International Symposium on 3D Imaging for
Interventional Catheterization in CHD
Nationwide Children's Hospital
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VesselNavigator and CT Overlay

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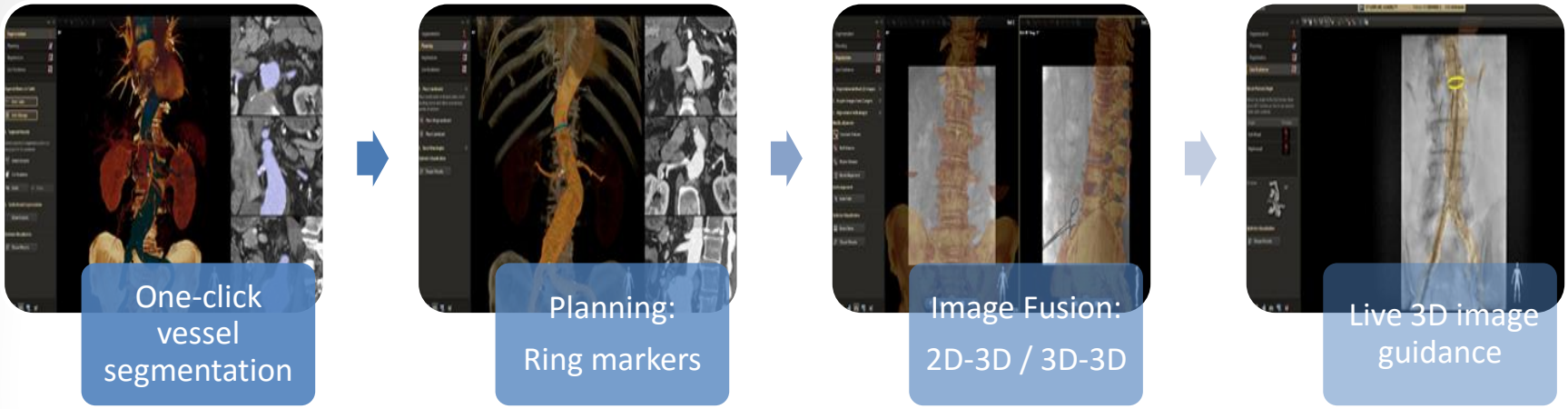
Research Institute

Introduction

- Recent advances in fusion software have enabled easy application of pre-intervention imaging, including computed tomography (CT) or magnetic resonance imaging (MRI) scans, to create a reliable roadmap for swift manipulation through complex cardiac anatomy.

  - Antegrade percutaneous closure of membranous ventricular septal defect using X-ray fused with magnetic resonance imaging. Ratnayaka K et al. JACC Cardiovasc Interv 2009
  - Targeted transendocardial therapeutic delivery guided by MRI-x-ray image fusion. Tomkowiak MT et al. Catheter Cardiovasc Interv. 2011
  - X-ray magnetic resonance fusion to internal markers and utility in congenital heart disease catheterization. Dori Y et al. Circ Cardiovasc Imaging. 2011
  - X-ray magnetic resonance fusion modality may reduce radiation exposure and contrast dose in diagnostic cardiac catheterization of congenital heart disease. Catheter Cardiovasc Interv. Abu Hazeem AA et al. 2014
  - CT angiography-fluoroscopy fusion imaging for percutaneous transapical access. Kliger C et al. JACC Cardiovasc Imaging. 2014
  - Multimodality 3-dimensional image integration for congenital cardiac catheterization. Fagan TE et al. Methodist Debakey Cardiovasc J. 2014
  - ....

VesselNavigator

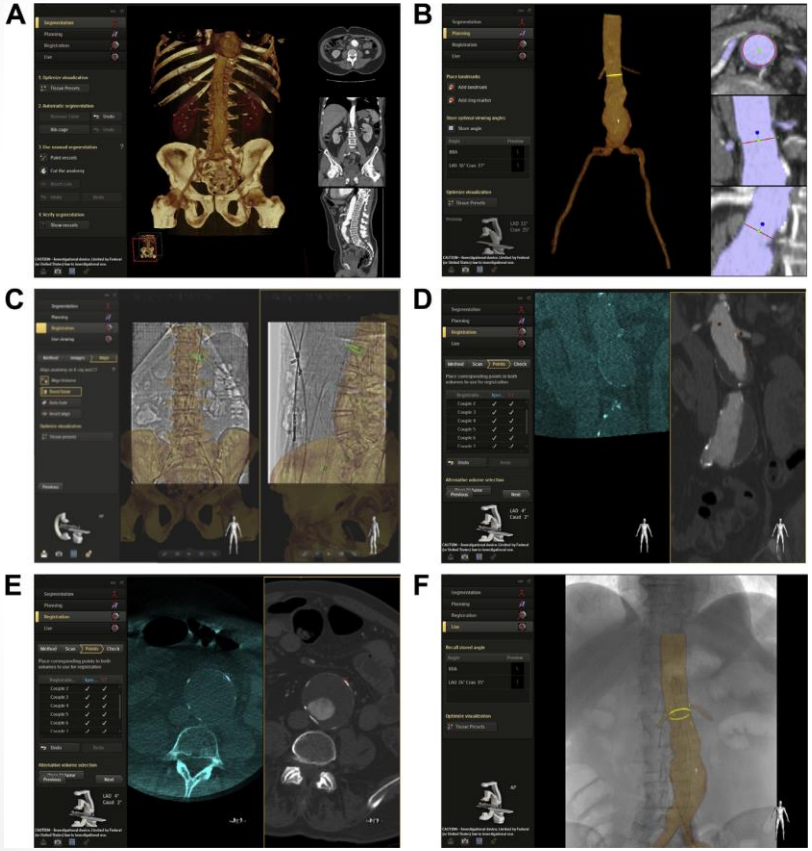


- VesselNavigator allows reuse of 3D vascular anatomical information from existing contrast **CT** and **MRI** datasets as a 3D roadmap overlay on a live X-ray image.

- VesselNavigator provides an intuitive and continuous **3D roadmap** to guide through **vasculature** during the entire procedure.

http://www.usa.philips.com/healthcare/product/HCNCVC465/vessel-navigator

Stangenberg L et al. A novel tool for three-dimensional roadmapping reduces radiation exposure and contrast agent dose in complex endovascular interventions. J Vasc Surg. 2015;62:448-55.



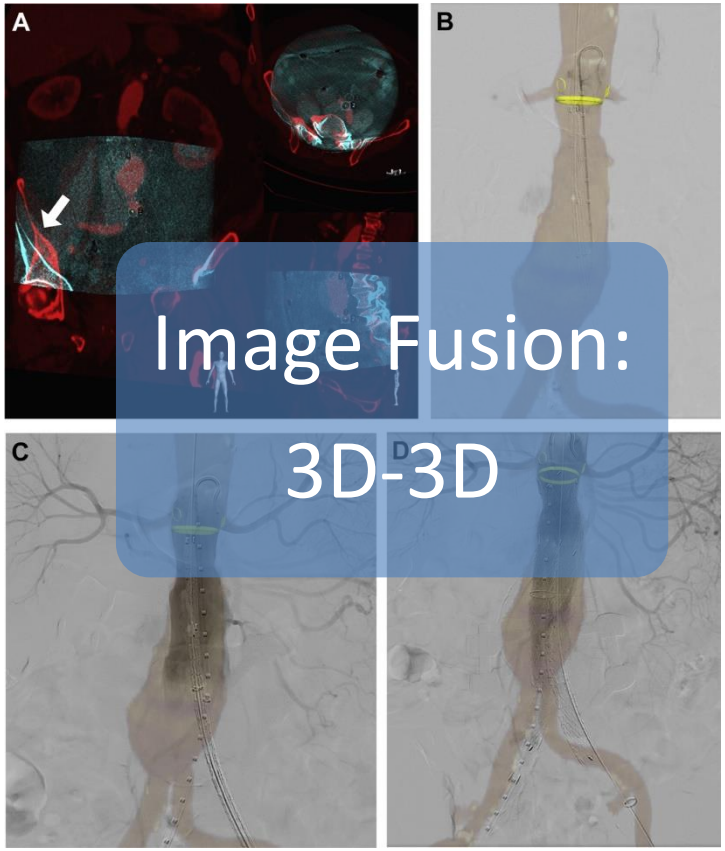


Image Fusion:

3D-3D

VesselNavigator HeartNavigator

Stenting of Subatretic Coarctation of Aorta Guided by Three Dimensional Roadmap Based on Computed Tomography or Magnetic Resonance Imaging Datasets.

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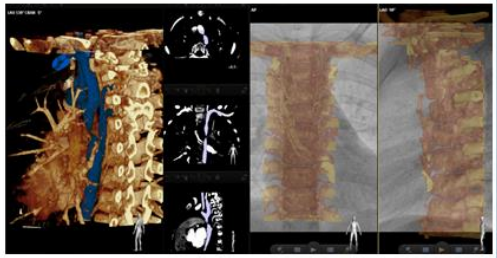
DEUTSCHES HERZZENTRUM BERLIN
STIFTUNG DES BÜRGERLICHEN RECHTS

INTRODUCTION Improvements in software development and image integration led to introduction of 3D reconstructed images for guidance of various transcatheter therapies. Recently available 3D roadmap based on Magnetic Resonance (MRI) or Computed Tomography (CT) datasets promises reduction in contrast and radiation exposure along with shorter procedural times. We describe application for 3D image integration for live guidance of stent implantation in subatretic coarctation of aorta (CoA) with the use of HeartNavigator Prototype (Phillips) and VesselNavigator (Phillips).

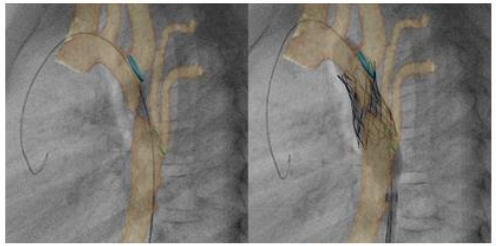
CASE ONE This 7 year old boy was referred with recently diagnosed CoA. Brachiocephalic hypertension was detectable with a gradient of 37-42 mmHg between arms and legs and reduced femoral pulse quality.

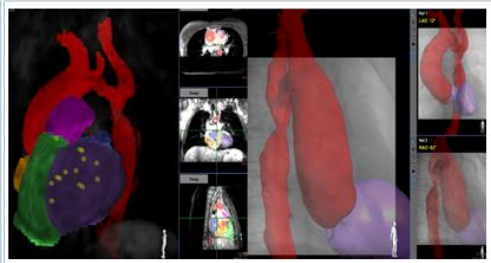
Echo: Flow acceleration (Vmax – 2.8 m/s) distal to the origin of the LSA with PG of 38 mmHg. Descending aorta with reduced pressure profile and diastolic "run-off".



CT scan: Subatretic CoA distal to the LSA, aortic arch between the LCA and the LSA 11x12.5 mm, descending aorta proximal to the narrowing 6x8 mm, CoA min. diameter 2x2 mm, post-stenotic dilation 14x13 mm.

Intervention: CoA predilation with an 8 mm balloon (Cordis) flowed by implantation of a 34 mm covered CP-stent (NuMed) on 16 mm BIB-balloon (NuMed) through a 12 Fr long sheath (Cook). Intervention was guided by CT derived 3D reconstruction overlay with VesselNavigator and Allura Xper FD (Phillips). Hemodynamic measurements showed no residual gradient. 3DRA was used to confirm optimal outcome of the intervention. Fluoroscopy time 4.2 min, DAP 12269 mGray*cm^2.

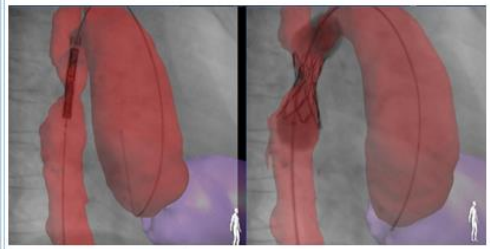




CASE TWO This 12 year old child with arterial hypertension already receiving ß-Blocker therapy. Brachiocephalic hypertension was detectable with a gradient of 47-56 mmHg between arms and legs and reduced femoral pulse quality.

Echo: Ascending aorta with 34-36 mm, descending aorta with reduced pressure profile and diastolic "run-off", gradient not clearly detectable.

MRI scan: Subatretic CoA distal to the LSA, aortic arch between the LCA and the LSA 10x12.5 mm, descending aorta proximal to the narrowing 11x12 mm, CoA min. diameter 5x5 mm, post-stenotic dilation 17x19 mm.



Intervention: Stent implantation in CoA with the use of a 28 mm covered CP-stent (NuMed) mounted on 12 mm BIB-balloon (NuMed) through an 11 Fr long sheath (Cook). Postdilation of the stent with an 18 mm sizing balloon (SJM/AGA Medical). Intervention was guided by MRI-overlay with HeartNavigator prototype on Allura Xper FD (Phillips). Calibration of the fluoroscopy and MRI data was done by two hand injections with 30° difference on angulation of the AP-plane. Fluoroscopy time 4,3 min, DAP 15940 mGray*cm^2.

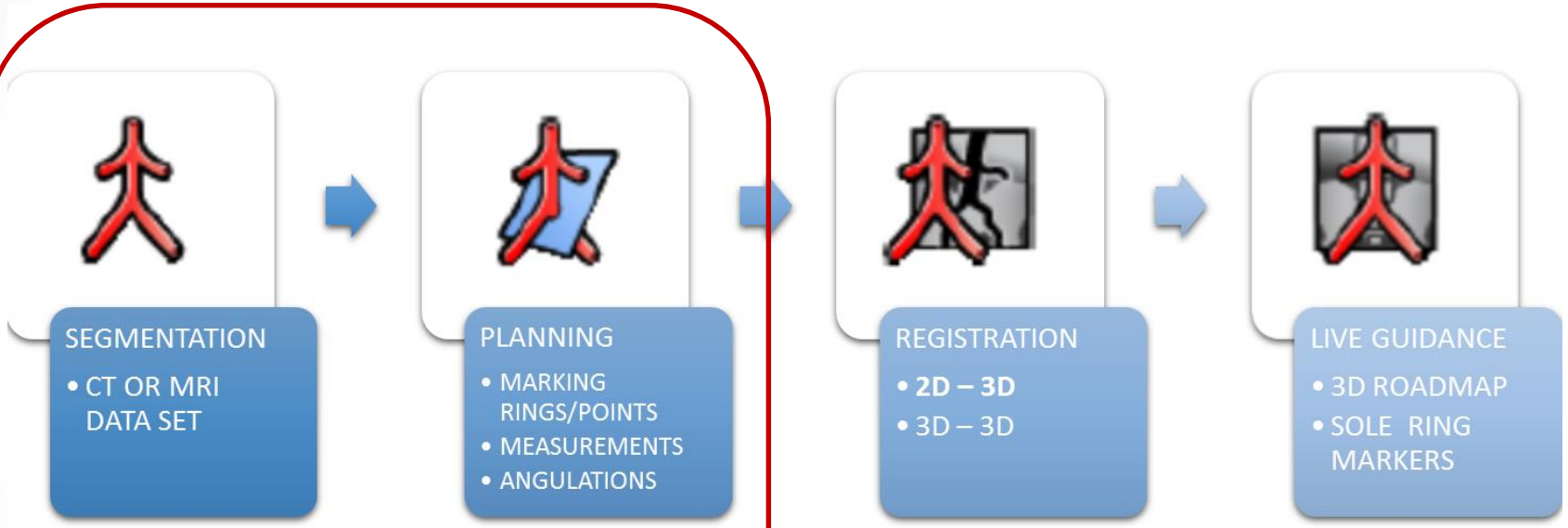
Learning points of the procedure:

CT dataset may be used for an **easy segmentation** and **production of 3D reconstruction** of the target lesion. Reliable overlay allows **resignation of diagnostic angiography** and enhances **precise stent positioning** and **implantation**. 3DRA allows large number of **"dynamic" angiographic** and **"static" reconstructed** images for **complete evaluation** of the final outcome.

3D mapping leads to **improved visualization** and might be performed with **CT**, **3DRA** or **MRI** data implementation. With the use of MRI data, a **decrease of radiation exposure** for hemodynamic assessment and guidance of interventional CoA treatment is possible. 3D mapping might be supportable, if it overall **increases efficacy** and **safety** of complex cardiovascular interventions. This has to be proven in larger series.

- The first VN assisted intervention at the Polish Mother's Memorial Hospital – October 2015

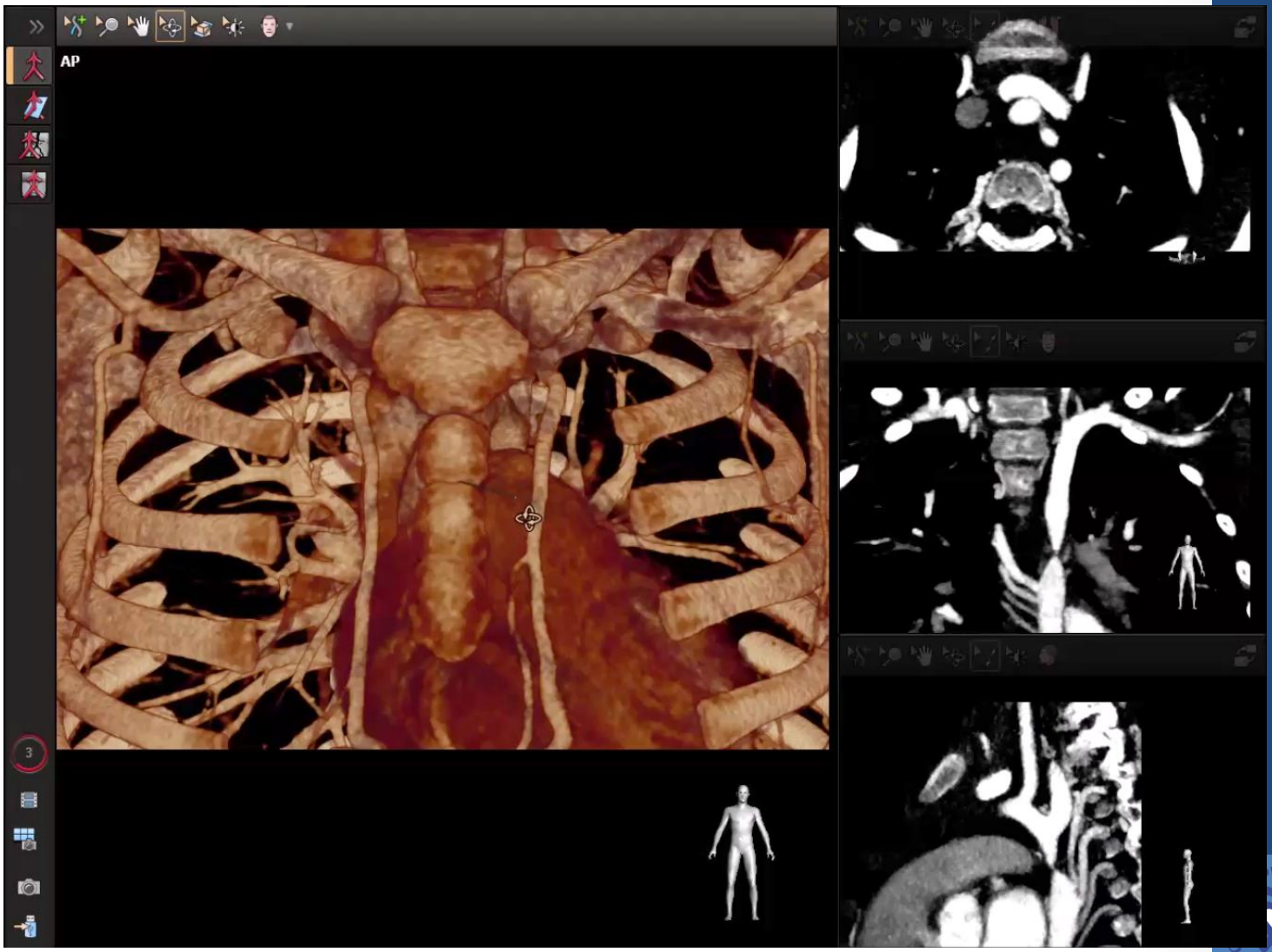
VesselNavigator Workflow



Performed before patient's arrival to the cath lab or during preparation.

