radial force of the stent graft

$$(F_R)_{rad} = f\,(\mathbf{Vessel}_m, \mathbf{Plaque}_m, \mathbf{Stent}_o, \mathbf{Blood}_p, \mathbf{Stent}_m)$$

$\mathbf{Vessel}_m$	=	vessel properties
$\mathbf{Plaque}_m$	=	plaque properties
$\mathbf{Stent}_o$	=	oversized stent graft
$\mathbf{Blood}_p$	=	blood pressure
$\mathbf{Stent}_m$	=	stent material properties

Int J Comput Assist Radiol Surg. 2014;9:617-33

Positional stability

Radial force of the stent graft

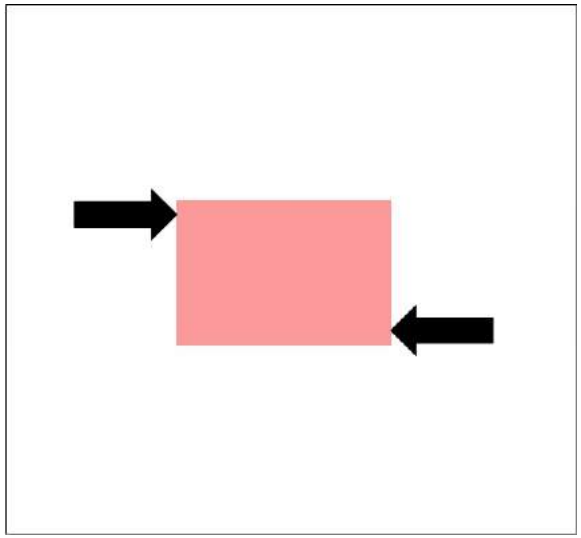
$$(F_R)_{rad} = f\,(\mathbf{Vessel_m,\ Plaque_m,\ Stent_o,\ Blood_p,\ Stent_m})$$

$Vessel_m$	=	vessel properties
$Plaque_m$	=	plaque properties
$Stent_o$	=	oversized stent graft
$Blood_p$	=	blood pressure
$Stent_m$	=	stent material properties