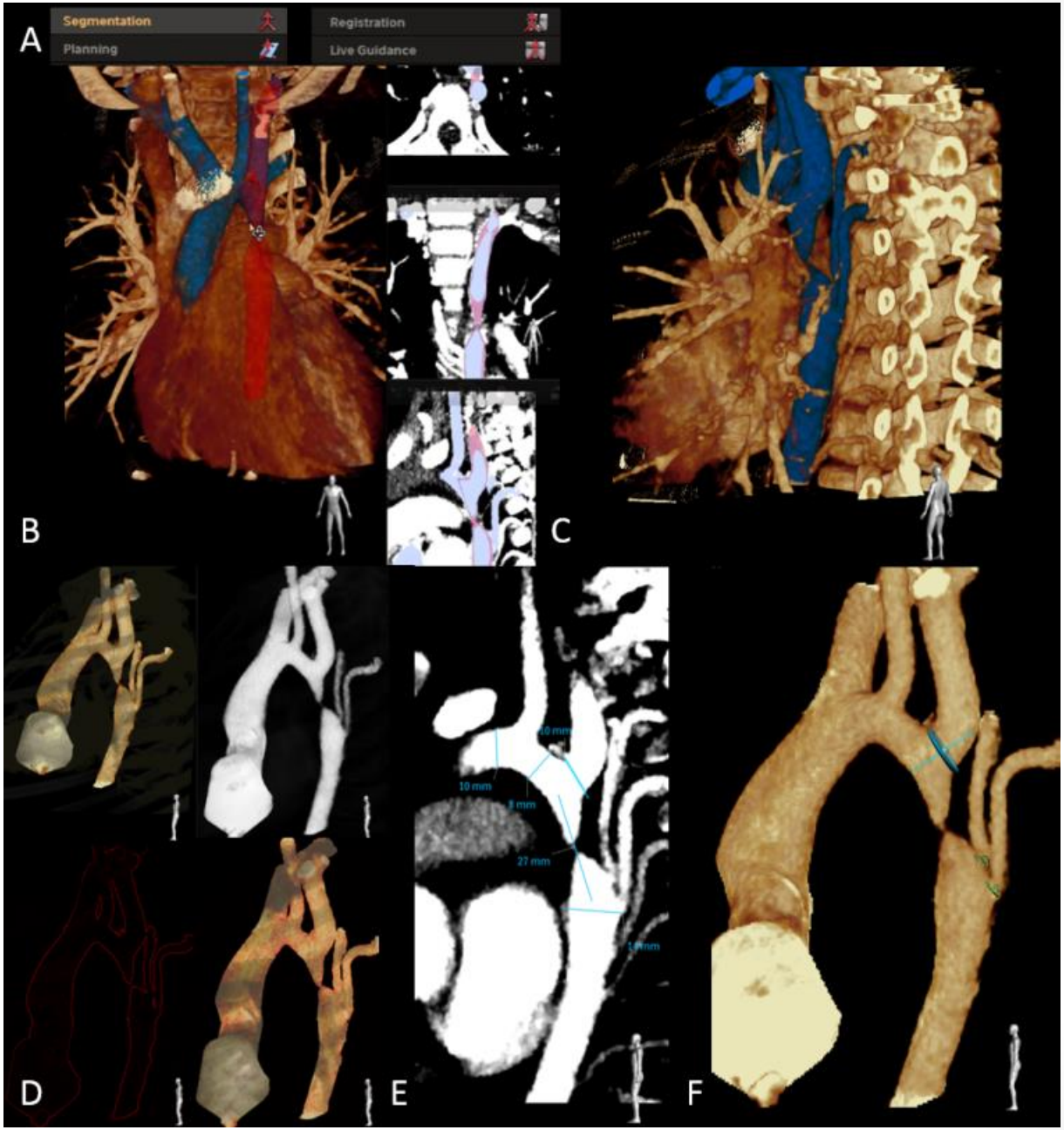
SEGMENTATION

- CT OR MR DATASET
- SINGLE CLICK
- CUT PLANE



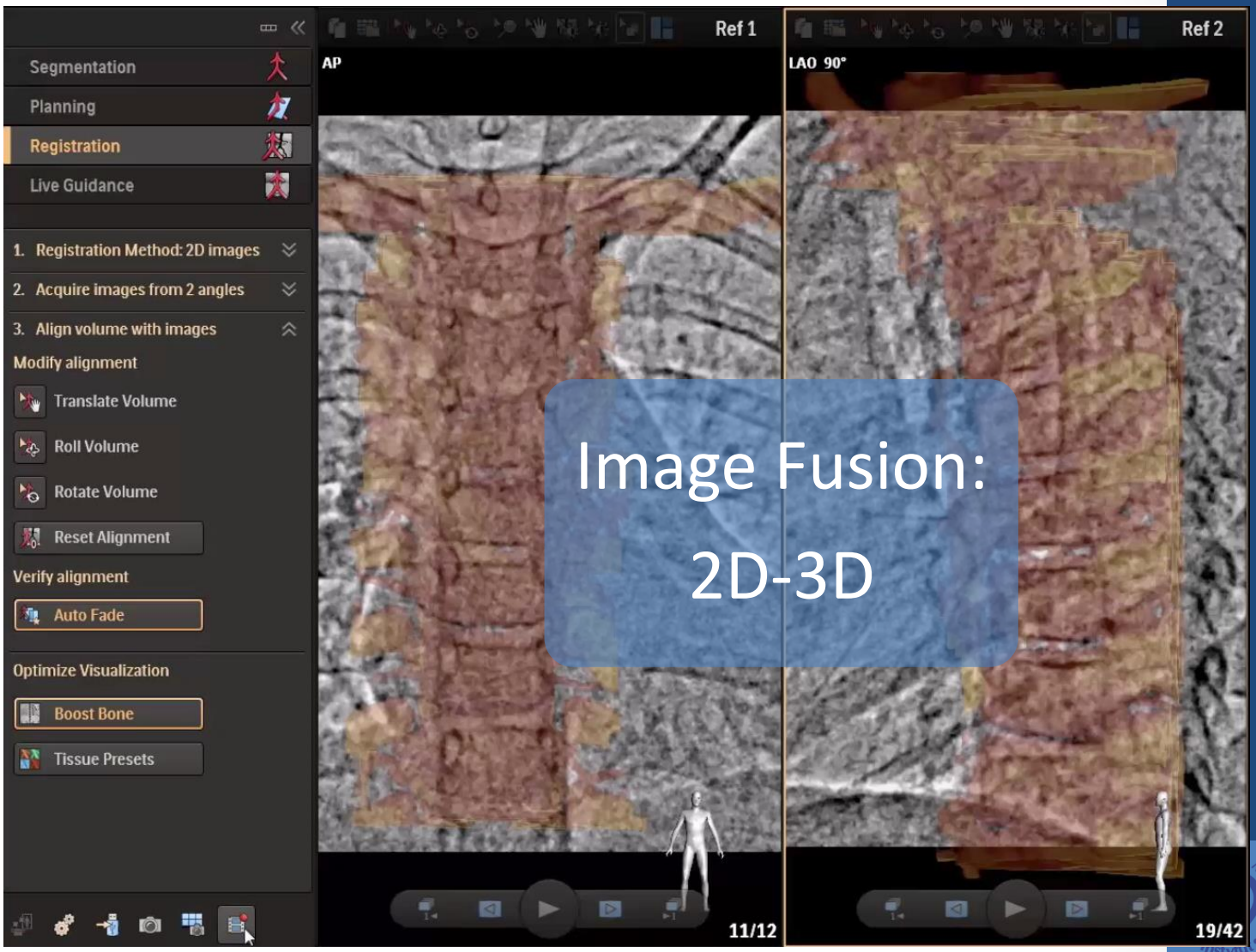
PLANNING

- RING MARKERS
- MARKING POINTS
- MEASUREMENTS
- ANGELS



REGISTRATION

- **2D – 3D**
- 3D – 3D



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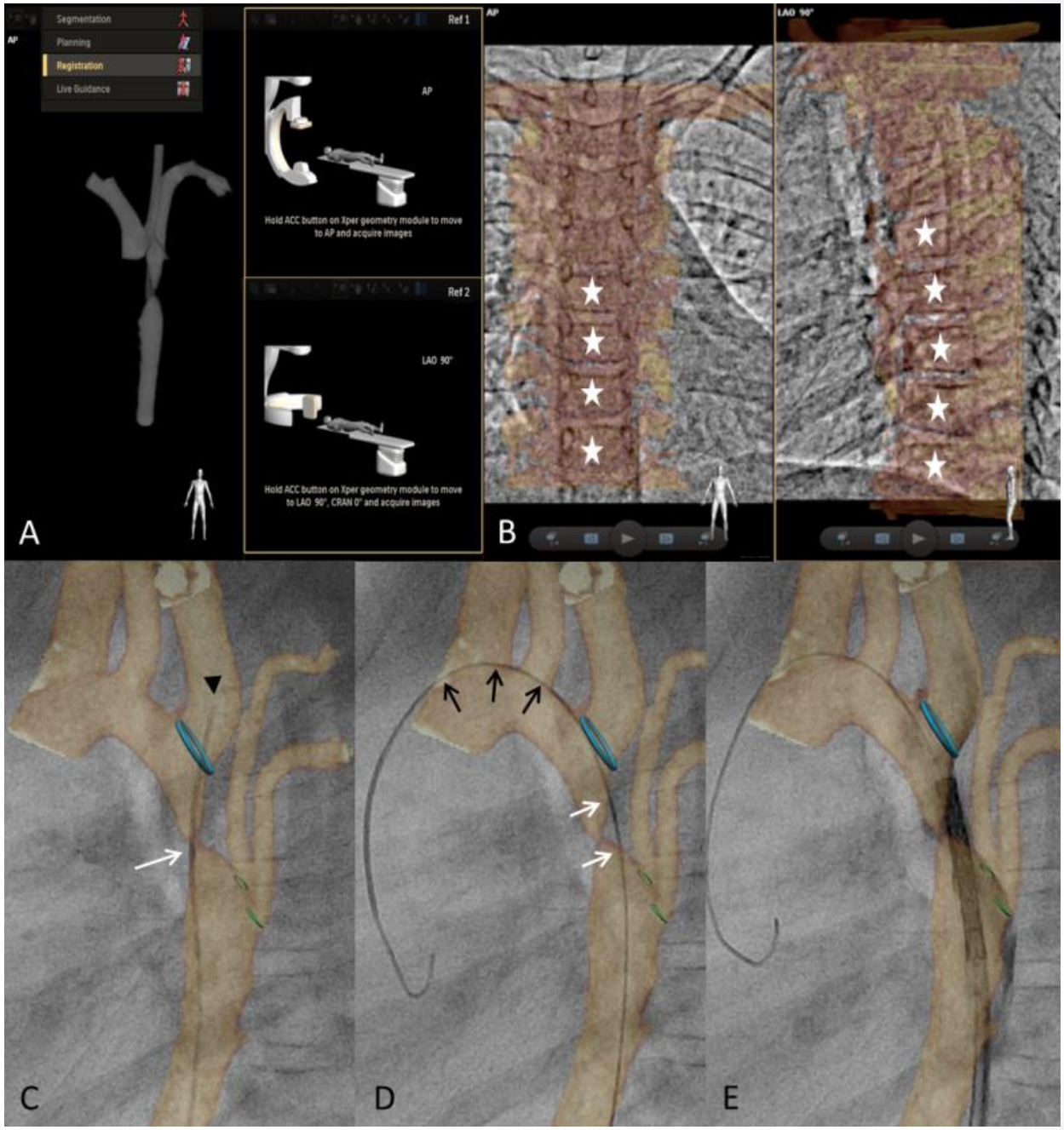
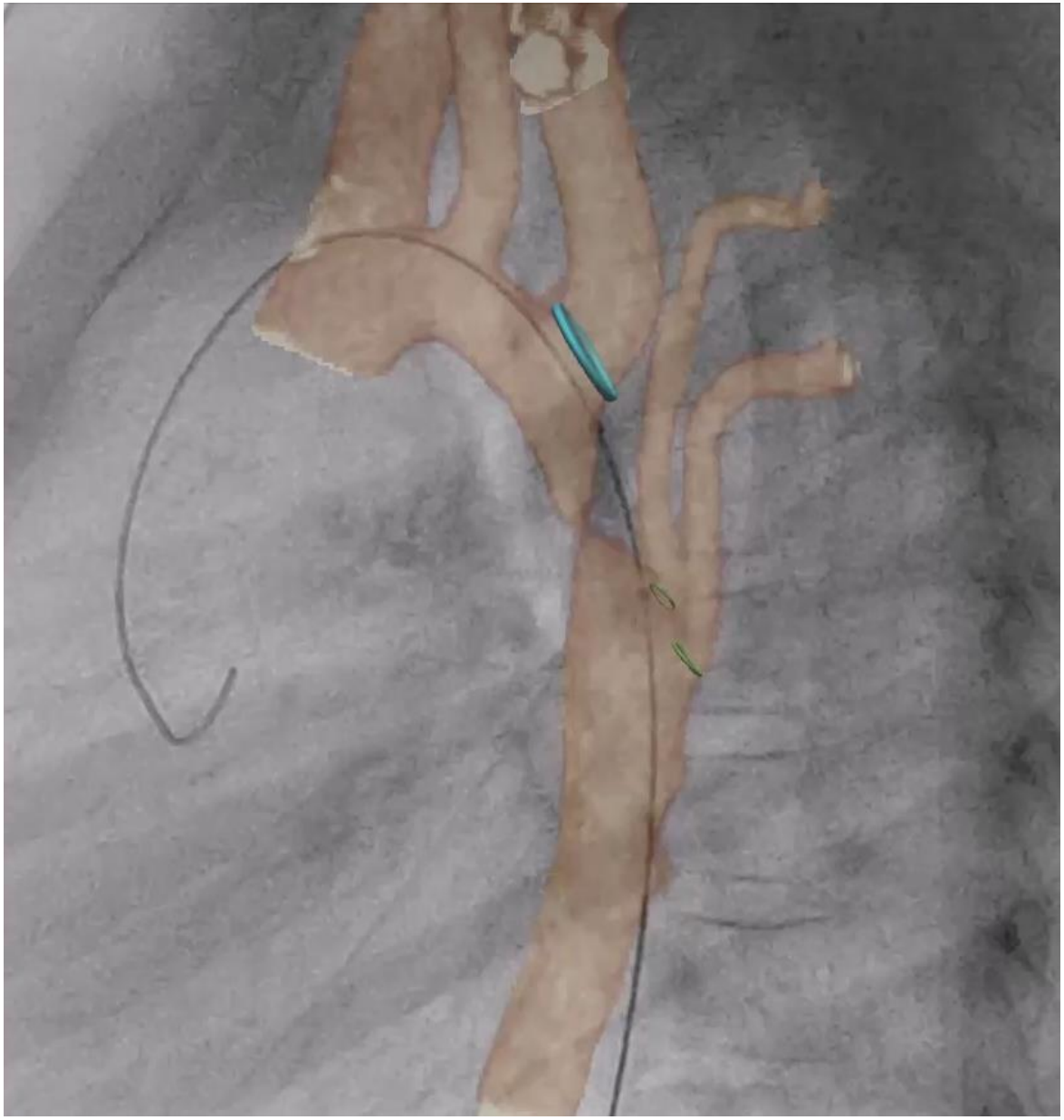
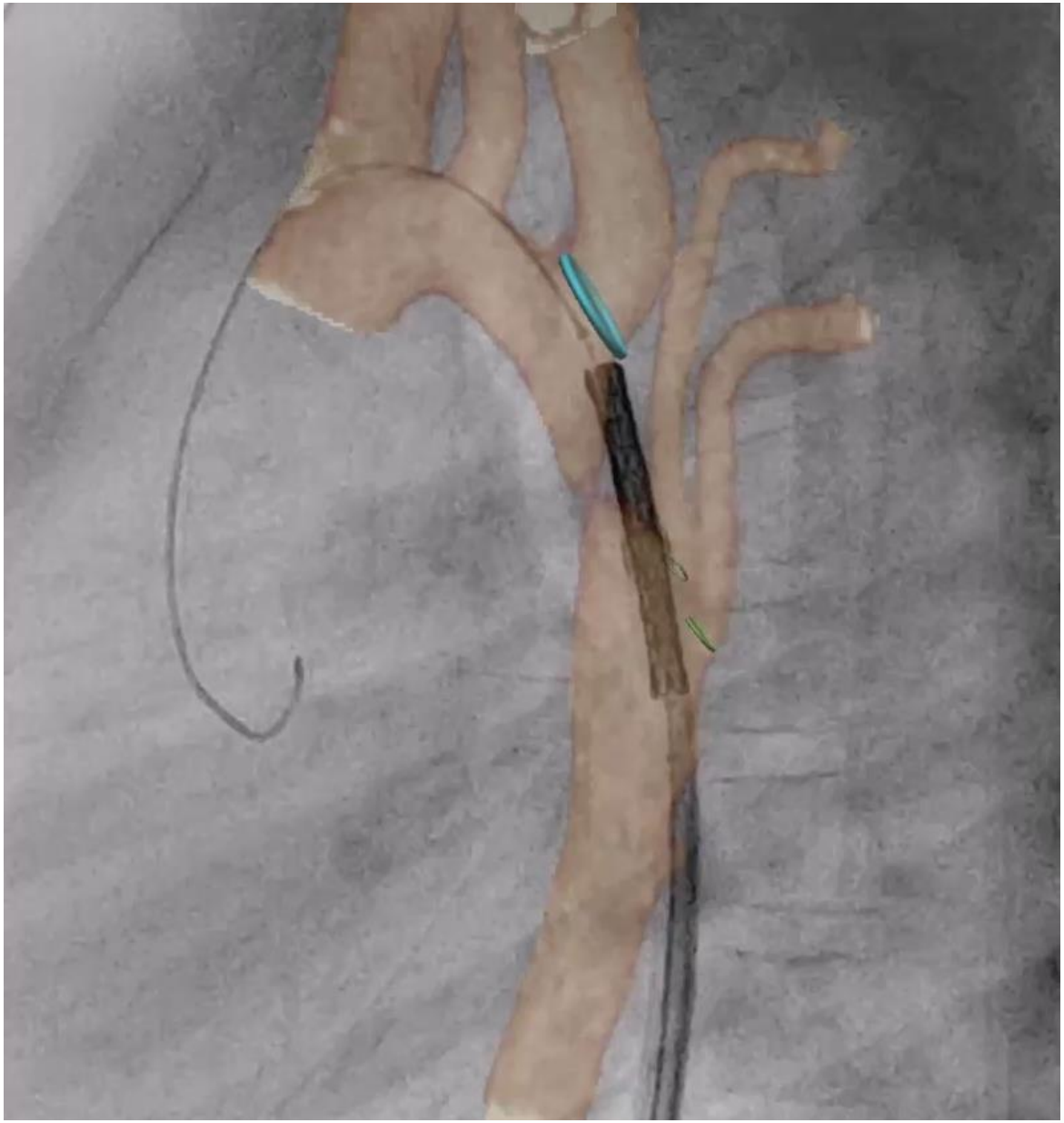


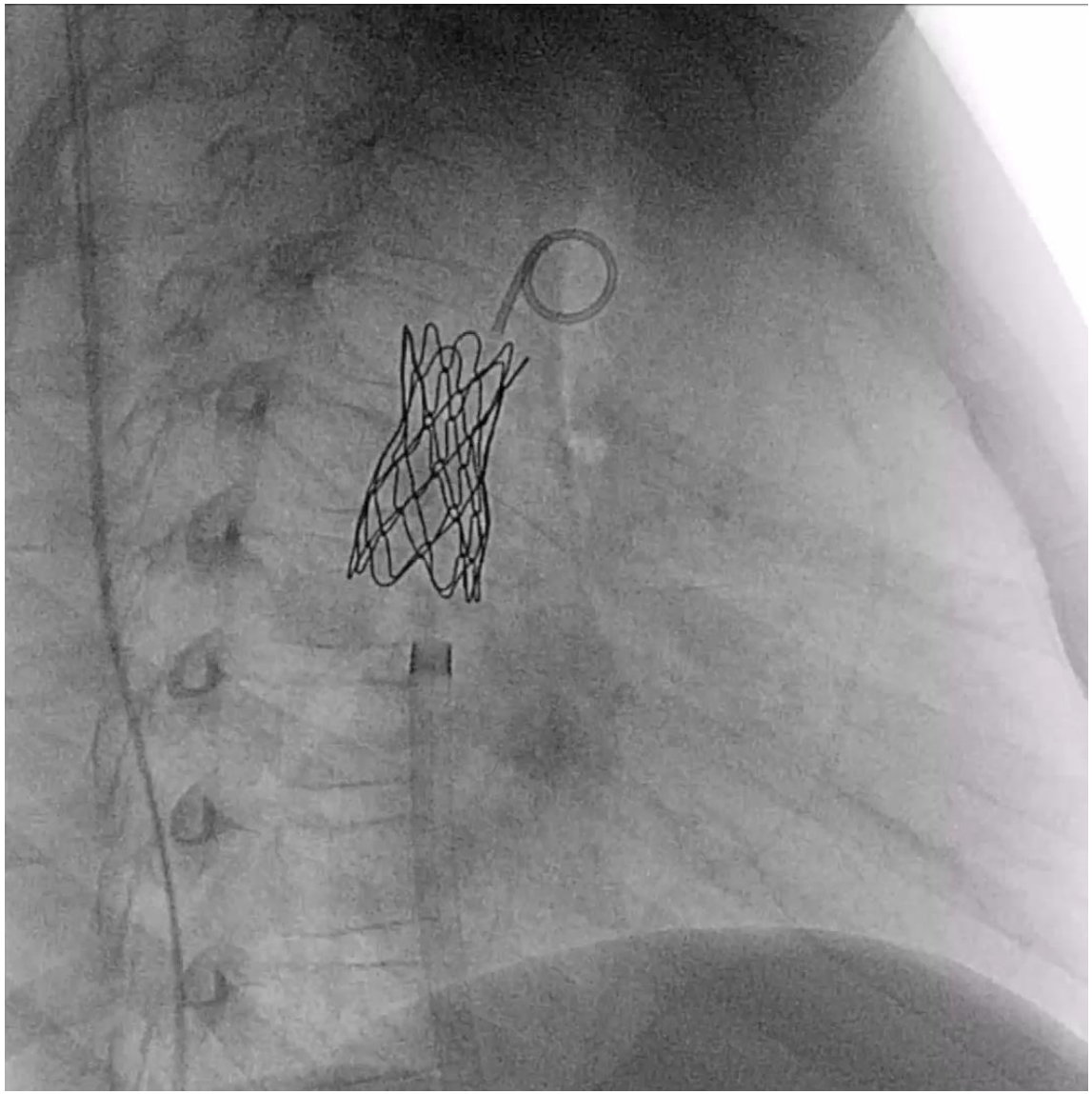
Accuracy of fusion should be confirmed during the later stages of the intervention.

LIVE GUIDANCE



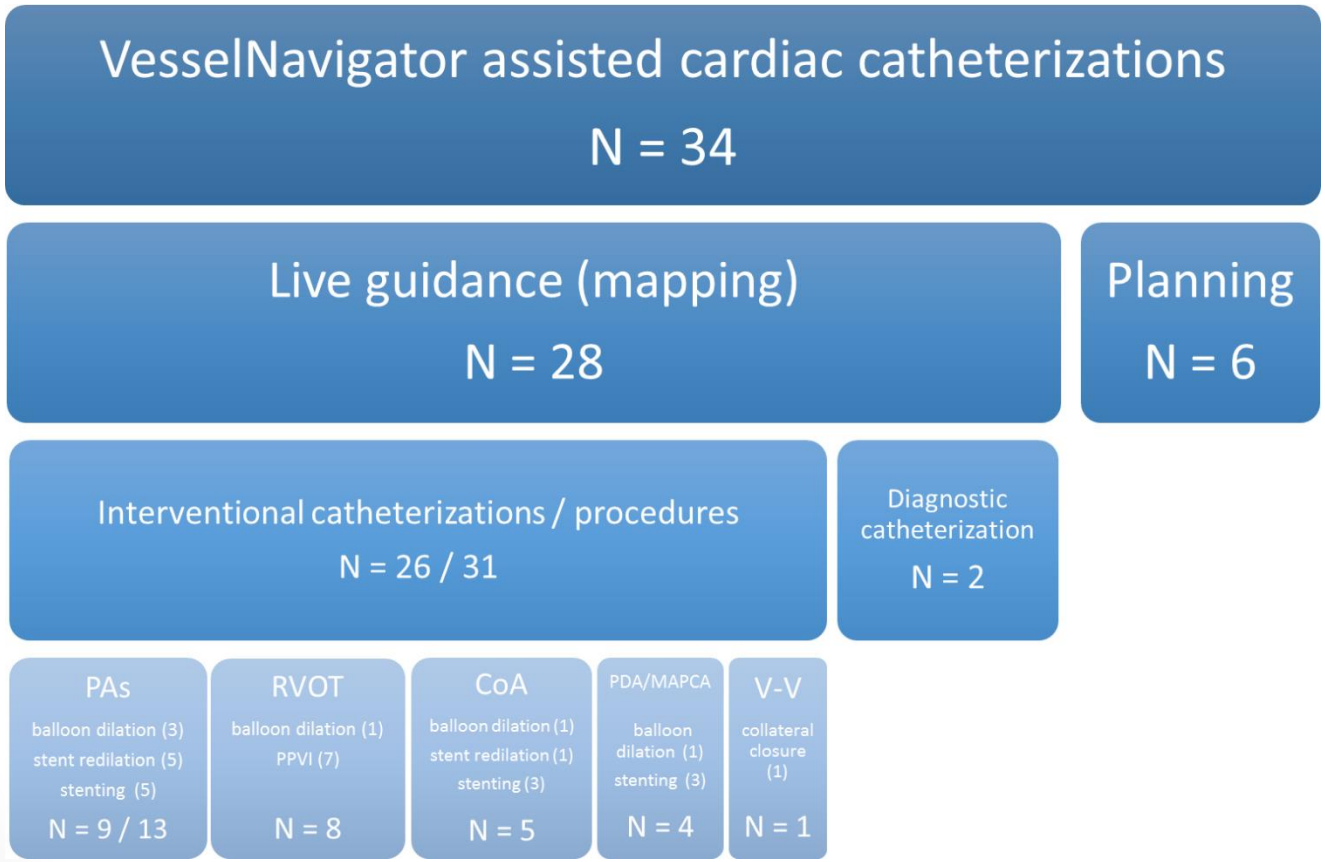
LIVE GUIDANCE





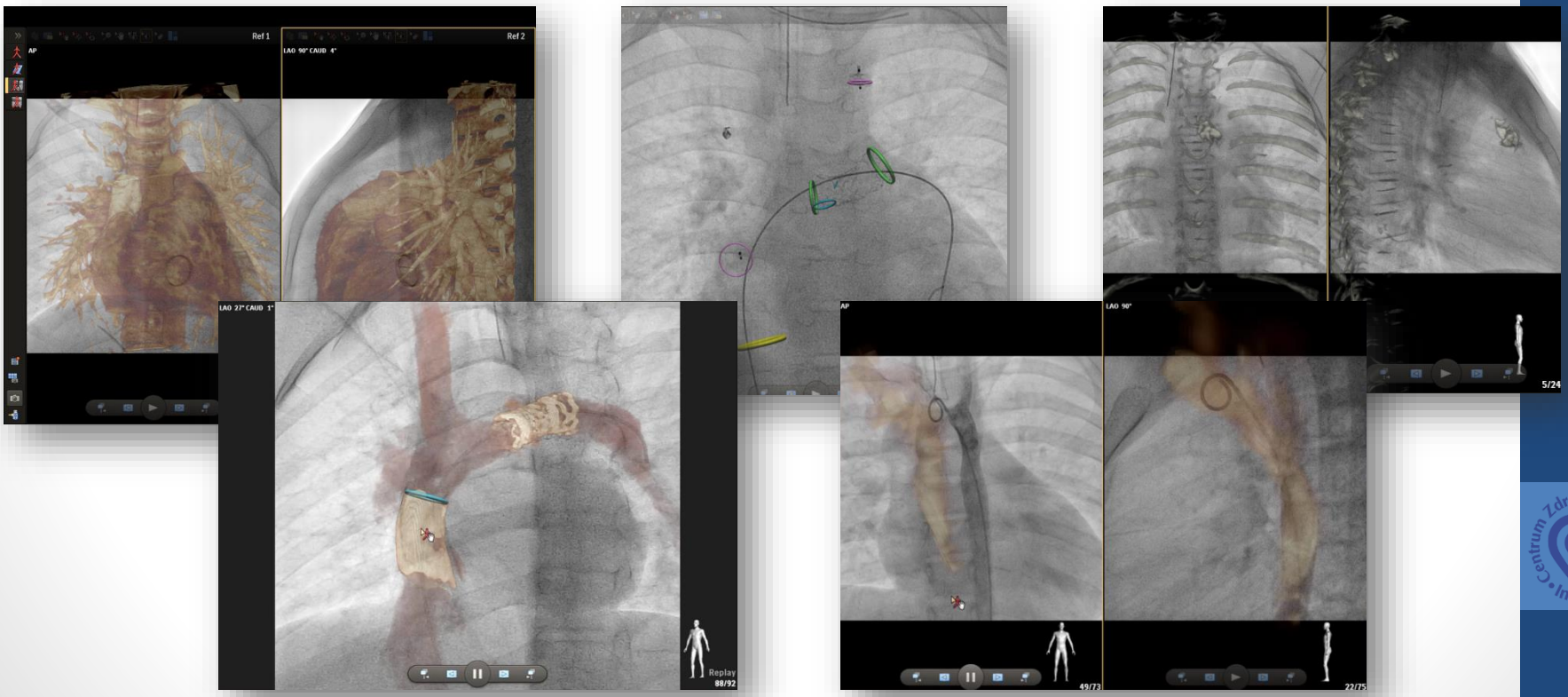
3D image fusion for interventions in CHD

- From 10/2015, VesselNavigator was applied in 34 patients for guidance (n=28) or planning (n=6) of cardiac catheterization.



3D image fusion for interventions in CHD

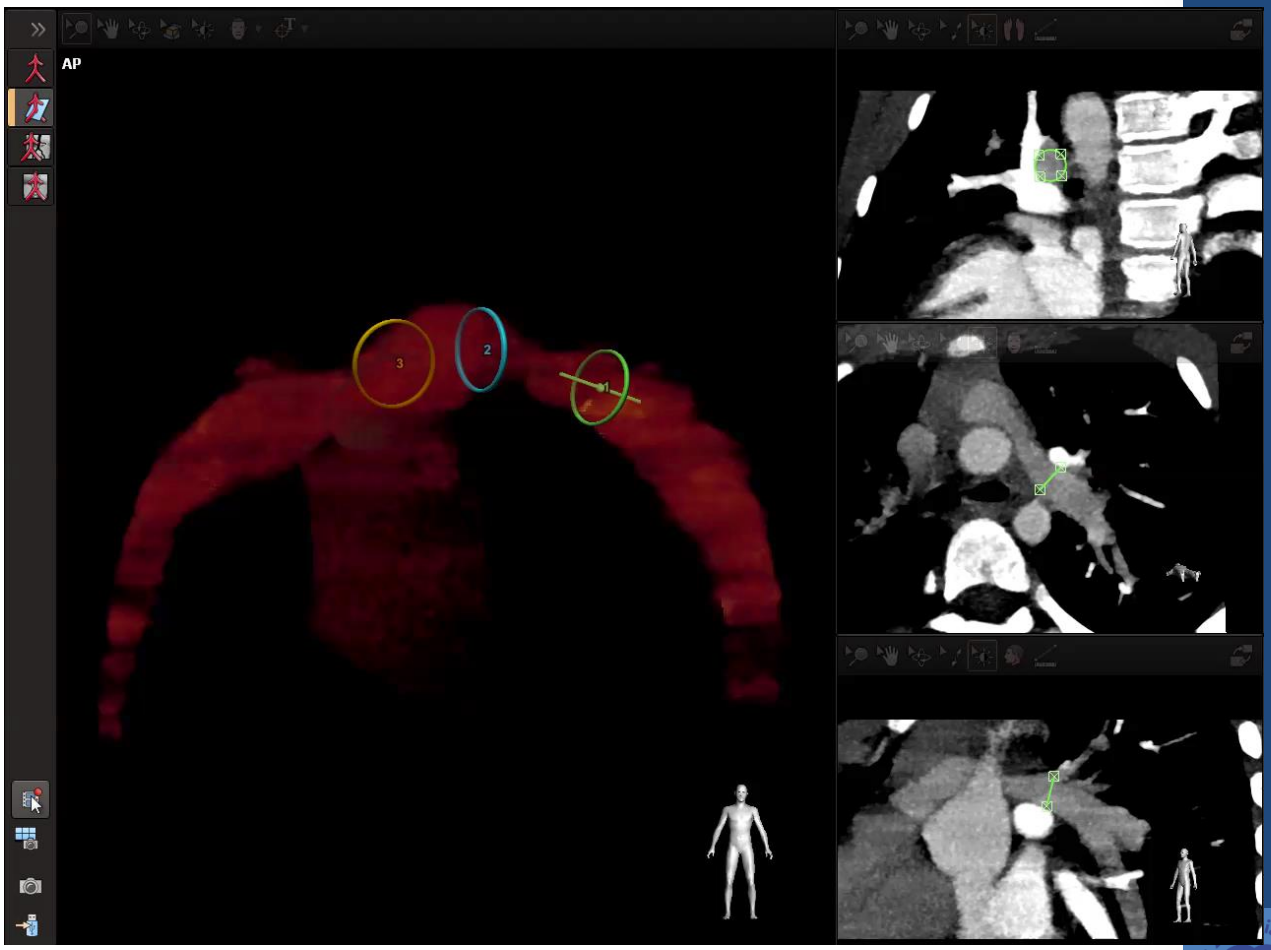
- Fusion was performed with:
  - bony structures combined with the cardiovascular silhouette in 26 patients (93%),
  - calcifications in 9 (32%),
  - previously implanted devices in 8 (29%),
  - low volume contrast injection in 7 patients (25%).