Int J Comput Assist Radiol Surg. 2014;9:617-33

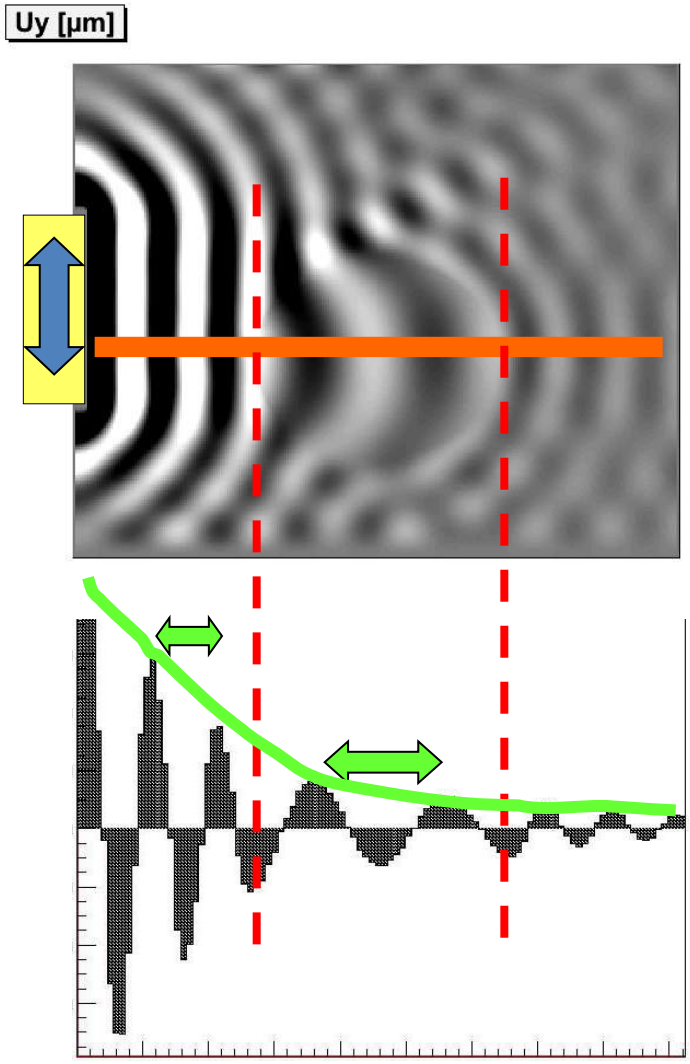
VESSEL WALL PROPERTIES

MR elastography

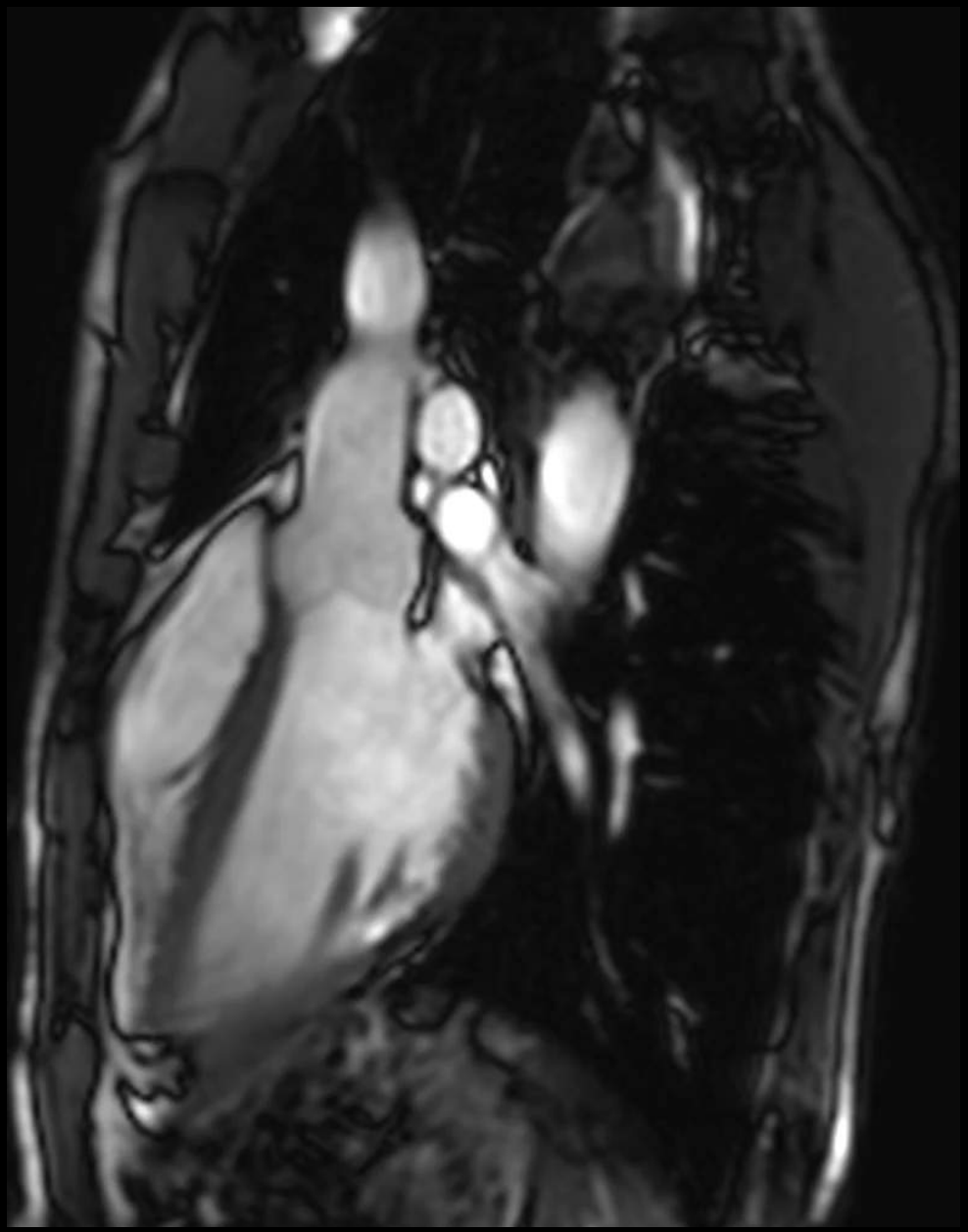


shear

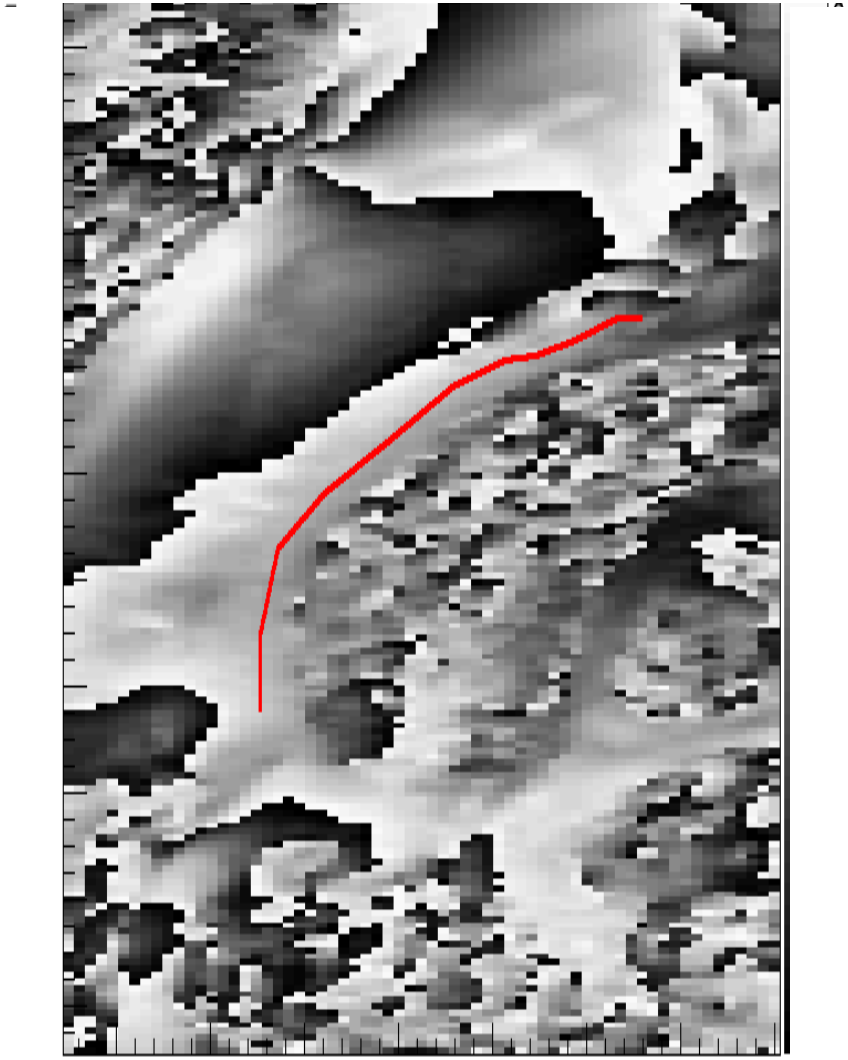
- unbalanced forces
- shape is changed
- volume is NOT changed