Patients characteristics	Total no of patients* N = 34	VesselNavigator assisted interventions, lesion site				Planning N = 6
		PAs (N = 9)	RVOT (N = 8)	CoA (N = 5)	PDA / MAPCA (N = 4)	
Sex (%)	Male, 22/34 (65%)	Male, 6/9 (66%)	Male, 4/8 (50%)	Male, 4/5 (80%)	Male, 2/4 (50%)	Male, 5/6 (83%)
Age (years)	9.8 (0.03 – 22.3)	9.6 (1 – 14.9)	11 (2.9 – 15.9)	7.6 (0.06 – 15.2)	1.1** (0.3 – 48.8)	12.9 (0.4 – 22.3)
Weight (kg)	33.0 (2.4 – 69.0)	30 (8.0 – 45.0)	38.4 (14.2 – 55.0)	35.0 (3.0 – 69.0)	3.2 (2.4 – 10.5)	40.3 (4.0 – 45.0)
BSA (m2)	1.1 (0.2 – 1.8)	1.0 (0.4 – 1.4)	1.2 (0.6 – 1.6)	1.1 (0.2 – 1.8)	0.2 (0.2 – 0.5)	1.2 (0.2 – 1.4)
Previous imaging						
CT	32/34 (94%)	9/9 (100%)	8/8 (100%)	4/5 (80%)	4/4 (100%)	6/6 (100%)
MRI	2/34 (6%)	0/9 (0%)	0/8 (0%)	1/5 (20%)	0/4 (0%)	0/6 (0%)
Time interval (days)	30 (0 – 912)	58 (1 – 912)	77 (0 – 245)	19.5 (0 – 181)	5 (1 – 7)	8 (0 – 78)
Contrast (ml)	24.5 (5 – 73)	24.0 (12 – 45)	34.5 (20 – 73)	22.5 (5 – 35)	5.5 (5 – 16)	37.5 (5 – 50)
Contrast (ml/kg)	1.2 (0.5 – 2.1)	1.3 (0.5 – 1.7)	1.0 (0.5 – 1.9)	1.0 (0.5 – 1.7)	1.7 (1.5 – 2.1)	1.1 (0.5 – 1.3)
DLP (mGy cm)	55.7 (12 – 460.3)	67.7 (12 – 213.2)	64.9 (35.5 – 327.7)	54.3 (36.4 – 460.3)	48.2 (33.9 – 65.6)	73.7 (39.0 – 445.5)
2D – 3D registration						
Bony structures	26/28 (93%)	9/9 (100%)	8/8 (100%)	4/5 (80%)	4/4 (100%)	-
Calcifications	9/28 (32%)	3/9 (33%)	6/8 (75%)	0/5 (0%)	0/4 (0%)	-
Devices	8/28 (29%)	4/9 (44%)	2/8 (25%)	2/5 (40%)	0/4 (0%)	-
Contrast injection	7/28 (25%)	1/9 (11%)	1/8 (12.5%)	2/5 (40%)	2/4 (50%)	-
3D roadmap alignment						
Initially accurate	25/28 (89%)	9/9 (100%)	8/8 (100%)	3/5 (60%)	3/4 (75%)	-
Inter-procedural readjustment	6/28 (22%)	3/9 (33%)	1/8 (12.5%)	1/5 (20%)	1/4 (25%)	-
Catheterization						
Contrast dose (ml)	35.0 (3 – 130)	32.0 (10 – 100)	55.5 (35 – 130)	30.0 (5 – 55)	16.5 (3 – 39)	-
Contrast dose (ml/kg)	1.3 (0.4 – 8.8)	1.1 (0.8 – 3.3)	1.5 (1.1 – 3.6)	0.9 (0.4 – 1.7)	2.5 (1.0 – 8.8)	-
DAP (µGy m2)	2072.0 (86.2 – 16694.1)	2284.0 (523.5 – 5833.8)	6431.3 (795.5 – 16694.1)	1860.1 (168.1 – 4535.1)	736.4 (86.2 – 1773.8)	-
Fluoroscopy time (min)	15.9 (3.3 – 53.5)	18.3 (6.4 – 32.5)	22.3 (9.3 – 53.5)	5.5 (3.3 – 9.5)	22.6 (4.3 – 37.4)	-
Procedural time (min)	75 (15 – 185)	75 (20 – 125)	122.5 (55 – 175)	40 (15 – 60)	50 (15 – 185)	-

VesselNavigator Guided Pulmonary Artery Interventions

Patients characteristics	VesselNavigator assisted interventions, lesion site
	PAs (N = 9)
Sex (%)	Male, 6/9 (66%)
Age (years)	9.6 (1 – 14.9)
Weight (kg)	30 (8.0 – 45.0)
BSA (m2)	1.0 (0.4 – 1.4)
Previous imaging	
CT	9/9 (100%)
MRI	0/9 (0%)
Time interval (days)	58 (1 – 912)
Contrast (ml)	24.0 (12 – 45)
Contrast (ml/kg)	1.3 (0.5 – 1.7)
DLP (mGy cm)	67.7 (12 – 213.2)
2D – 3D registration	
Bony structures	9/9 (100%)
Calcifications	3/9 (33%)
Devices	4/9 (44%)
Contrast injection	1/9 (11%)
3D roadmap alignment	
Initially accurate	9/9 (100%)
Inter-procedural readjustment	3/9 (33%)
Catheterization	
Contrast dose (ml)	32.0 (10 – 100)
Contrast dose (ml/kg)	1.1 (0.8 – 3.3)
DAP (µGy m2)	2284.0 (523.5 – 5833.8)
Fluoroscopy time (min)	18.3 (6.4 – 32.5)
Procedural time (min)	75 (20 – 125)



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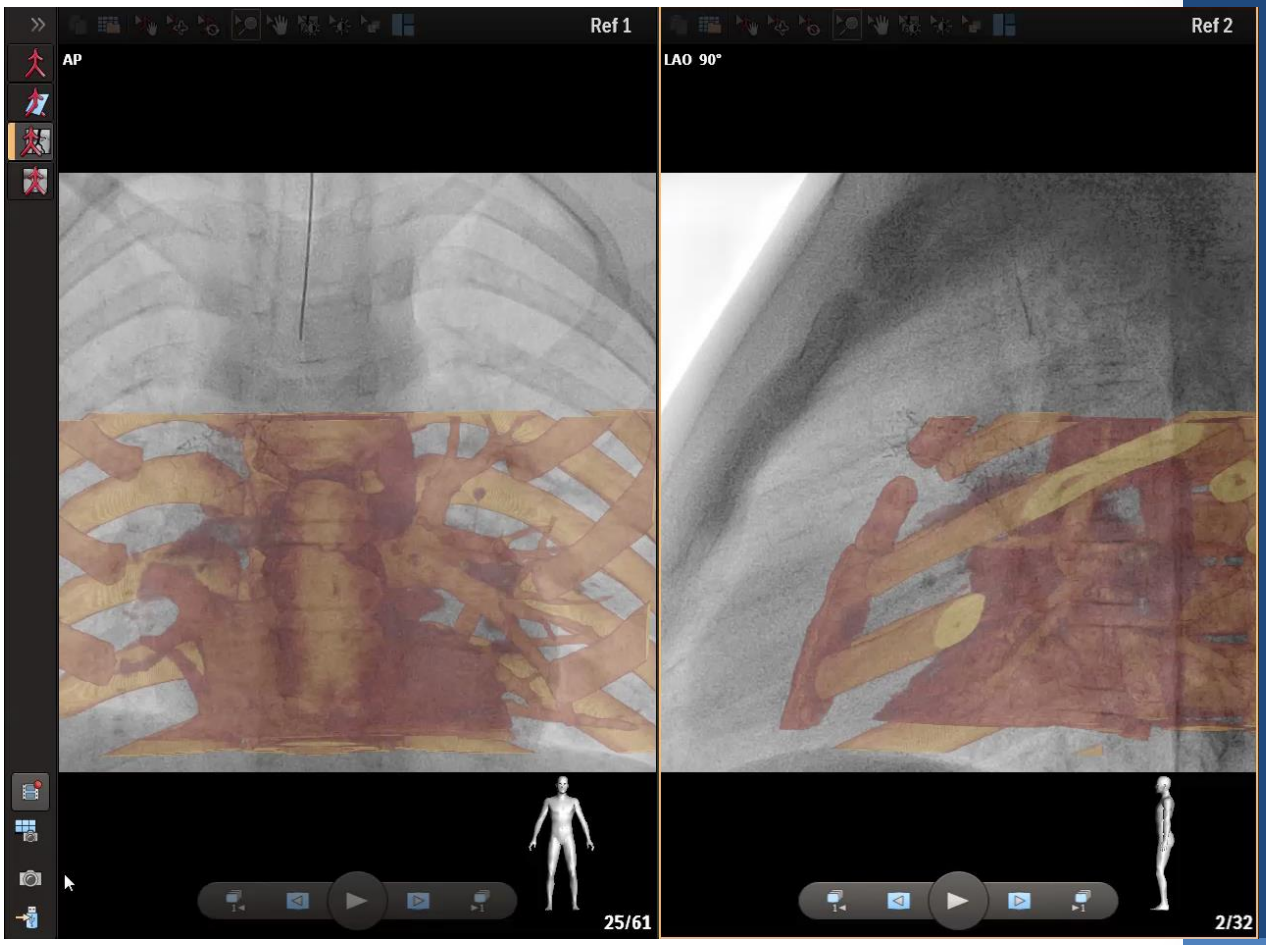

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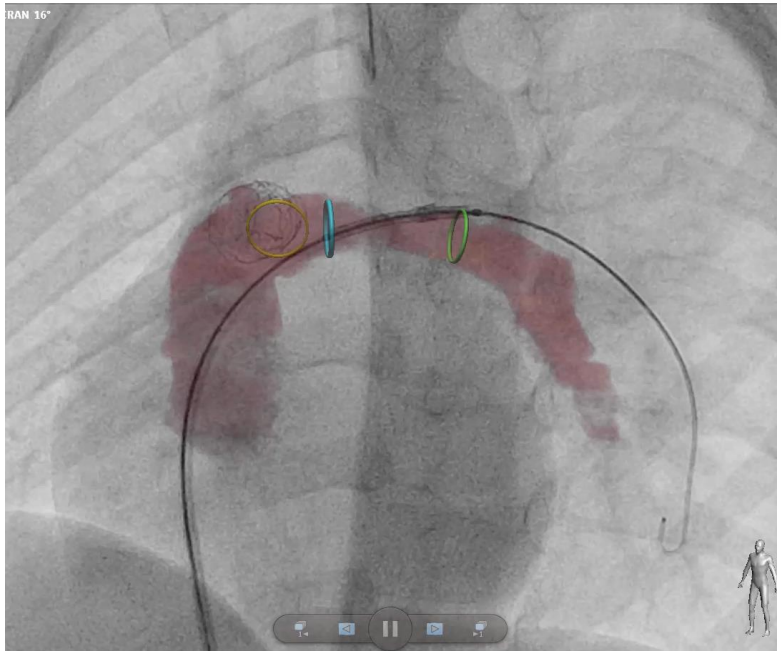

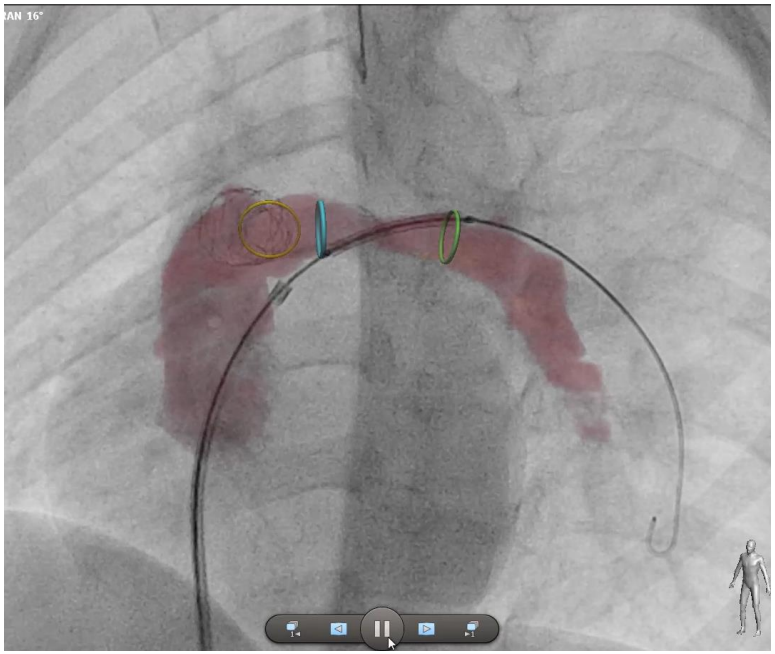

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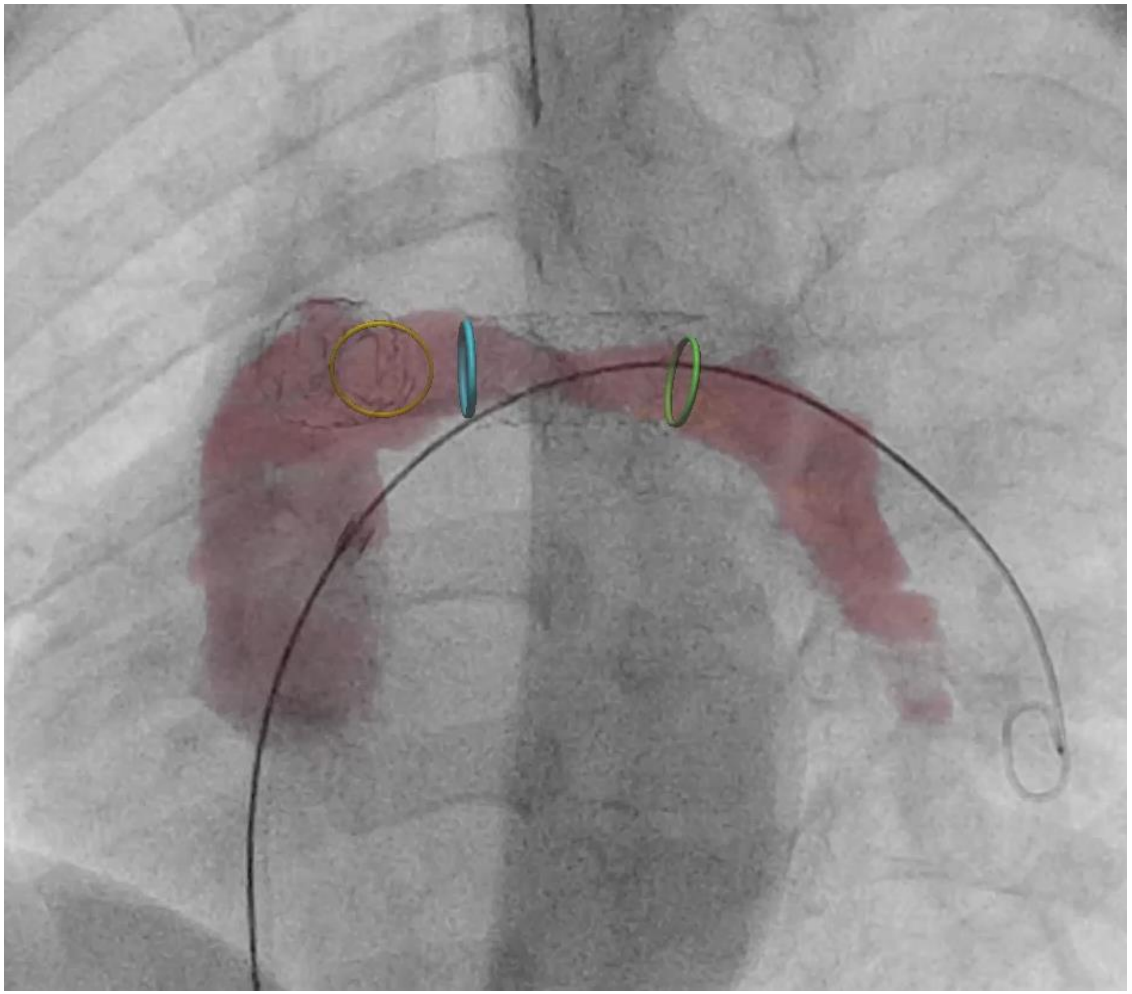

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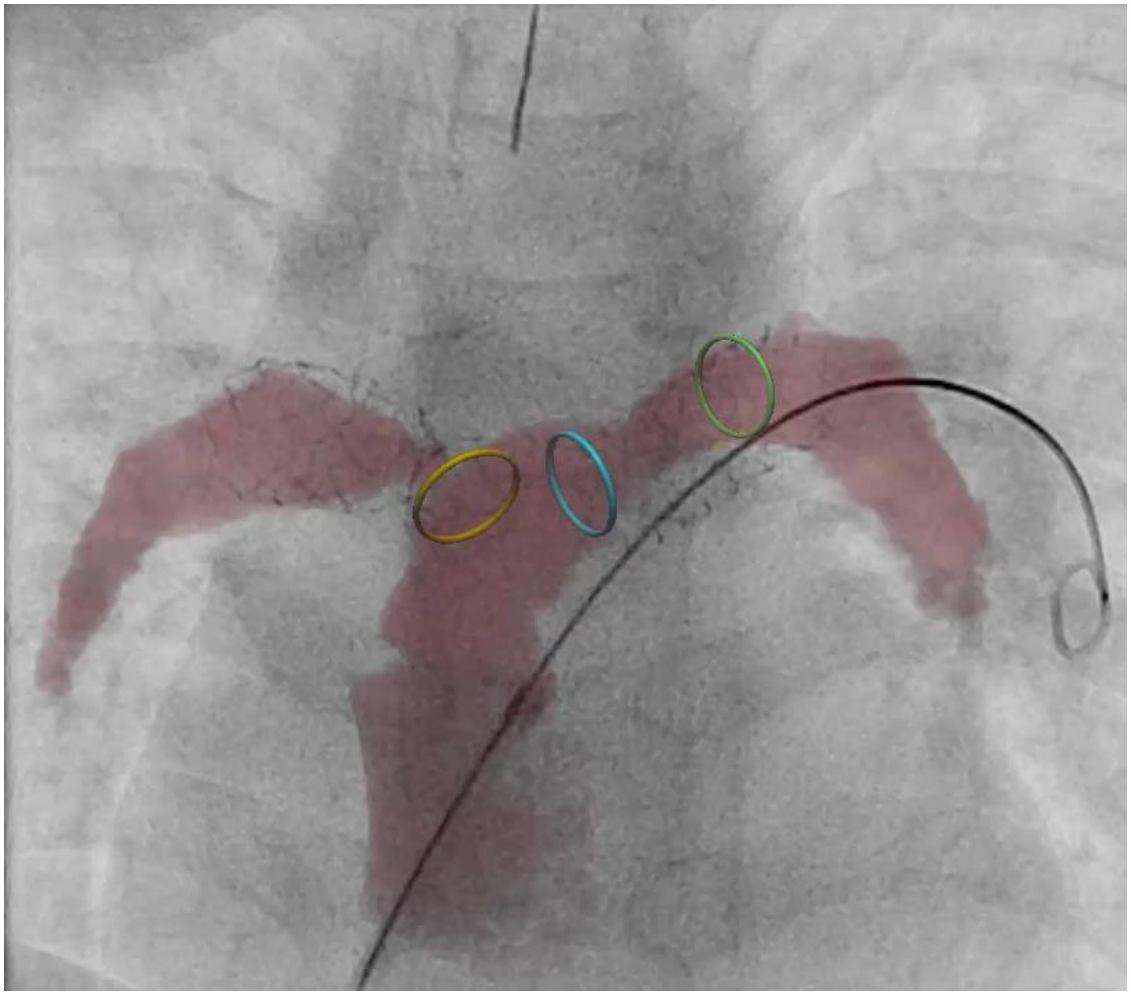
Fluoroscopy time (min)	18.3 (6.4 – 32.5)
Procedural time (min)	75 (20 – 125)



VesselNavigator Guided RVOT Interventions

Patients characteristics	VesselNavigator assisted interventions, lesion site
	RVOT (N = 8)
Sex (%)	Male, 4/8 (50%)
Age (years)	11 (2.9 – 15.9)
Weight (kg)	38.4 (14.2 – 55.0)
BSA (m2)	1.2 (0.6 – 1.6)
Previous imaging	
CT	8/8 (100%)
MRI	0/8 (0%)
Time interval (days)	77 (0 – 245)
Contrast (ml)	34.5 (20 – 73)
Contrast (ml/kg)	1.0 (0.5 – 1.9)
DLP (mGy cm)	64.9 (35.5 – 327.7)
2D – 3D registration	
Bony structures	8/8 (100%)
Calcifications	6/8 (75%)
Devices	2/8 (25%)
Contrast injection	1/8 (12.5%)
3D roadmap alignment	
Initially accurate	8/8 (100%)
Inter-procedural readjustment	1/8 (12.5%)
Catheterization	
Contrast dose (ml)	55.5 (35 – 130)
Contrast dose (ml/kg)	1.5 (1.1 – 3.6)
DAP (µGy m2)	6431.3 (795.5 – 16694.1)
Fluoroscopy time (min)	22.3 (9.3 – 53.5)
Procedural time (min)	122.5 (55 – 175)

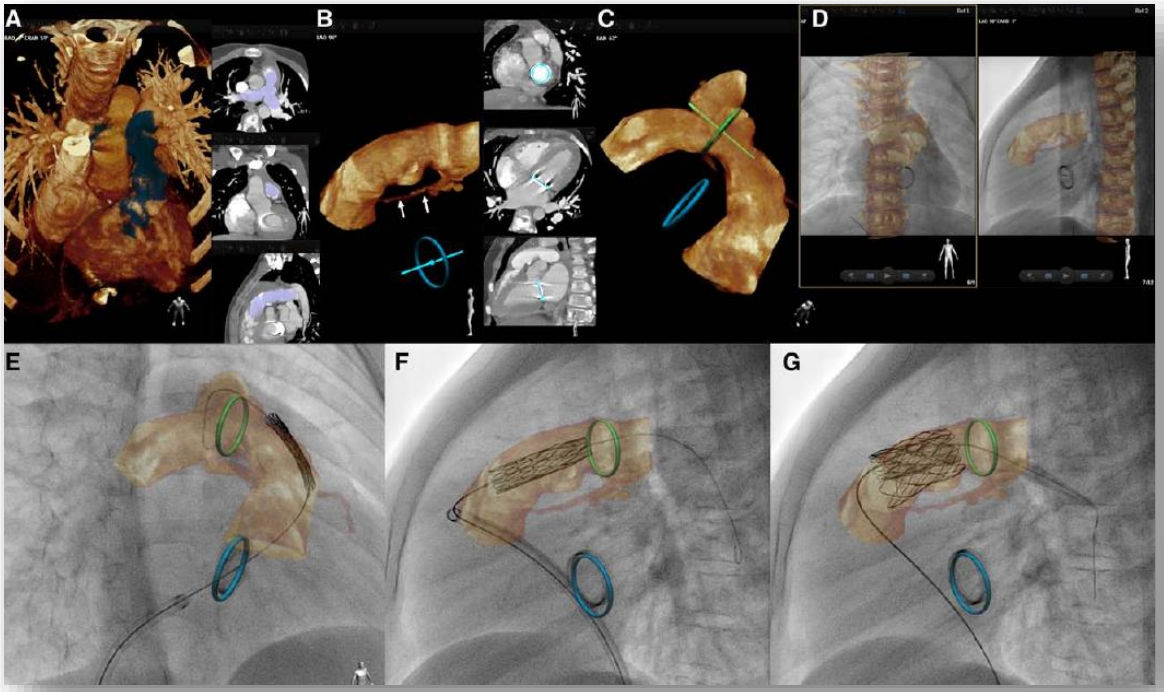
Circulation
Cardiovascular Interventions

American Heart Association®

Novel 3-Dimensional Image Fusion Software for Live Guidance of Percutaneous Pulmonary Valve Implantation

Sebastian Goreczny, Pawel Dryzek and Tomasz Moszura

Circ Cardiovasc Interv. 2016;9:
doi: 10.1161/CIRCINTERVENTIONS.116.003711



Patients characteristics	VesselNavigator assisted interventions, lesion site
	RVOT (N = 8)
Sex (%)	Male, 4/8 (50%)
Age (years)	11 (2.9 – 15.9)
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Previous imaging	
CT	8/8 (100%)
MRI	0/8 (0%)
Time interval (days)	77 (0 – 245)
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3D roadmap alignment	
Initially accurate	8/8 (100%)
Inter-procedural readjustment	1/8 (12.5%)
Catheterization	
Contrast dose (ml)	55.5 (35 – 130)
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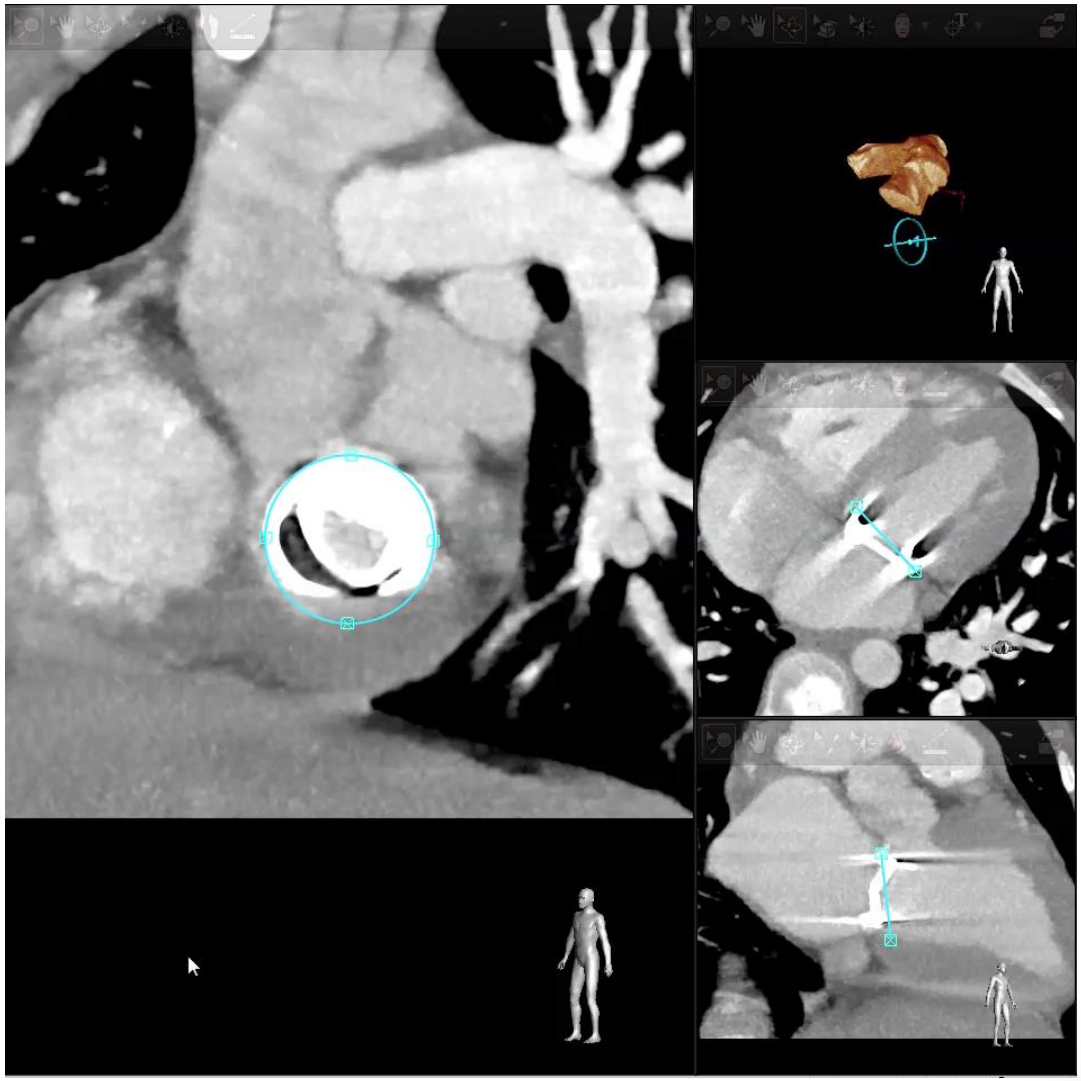
VesselNavigator Guided RVOT Interventions



VesselNavigator Guided RVOT Interventions

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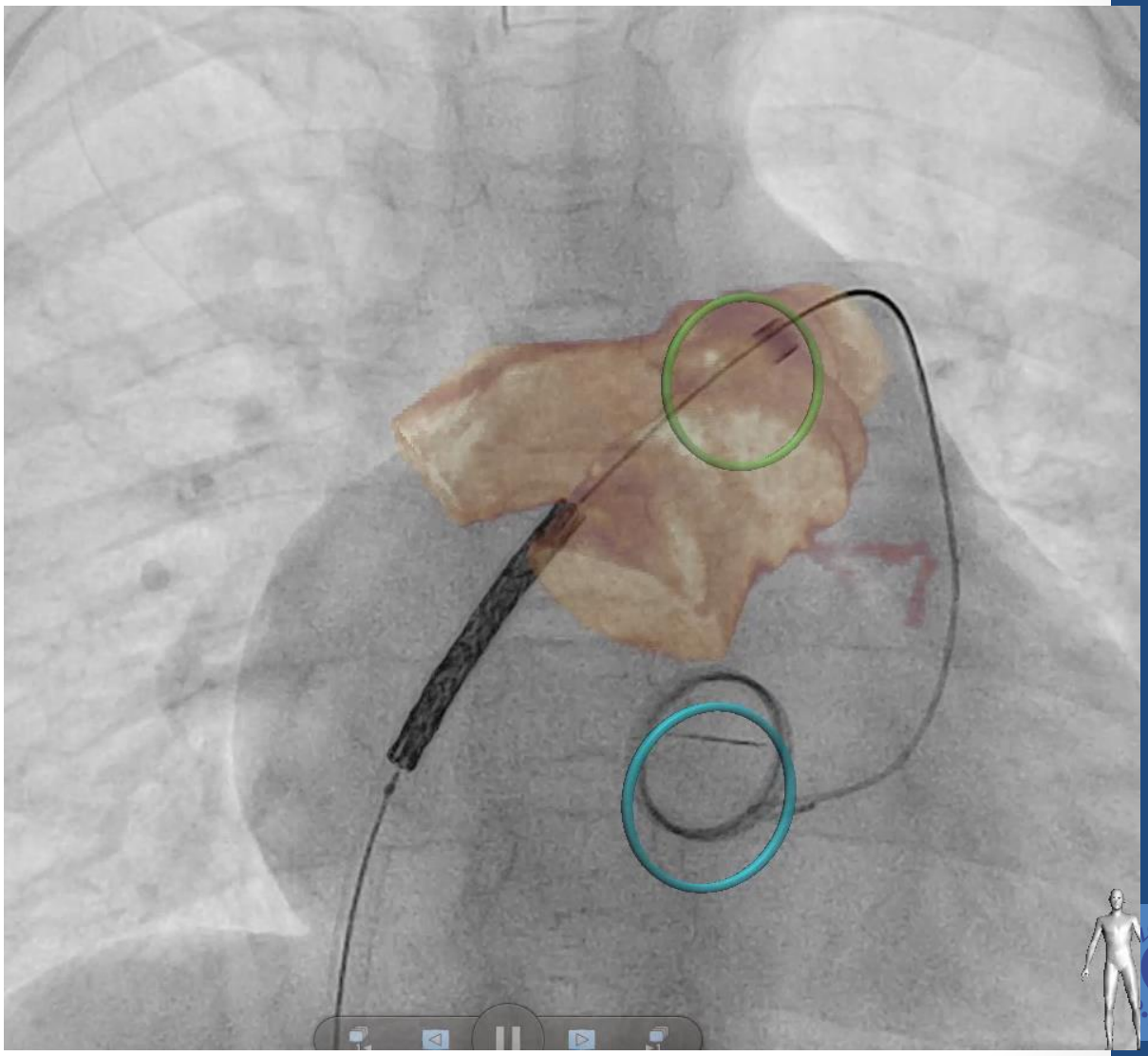

VesselNavigator Guided RVOT Interventions

Patients characteristics	VesselNavigator assisted interventions, lesion site
	RVOT (N = 8)
Sex (%)	Male, 4/8 (50%)
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Time interval (days)	77 (0 – 245)
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DLP (mGy cm)	64.9 (35.5 – 327.7)
2D – 3D registration	
Bony structures	8/8 (100%)
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3D roadmap alignment	
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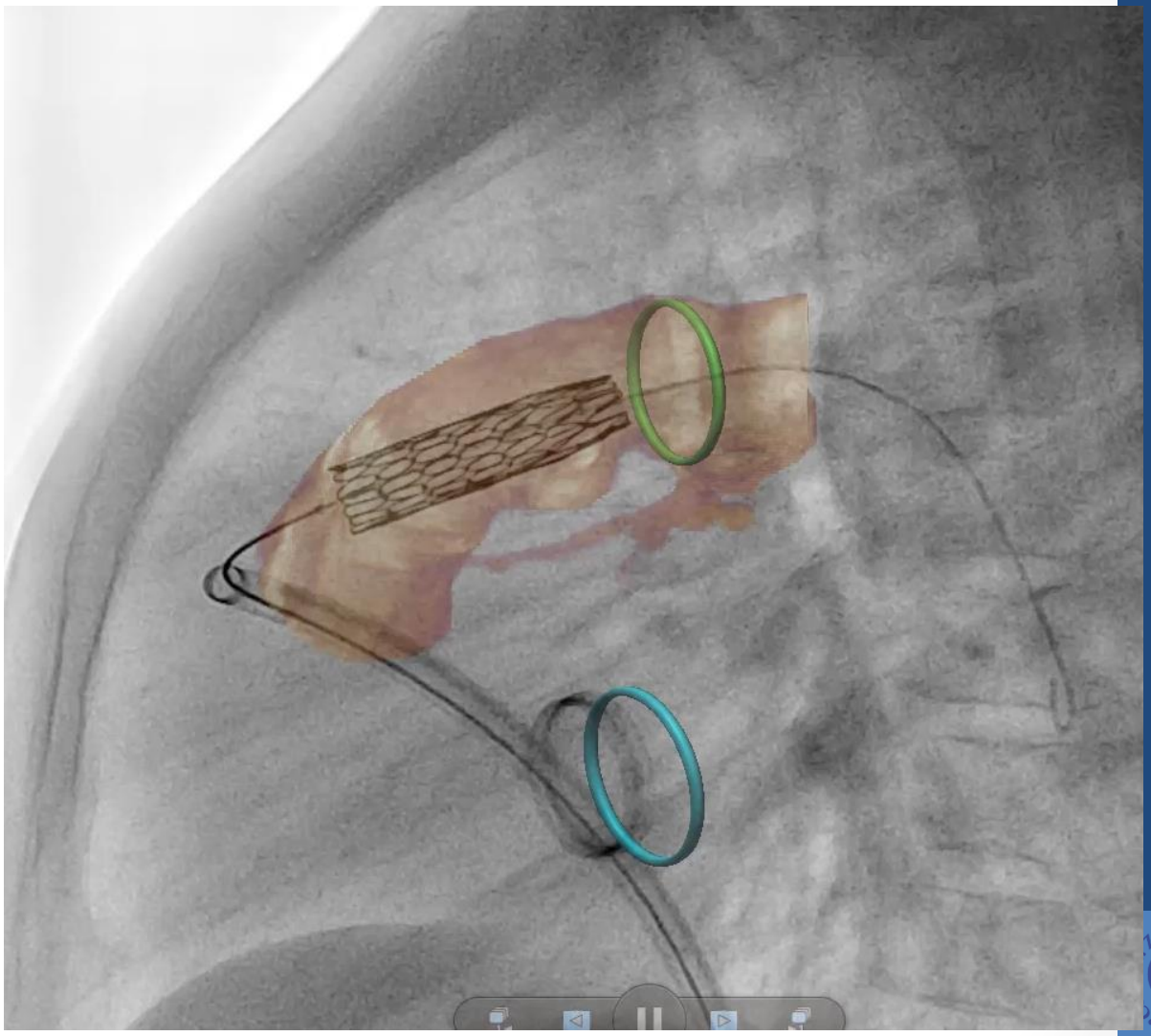