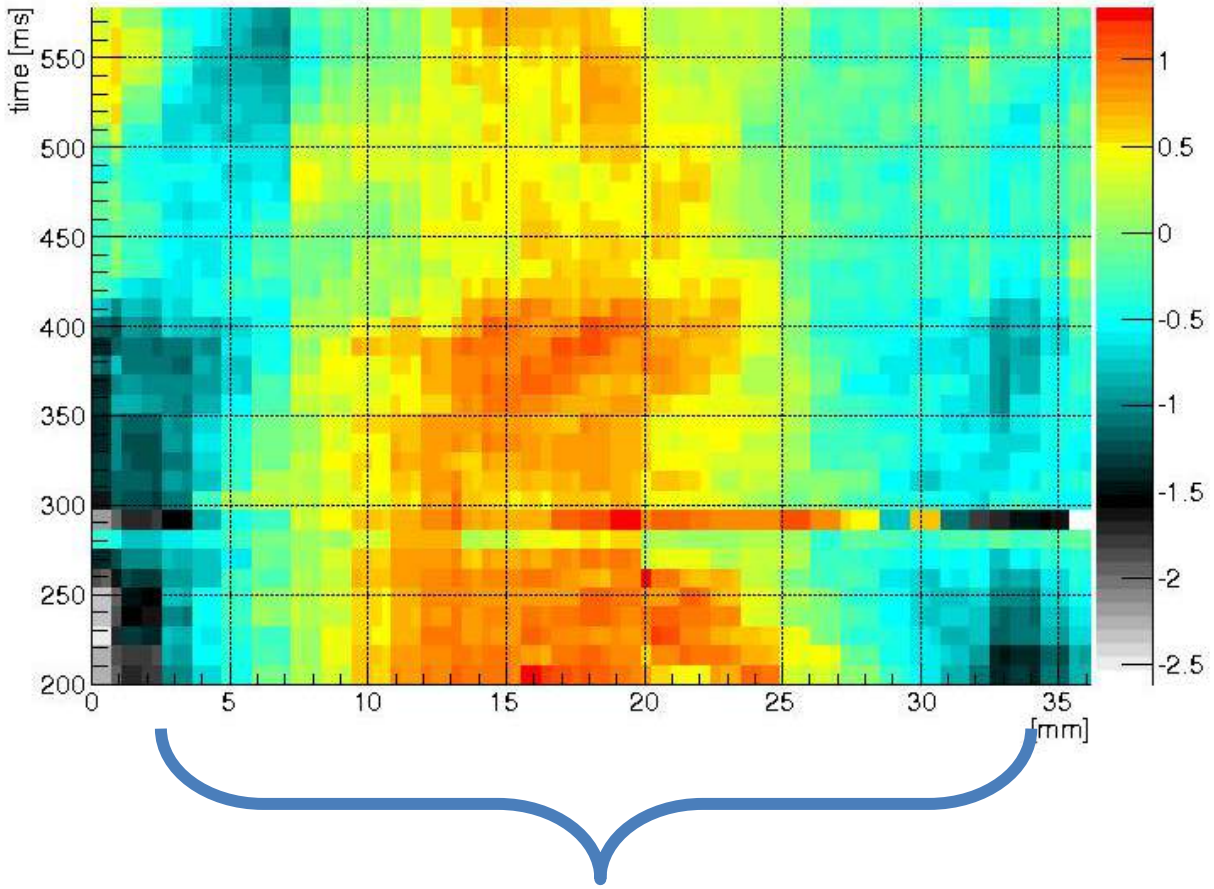
Elasticity



MR elastography



MR elastography

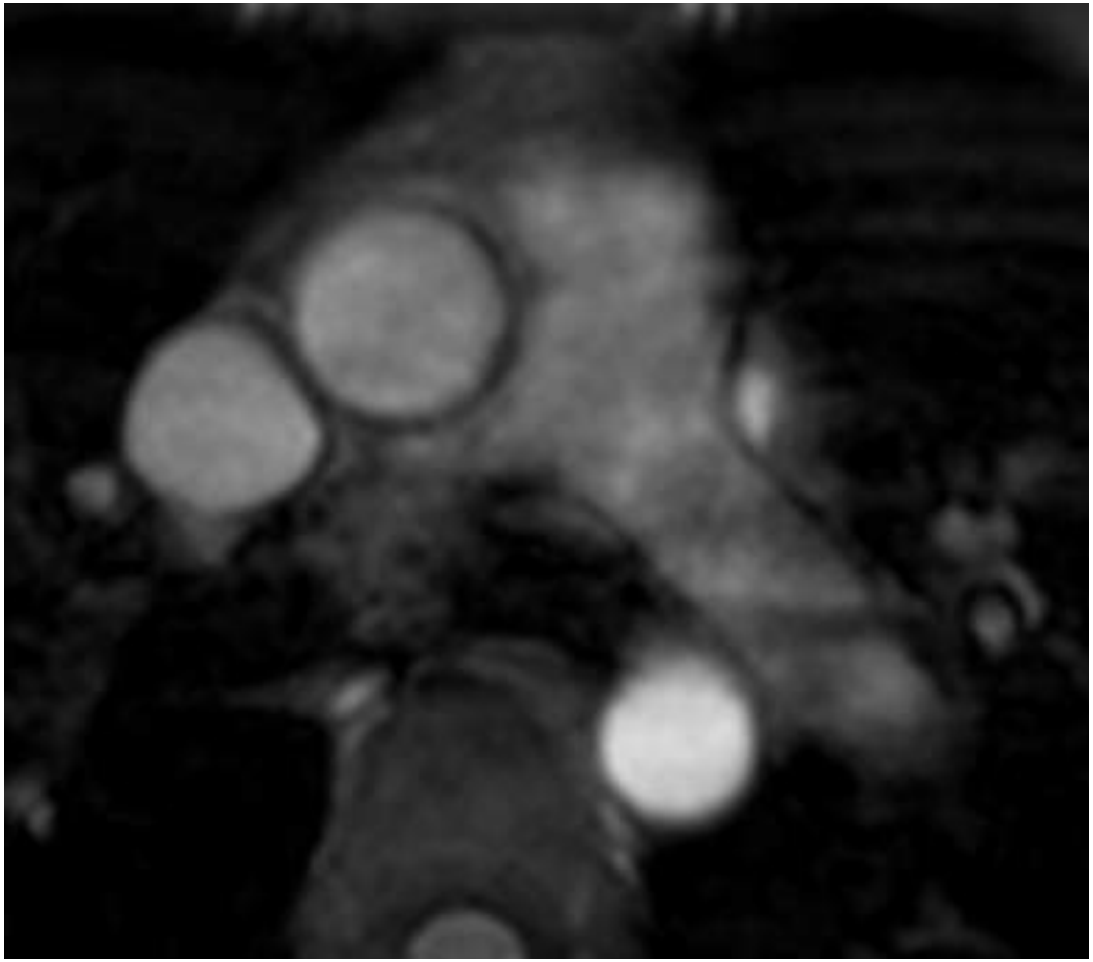