VesselNavigator and CT Overlay

VesselNavigator Guided RVOT Interventions

Patients characteristics	VesselNavigator assisted interventions, lesion site
	RVOT (N = 8)
Sex (%)	Male, 4/8 (50%)
Age (years)	11 (2.9 – 15.9)
Weight (kg)	38.4 (14.2 – 55.0)
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Bony structures	8/8 (100%)
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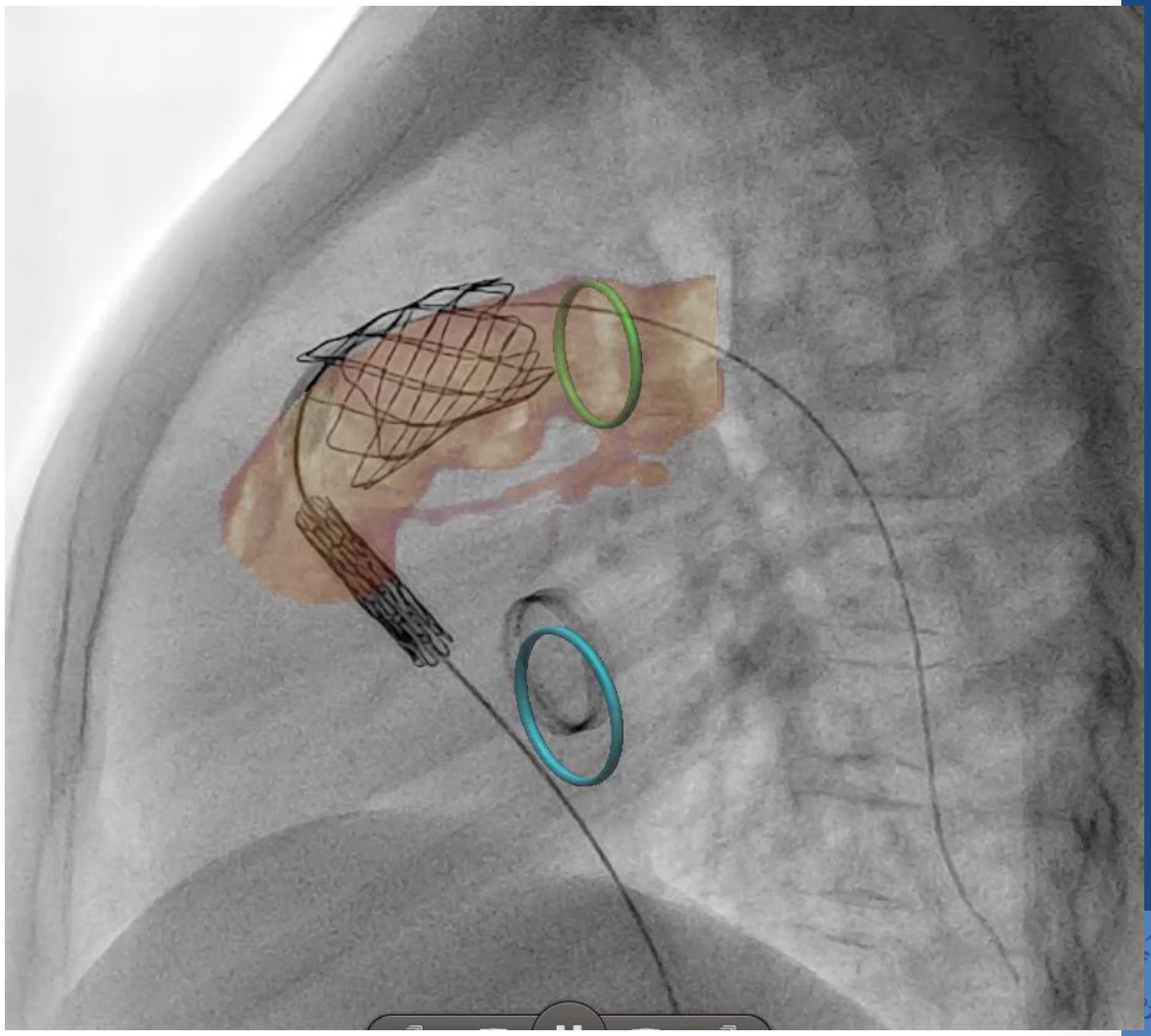
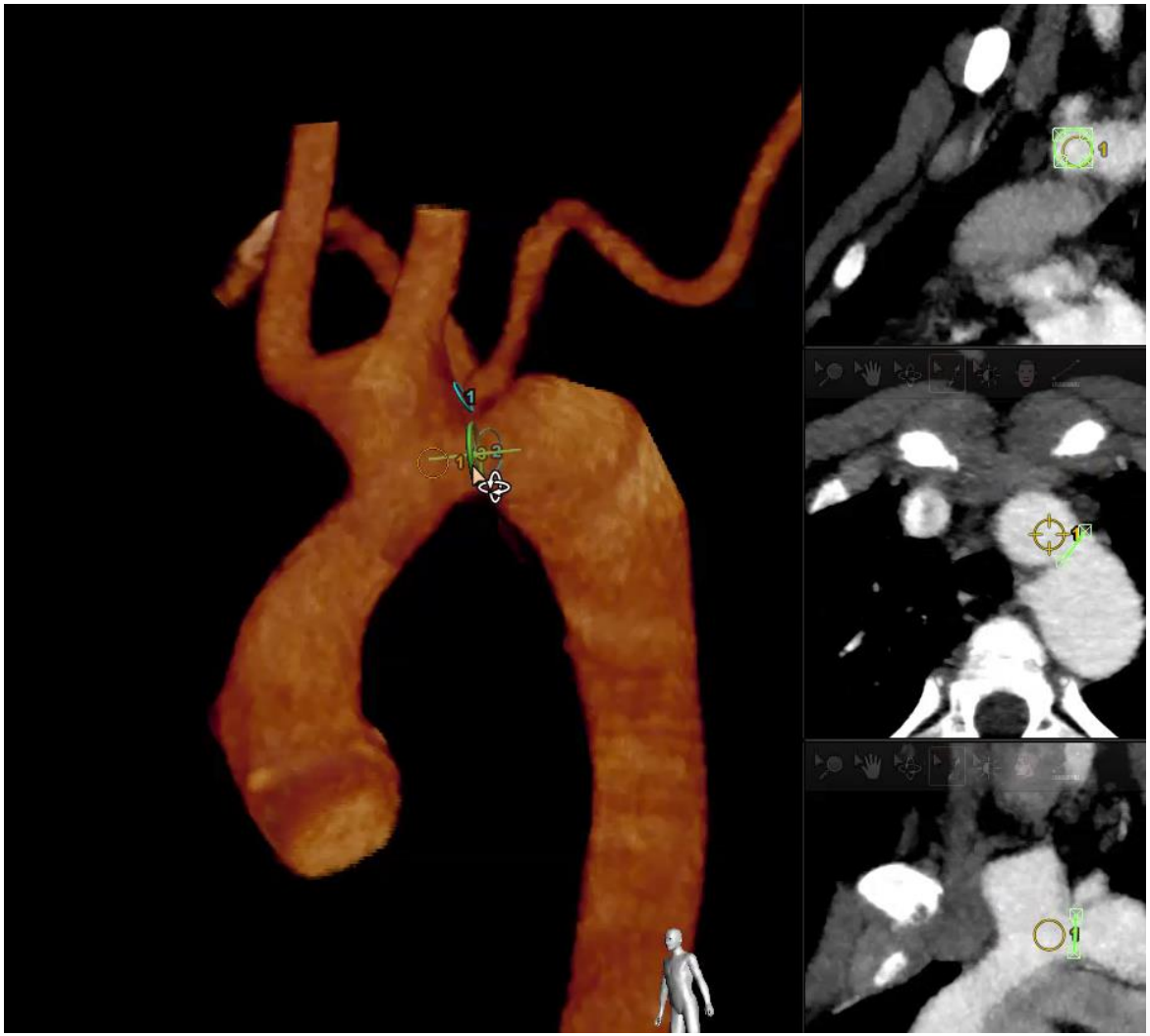
Devices	2/8 (25%)
Contrast injection	1/8 (12.5%)
3D roadmap alignment	
Initially accurate	8/8 (100%)
Inter-procedural readjustment	1/8 (12.5%)
Catheterization	
Contrast dose (ml)	55.5 (35 – 130)
Contrast dose (ml/kg)	1.5 (1.1 – 3.6)
DAP (µGy m2)	6431.3 (795.5 – 16694.1)
Fluoroscopy time (min)	22.3 (9.3 – 53.5)
Procedural time (min)	122.5 (55 – 175)



VesselNavigator and CT Overlay

VesselNavigator Guided Aortic Interventions

Patients characteristics	VesselNavigator assisted interventions, lesion site
	CoA (N = 5)
Sex (%)	Male, 4/5 (80%)
Age (years)	7.6 (0.06 – 15.2)
Weight (kg)	35.0 (3.0 – 69.0)
BSA (m2)	1.1 (0.2 – 1.8)
Previous imaging	
CT	4/5 (80%)
MRI	1/5 (20%)
Time interval (days)	19.5 (0 – 181)
Contrast (ml)	22.5 (5 – 35)
Contrast (ml/kg)	1.0 (0.5 – 1.7)
DLP (mGy cm)	54.3 (36.4 – 460.3)
2D – 3D registration	
Bony structures	4/5 (80%)
Calcifications	0/5 (0%)
Devices	2/5 (40%)
Contrast injection	2/5 (40%)
3D roadmap alignment	
Initially accurate	3/5 (60%)
Inter-procedural readjustment	1/5 (20%)
Catheterization	
Contrast dose (ml)	30.0 (5 – 55)
Contrast dose (ml/kg)	0.9 (0.4 – 1.7)
DAP (µGy m2)	1860.1 (168.1 – 4535.1)
Fluoroscopy time (min)	5.5 (3.3 – 9.5)
Procedural time (min)	40 (15 – 60)



VesselNavigator and CT Overlay

VesselNavigator Guided Aortic Interventions

Patients characteristics	VesselNavigator assisted interventions, lesion site
	CoA (N = 5)
Sex (%)	Male, 4/5 (80%)
Age (years)	7.6 (0.06 – 15.2)
Weight (kg)	35.0 (3.0 – 69.0)
BSA (m2)	1.1 (0.2 – 1.8)
Previous imaging	
CT	4/5 (80%)
MRI	1/5 (20%)
Time interval (days)	19.5 (0 – 181)
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DLP (mGy cm)	54.3 (36.4 – 460.3)
2D – 3D registration	
Bony structures	4/5 (80%)
Calcifications	0/5 (0%)
Devices	2/5 (40%)
Contrast injection	2/5 (40%)
3D roadmap alignment	
Initially accurate	3/5 (60%)
Inter-procedural readjustment	1/5 (20%)
Catheterization	
Contrast dose (ml)	30.0 (5 – 55)
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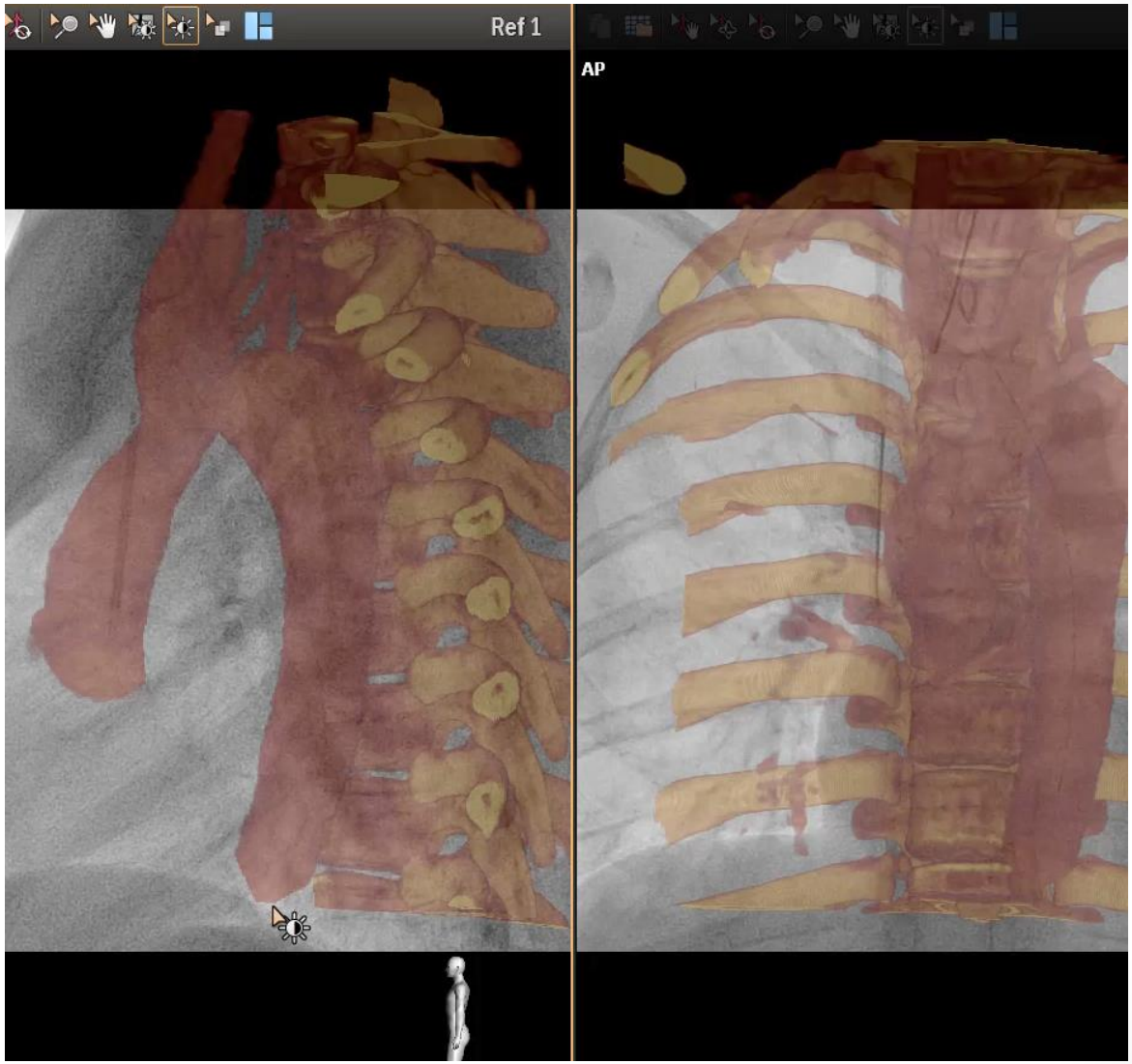
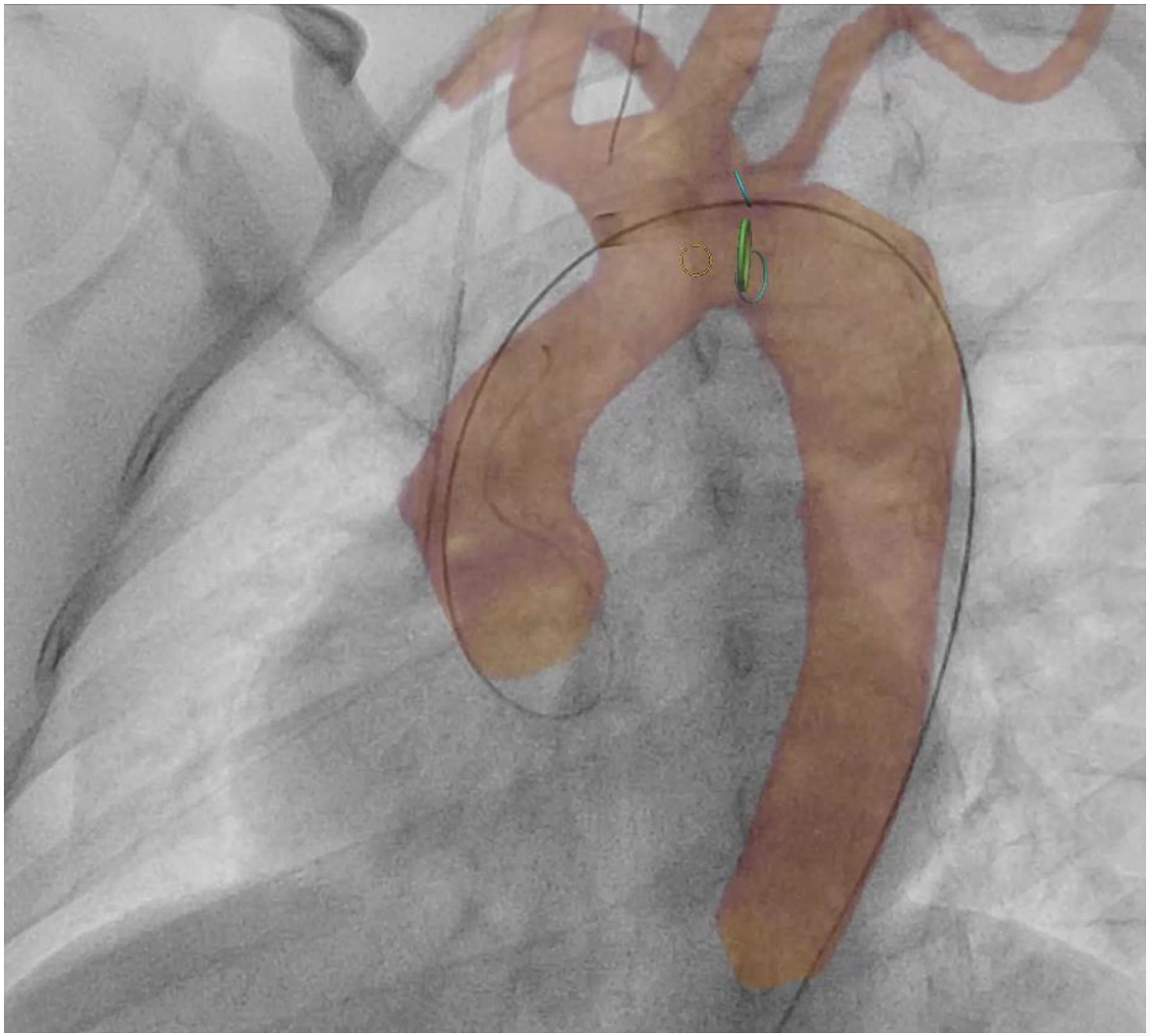


VesselNavigator Guided Aortic Interventions

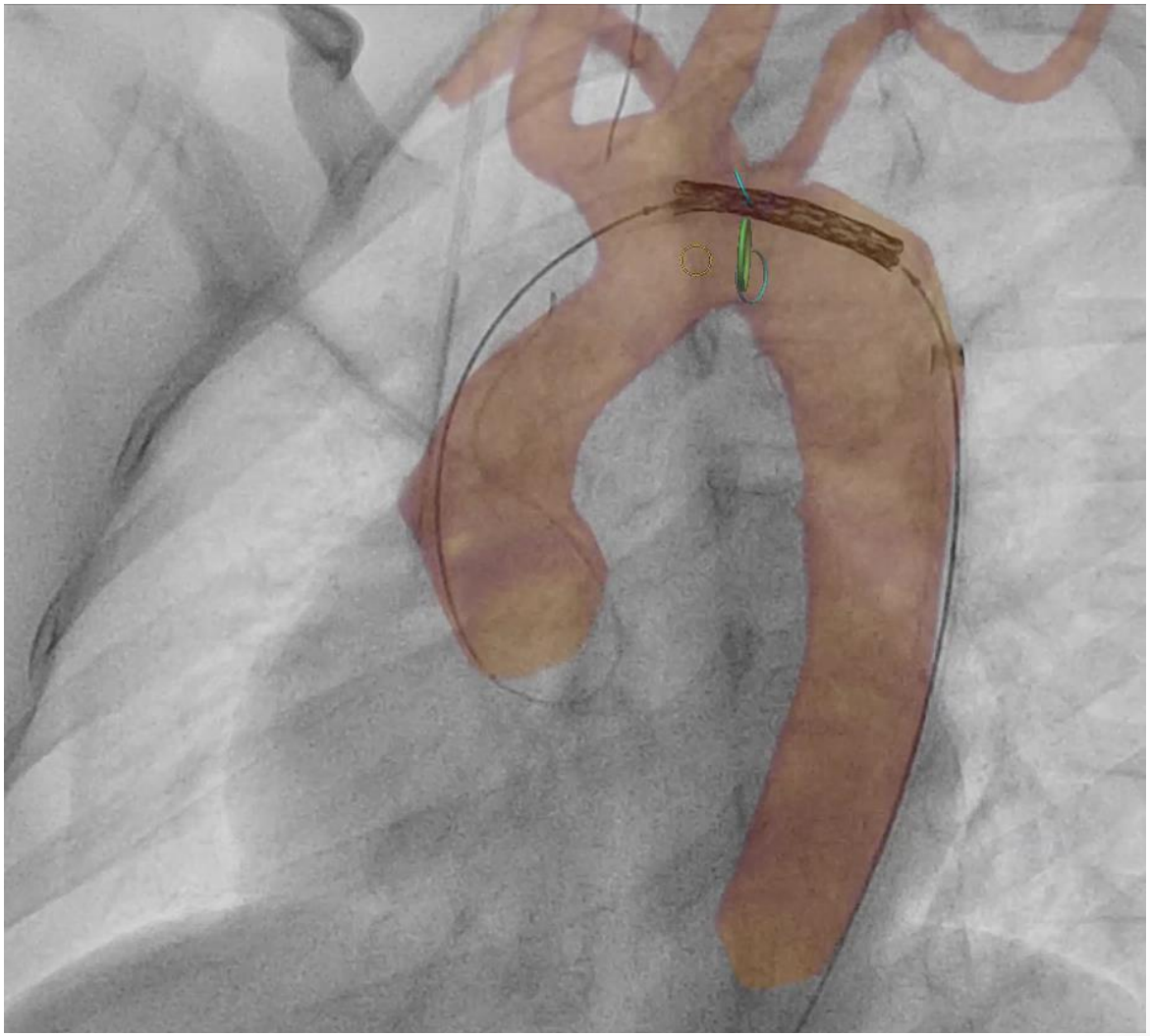
Patients characteristics	VesselNavigator assisted interventions, lesion site
	CoA (N = 5)
Sex (%)	Male, 4/5 (80%)
Age (years)	7.6 (0.06 – 15.2)
Weight (kg)	35.0 (3.0 – 69.0)
BSA (m2)	1.1 (0.2 – 1.8)
Previous imaging	
CT	4/5 (80%)
MRI	1/5 (20%)
Time interval (days)	19.5 (0 – 181)
Contrast (ml)	22.5 (5 – 35)
Contrast (ml/kg)	1.0 (0.5 – 1.7)
DLP (mGy cm)	54.3 (36.4 – 460.3)
2D – 3D registration	
Bony structures	4/5 (80%)
Calcifications	0/5 (0%)
Devices	2/5 (40%)
Contrast injection	2/5 (40%)
3D roadmap alignment	
Initially accurate	3/5 (60%)
Inter-procedural readjustment	1/5 (20%)
Catheterization	
Contrast dose (ml)	30.0 (5 – 55)
Contrast dose (ml/kg)	0.9 (0.4 – 1.7)
DAP (µGy m2)	1860.1 (168.1 – 4535.1)
Fluoroscopy time (min)	5.5 (3.3 – 9.5)
Procedural time (min)	40 (15 – 60)



VesselNavigator and CT Overlay

VesselNavigator Guided Aortic Interventions

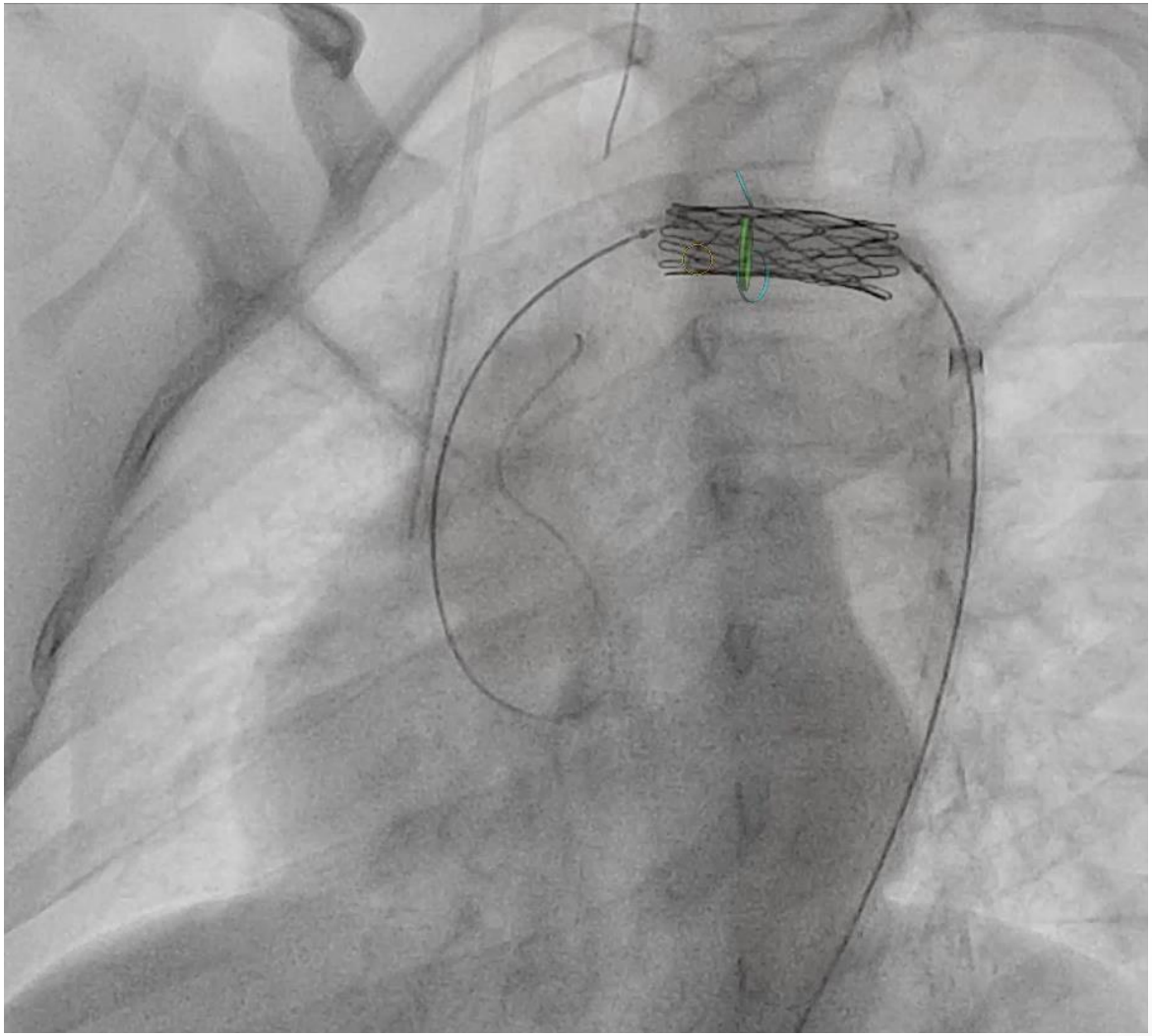
Patients characteristics	VesselNavigator assisted interventions, lesion site
	CoA (N = 5)
Sex (%)	Male, 4/5 (80%)
Age (years)	7.6 (0.06 – 15.2)
Weight (kg)	35.0 (3.0 – 69.0)
BSA (m2)	1.1 (0.2 – 1.8)
Previous imaging	
CT	4/5 (80%)
MRI	1/5 (20%)
Time interval (days)	19.5 (0 – 181)
Contrast (ml)	22.5 (5 – 35)
Contrast (ml/kg)	1.0 (0.5 – 1.7)
DLP (mGy cm)	54.3 (36.4 – 460.3)
2D – 3D registration	
Bony structures	4/5 (80%)
Calcifications	0/5 (0%)
Devices	2/5 (40%)
Contrast injection	2/5 (40%)
3D roadmap alignment	
Initially accurate	3/5 (60%)
Inter-procedural readjustment	1/5 (20%)
Catheterization	
Contrast dose (ml)	30.0 (5 – 55)
Contrast dose (ml/kg)	0.9 (0.4 – 1.7)
DAP (µGy m2)	1860.1 (168.1 – 4535.1)
Fluoroscopy time (min)	5.5 (3.3 – 9.5)
Procedural time (min)	40 (15 – 60)



VesselNavigator and CT Overlay

VesselNavigator Guided Aortic Interventions

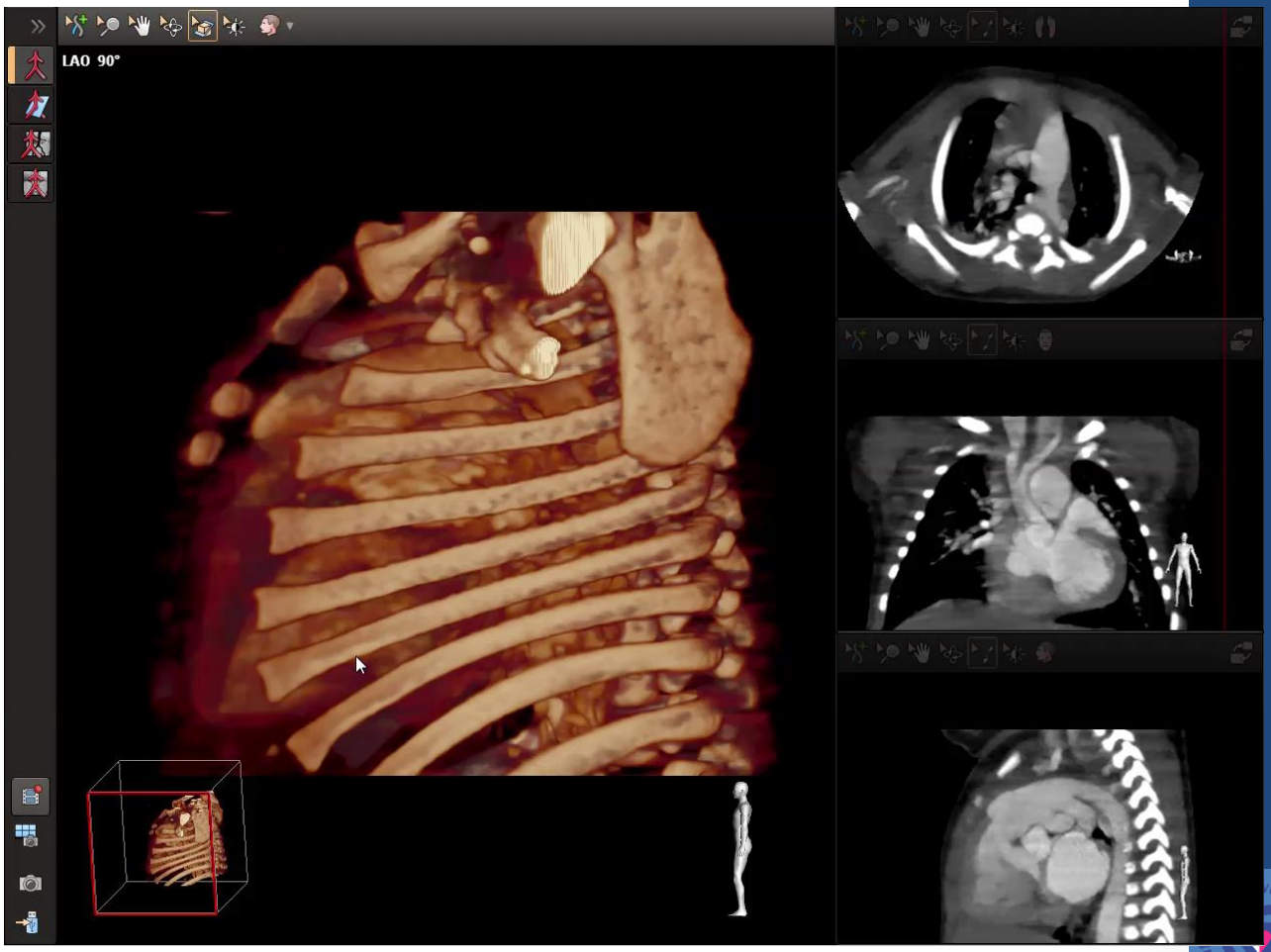
Patients characteristics	VesselNavigator assisted interventions, lesion site
	CoA (N = 5)
Sex (%)	Male, 4/5 (80%)
Age (years)	7.6 (0.06 – 15.2)
Weight (kg)	35.0 (3.0 – 69.0)
BSA (m2)	1.1 (0.2 – 1.8)
Previous imaging	
CT	4/5 (80%)
MRI	1/5 (20%)
Time interval (days)	19.5 (0 – 181)
Contrast (ml)	22.5 (5 – 35)
Contrast (ml/kg)	1.0 (0.5 – 1.7)
DLP (mGy cm)	54.3 (36.4 – 460.3)
2D – 3D registration	
Bony structures	4/5 (80%)
Calcifications	0/5 (0%)
Devices	2/5 (40%)
Contrast injection	2/5 (40%)
3D roadmap alignment	
Initially accurate	3/5 (60%)
Inter-procedural readjustment	1/5 (20%)
Catheterization	
Contrast dose (ml)	30.0 (5 – 55)
Contrast dose (ml/kg)	0.9 (0.4 – 1.7)
DAP (µGy m2)	1860.1 (168.1 – 4535.1)
Fluoroscopy time (min)	5.5 (3.3 – 9.5)
Procedural time (min)	40 (15 – 60)



VesselNavigator and CT Overlay

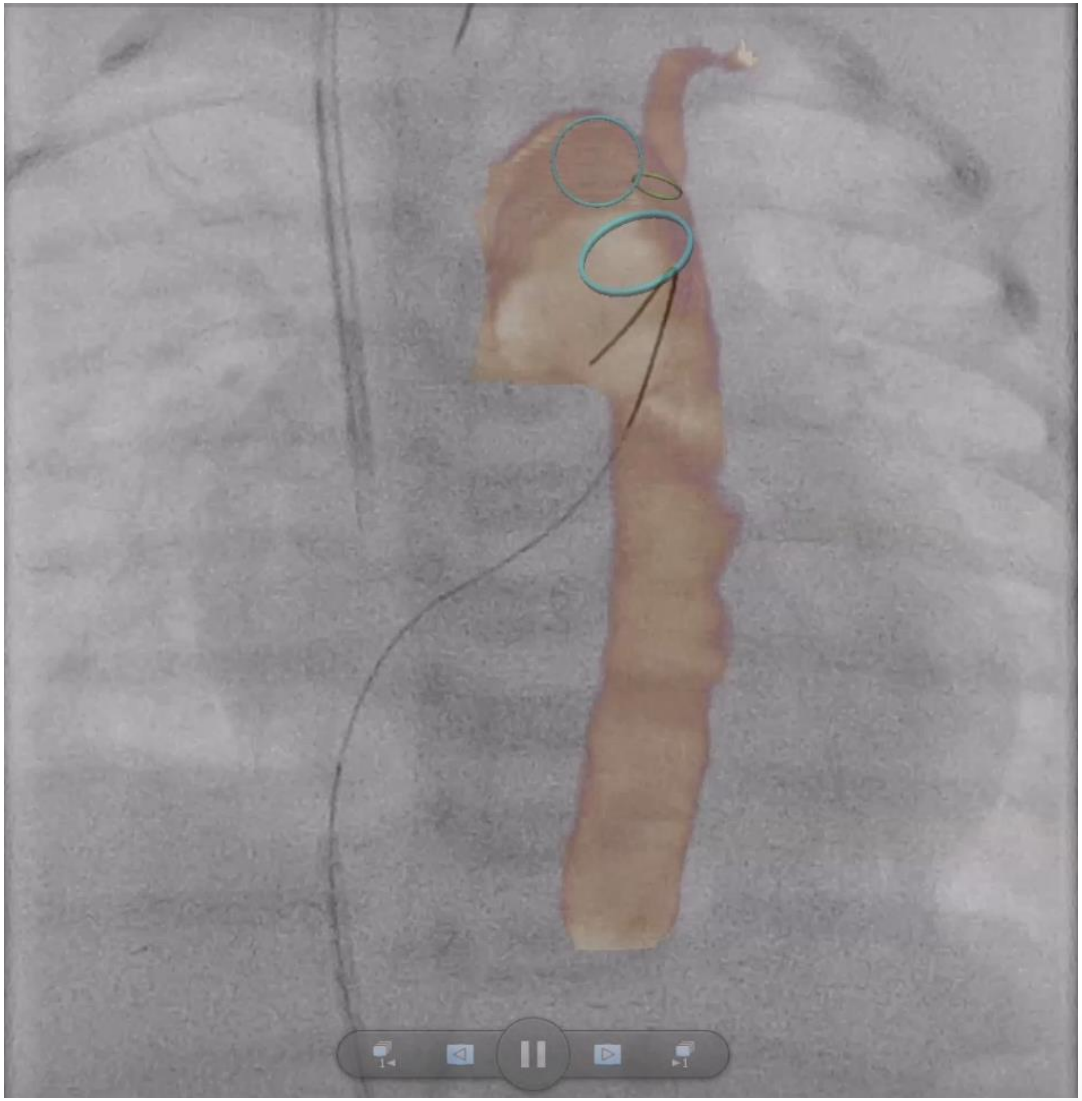
VesselNavigator Guided Ductus Arteriosus Interventions