Time of aortic valve closure

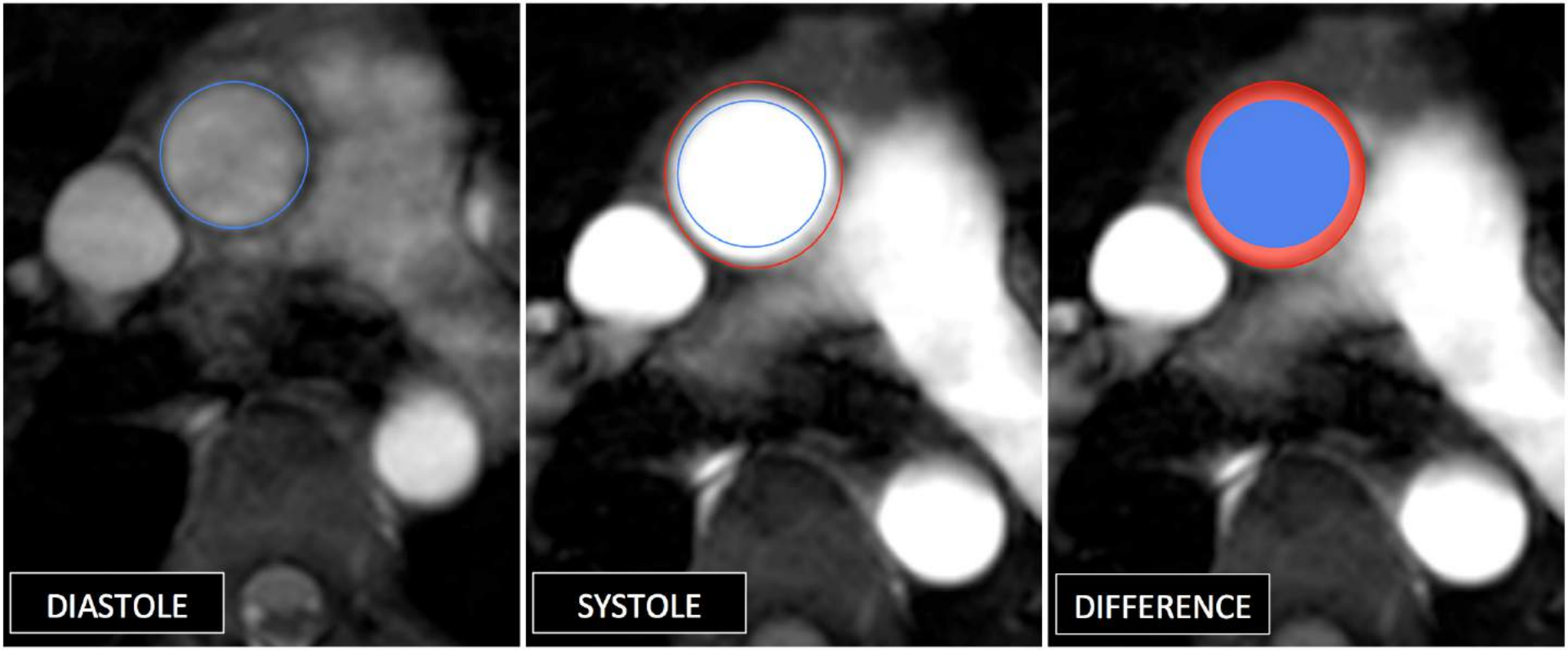
$\lambda = 32mm \rightarrow \quad c_s = \lambda * \nu = 0.032 * 165 = 5.3$ m/s