Patients characteristics	VesselNavigator assisted interventions, lesion site
	PDA / MAPCA (N = 4)
Sex (%)	Male, 2/4 (50%)
Age (years)	1.1** (0.3 – 48.8)
Weight (kg)	3.2 (2.4 – 10.5)
BSA (m2)	0.2 (0.2 – 0.5)
Previous imaging	
CT	4/4 (100%)
MRI	0/4 (0%)
Time interval (days)	5 (1 – 7)
Contrast (ml)	5.5 (5 – 16)
Contrast (ml/kg)	1.7 (1.5 – 2.1)
DLP (mGy cm)	48.2 (33.9 – 65.6)
2D – 3D registration	
Bony structures	4/4 (100%)
Calcifications	0/4 (0%)
Devices	0/4 (0%)
Contrast injection	2/4 (50%)
3D roadmap alignment	
Initially accurate	3/4 (75%)
Inter-procedural readjustment	1/4 (25%)
Catheterization	
Contrast dose (ml)	16.5 (3 – 39)
Contrast dose (ml/kg)	2.5 (1.0 – 8.8)
DAP (µGy m2)	736.4 (86.2 – 1773.8)
Fluoroscopy time (min)	22.6 (4.3 – 37.4)
Procedural time (min)	50 (15 – 185)



VesselNavigator Guided Ductus Arteriosus Interventions

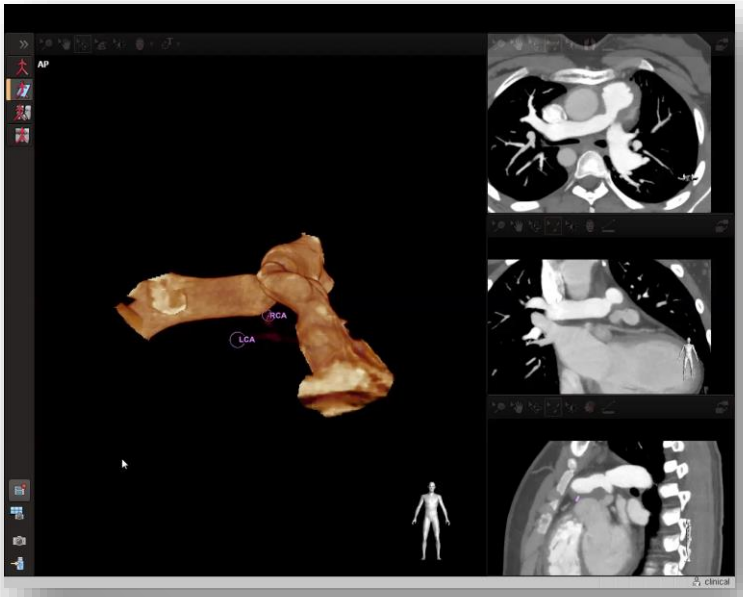
Patients characteristics	VesselNavigator assisted interventions, lesion site
	PDA / MAPCA (N = 4)
Sex (%)	Male, 2/4 (50%)
Age (years)	1.1** (0.3 – 48.8)
Weight (kg)	3.2 (2.4 – 10.5)
BSA (m2)	0.2 (0.2 – 0.5)
Previous imaging	
CT	4/4 (100%)
MRI	0/4 (0%)
Time interval (days)	5 (1 – 7)
Contrast (ml)	5.5 (5 – 16)
Contrast (ml/kg)	1.7 (1.5 – 2.1)
DLP (mGy cm)	48.2 (33.9 – 65.6)
2D – 3D registration	
Bony structures	4/4 (100%)
Calcifications	0/4 (0%)
Devices	0/4 (0%)
Contrast injection	2/4 (50%)
3D roadmap alignment	
Initially accurate	3/4 (75%)
Inter-procedural readjustment	1/4 (25%)
Catheterization	
Contrast dose (ml)	16.5 (3 – 39)
Contrast dose (ml/kg)	2.5 (1.0 – 8.8)
DAP (µGy m2)	736.4 (86.2 – 1773.8)
Fluoroscopy time (min)	22.6 (4.3 – 37.4)
Procedural time (min)	50 (15 – 185)

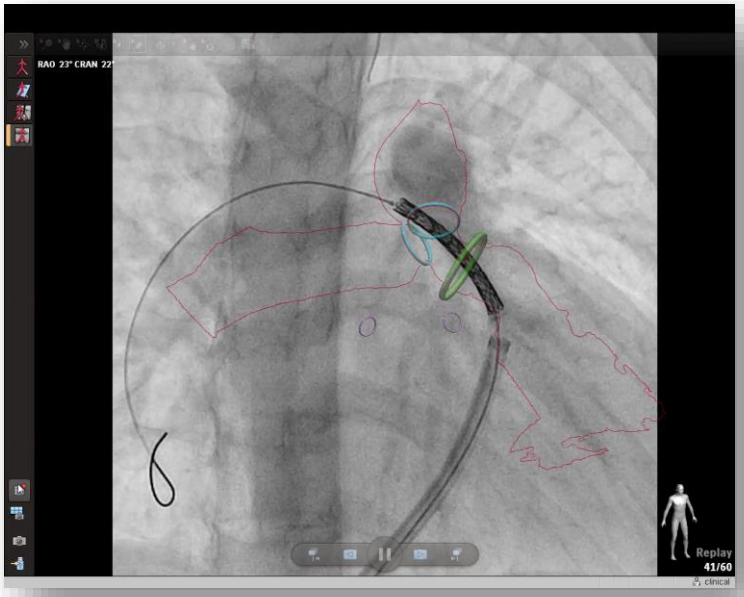


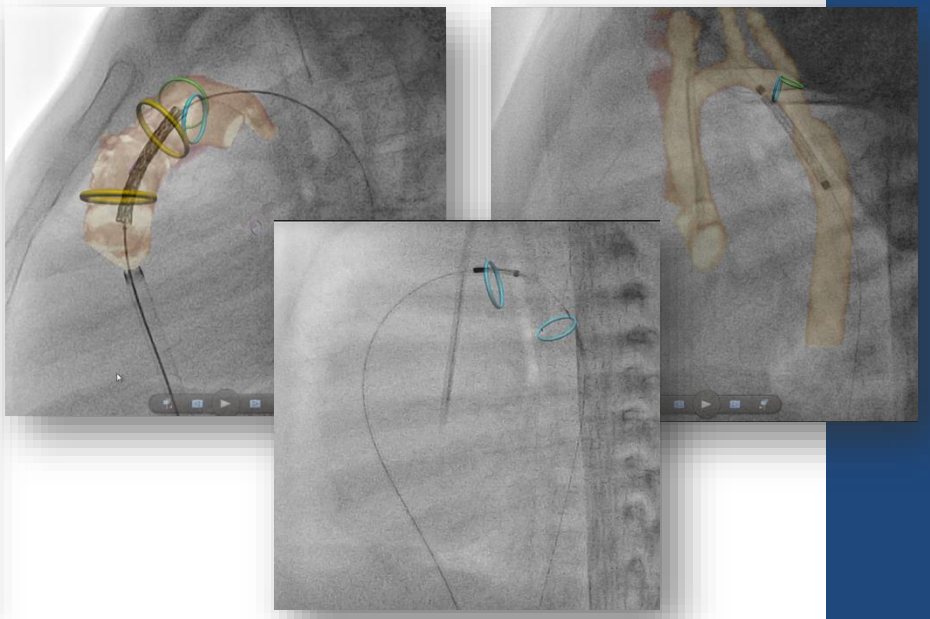
VesselNavigator and CT Overlay

3D image fusion for interventions in CHD

- **Accurate initial** 3D roadmap **alignment** was achieved in 25 patients (89%).
- Six patients (22%) required **realignment** during the procedure due to distortion of the anatomy after introduction of stiff equipment.
- Overall, VesselNavigator was applied **successfully** in 27 patients (**96%**) without any complications related to 3D image overlay.







- We performed a retrospective review of all procedures involving **stent implantation** guided with VesselNavigator.

- Patient characteristics and catheterization data were reviewed with focus on fusion of pre-intervention imaging and intervention guidance including:
  - structures used for registration,
  - accurateness of 3D reconstruction overlay,
  - need for intra-procedural roadmap readjustment.

Results: **VN Guided Stent Implantation**

- **Eighteen** patients underwent trans-catheter stent implantation for:
  - landing zone followed by percutaneous pulmonary valve implantation (n=8);
  - pulmonary artery stenosis (n=5),
  - aortic coarctation (n=3),
  - aorto-pulmonary collateral (n=2),
  - arterial duct (n=1).

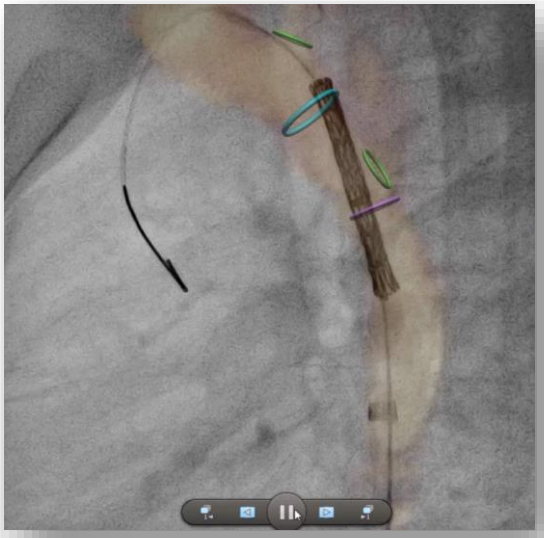
- A **3D roadmap** was created either from existing **CT** (n=17) or MR (n=1) datasets.

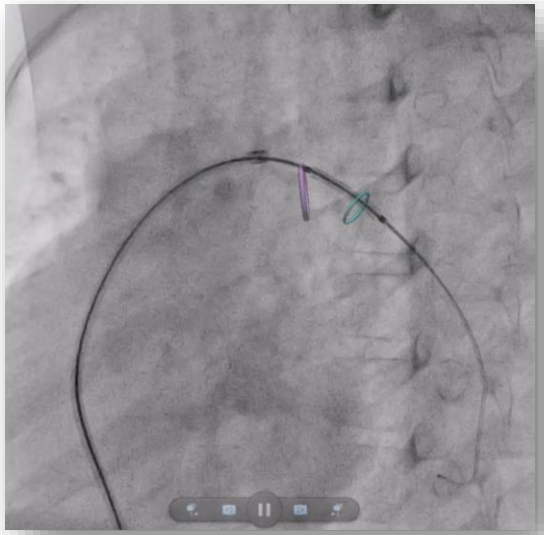
- **Accurate overlay** was achieved in all but 2 patients (89%).

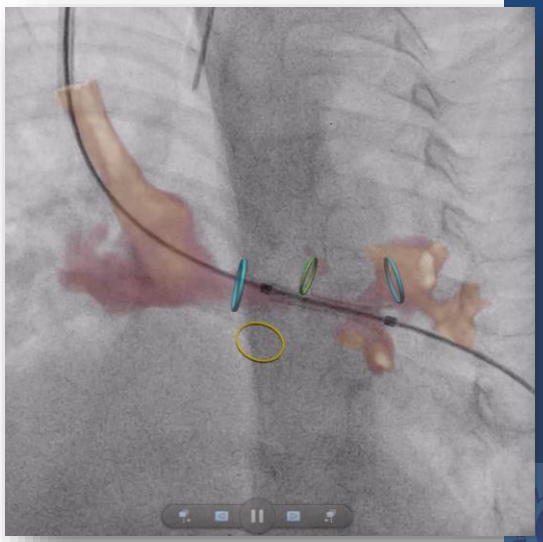
- Further 2 patients (11%) required **intra-procedural realignment** due to introduction of a stiff wire and balloon/stent assembly.

Results: **VN Guided Stent Implantation**

- In 13 patients (**72%**) the stent was positioned and deployed **without preceding contrast injection**.
- **All stents** were **deployed at desired locations** with no complications.







VesselNavigator guidance for percutaneous pulmonary valve implantation leads to reduction in contrast and radiation exposure – comparison with traditional two-dimensional guidance and three-dimensional rotational angiography.

Tomasz Moszura[1], Pawel Dryzek[1], Marek Grygier[2], Maciek Lukaszewski[3], Alexandra Karwczuk[4], Jadwiga Anna Moll[1], Sebastian Goreczny[1]

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METHODS

- In this retrospective review, patients were assigned to three groups according to the mode of imaging guidance:
  - Two-dimensional angiography (**2DA**),
  - Three-dimensional rotational angiography (**3DRA**)
  - VesselNavigator (**VN**) assisted valve implantation.

- Patient characteristics and catheterization data were reviewed with a focus on **contrast** and **radiation exposure**, **fluoroscopy**, and **procedural times**.

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VesselNavigator guidance for percutaneous pulmonary valve implantation leads to reduction in contrast and radiation exposure – comparison with traditional two-dimensional guidance and three-dimensional rotational angiography.

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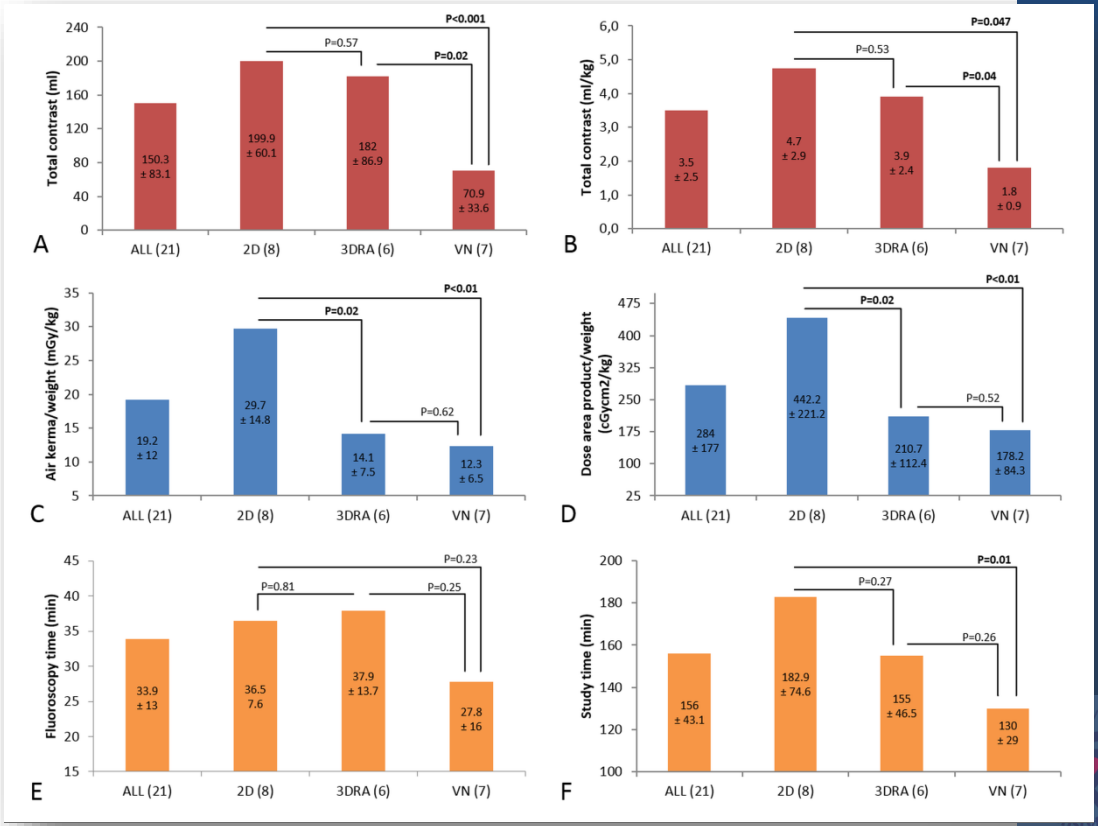
RESULTS

Between 7/2012 and 07/2016, 21 patients underwent PPVI;

- 8 ptswith 2D guidance,
- 6 pts with 3DRA
- most recently 7 pts with VN assistance.



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RESULTS

- Patents in the VN group received significantly **less** absolute and weight indexed **contrast** when compared to those with 2DA or 3DRA guided PPVI.

- Patients in the 2DA group received a significantly higher **total DAP** and **AK** in comparison to patients with 3DRA and VN guided intervention.

- Application of VN resulted in the **shortest fluoroscopy time**, although not statistically significant, and **significantly shorter study** time when compared with 2DA.

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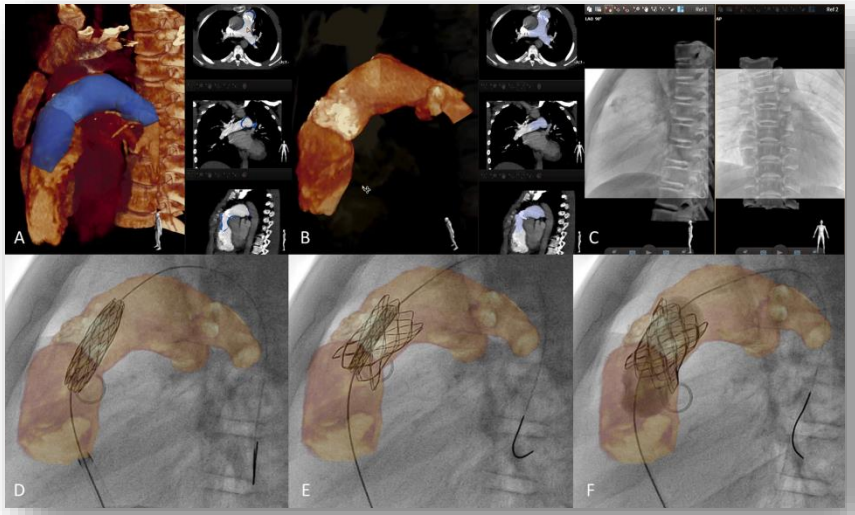
CONCLUSIONS

- Utilization of pre-intervention image manipulation with VesselNavigator for 3D guidance of PPVI results in a **reduction** in **contrast** and **radiation exposure** and **study time** as compared to traditional 2D guidance, and **contrast usage** as compared to 3DRA.



Conclusions

- VesselNavigator – limitations:
  - no options to cut on the segmented volume,
  - difficulties in segmentation of small and adjacent structures,
  - no option to save more than one segmentation,
  - rigid registration (segmented volume does not follow changes in anatomy).

- VesselNavigator – benefits:
  - intuitive and quick segmentation,
  - ring markers (improving segmentation of poor quality data sets),
  - quick measurements,
  - easy fusion (2D-3D) with live fluoroscopy,
  - reliable roadmap,
  - easy conversion of stored images, videos for MDMs, presentations, ...

Multi-centre experience with novel there-dimensional image fusion software for guidance of complex cardiac catheterizations in congenital heart disease.

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Thank you for your attention !-)

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