STENT GRAFT OVER-SIZING

Sizing



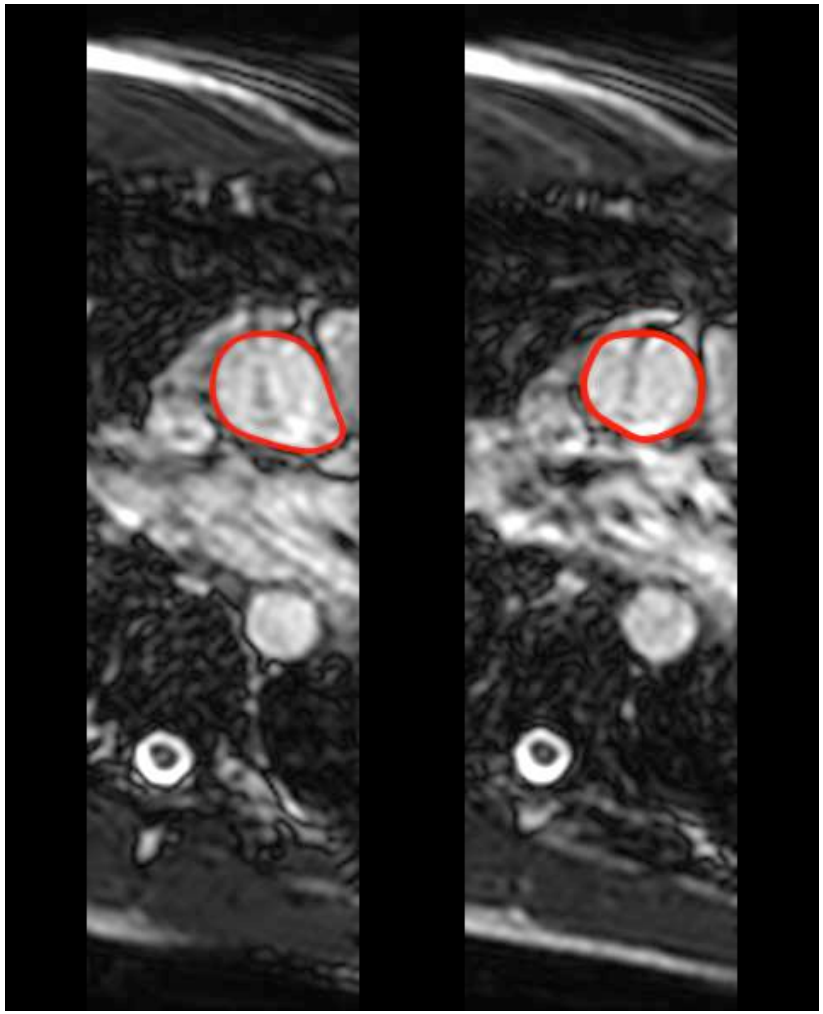
- oversizing 10 - 25%
- 2-3mm

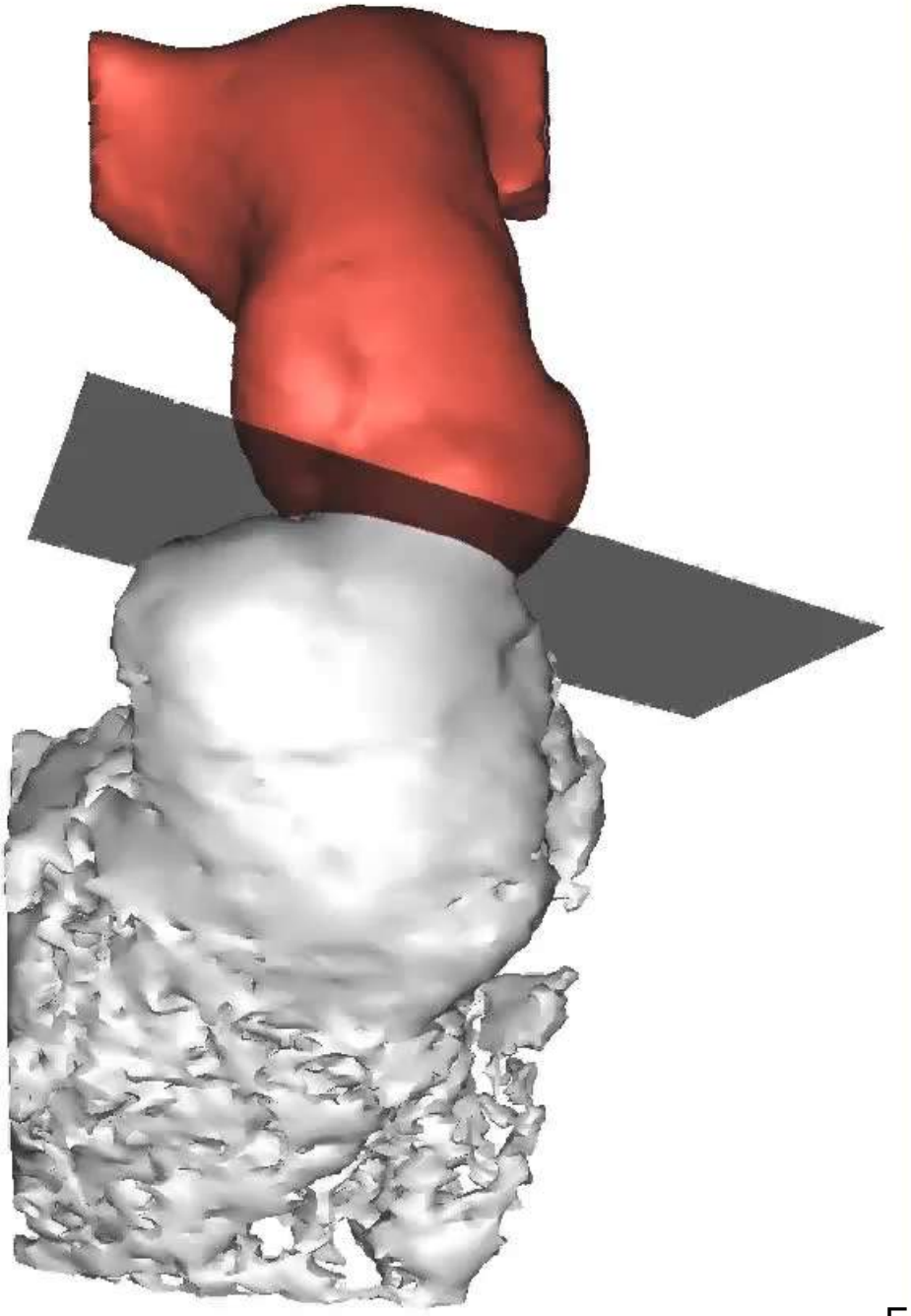


18 % difference in diameter between systole to diastole

Radiology. 2011;260:591-8

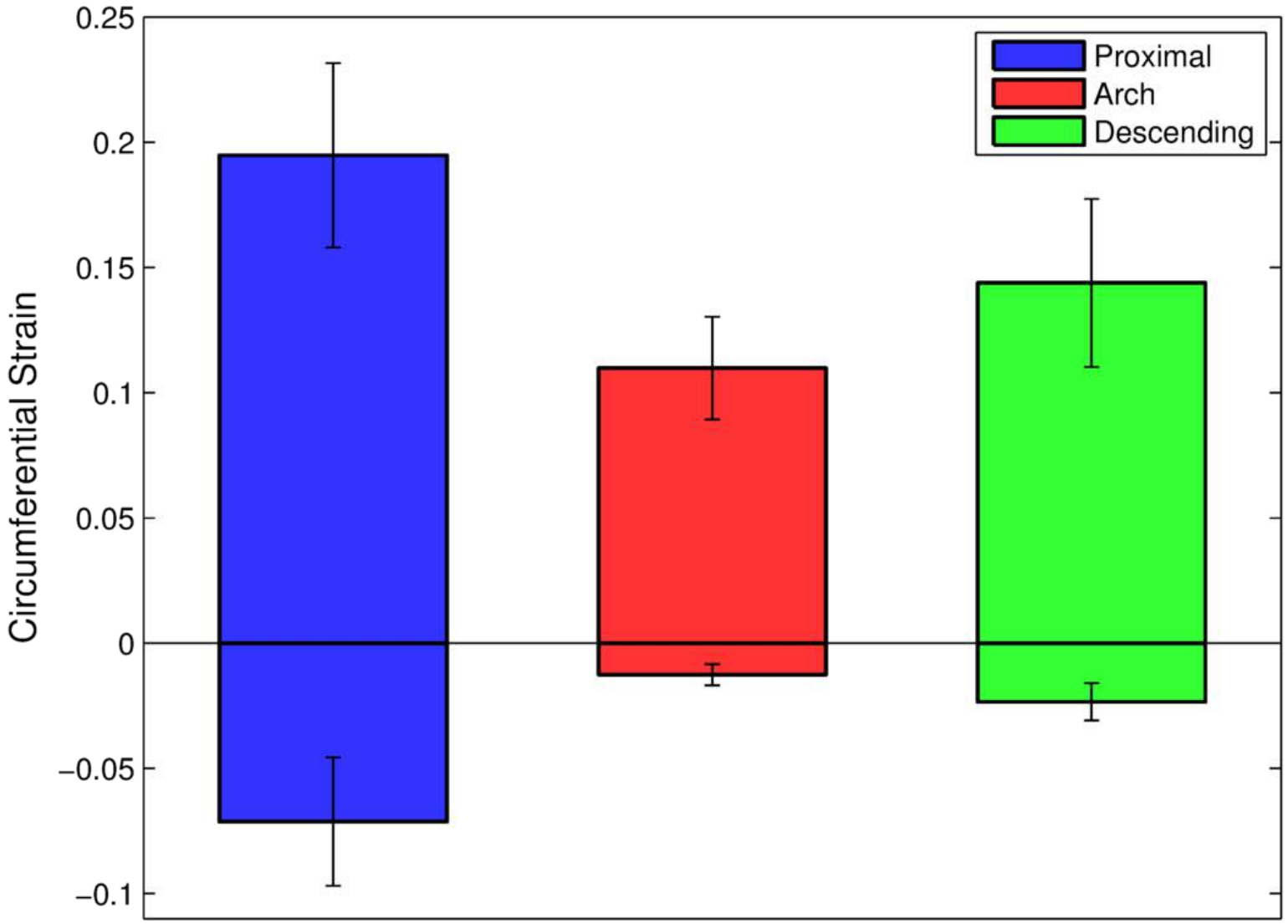
Through-plane movement





Eur Radiol. 2011;21:36-45

Pulsatile distension - cardiac motion



Conclusion

- The aortic root and ascending aorta are highly dynamic structures
- Quantifying and understanding these aortic biomechanics could improve the outcome of these endovascular techniques and aid the development of patient-specific treatments