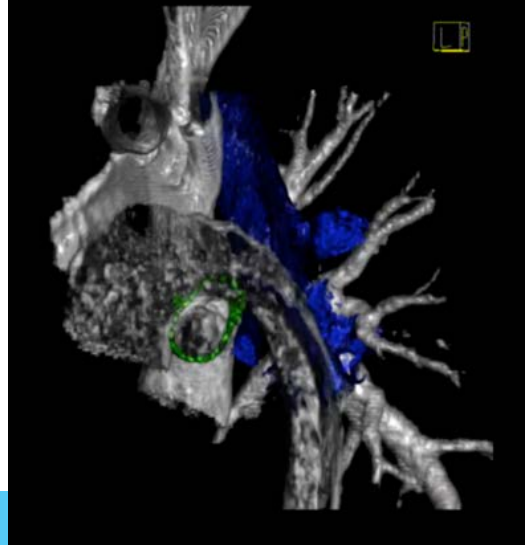
Airway and Oesophagus

realize anatomy when doing cath

Gregor Krings

Children’s Heart Centre

UMC Utrecht, The Netherlands



Disclosure

consultant & grants Edwards

member advisory board & grants Siemens

when to expect **bronchus compression ?**

Single Ventricle due to reduced Asc – Desc – LPA space

Norwood, DKS …

Bi Ventricle due to severe airway shift

after major AoArch surgery

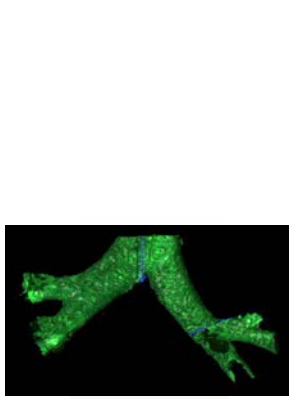
TAC, Ross Konno, Yasui

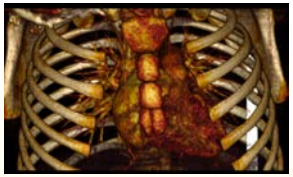
LPA / RPA / AoArch stent

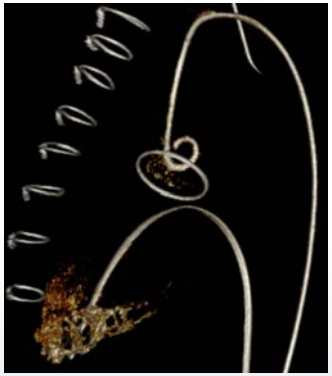
Hounsfield Units

How to visualize the airway ?

Hounsfield Units : where is what ?







-500 0 500 1000 1500 2000 2500 3000

Airway

Vessel / Heart CTA

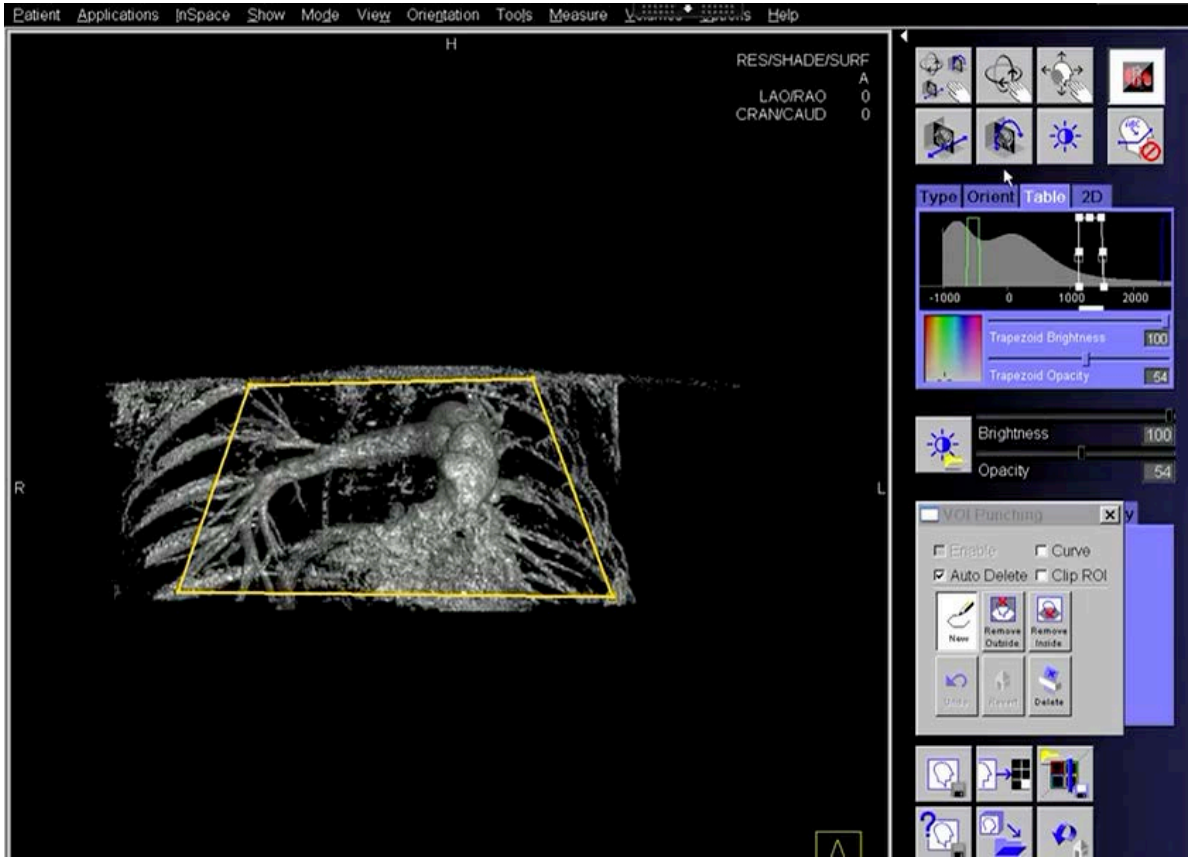
Vessel / Heart 3DRA

Metal / Bones

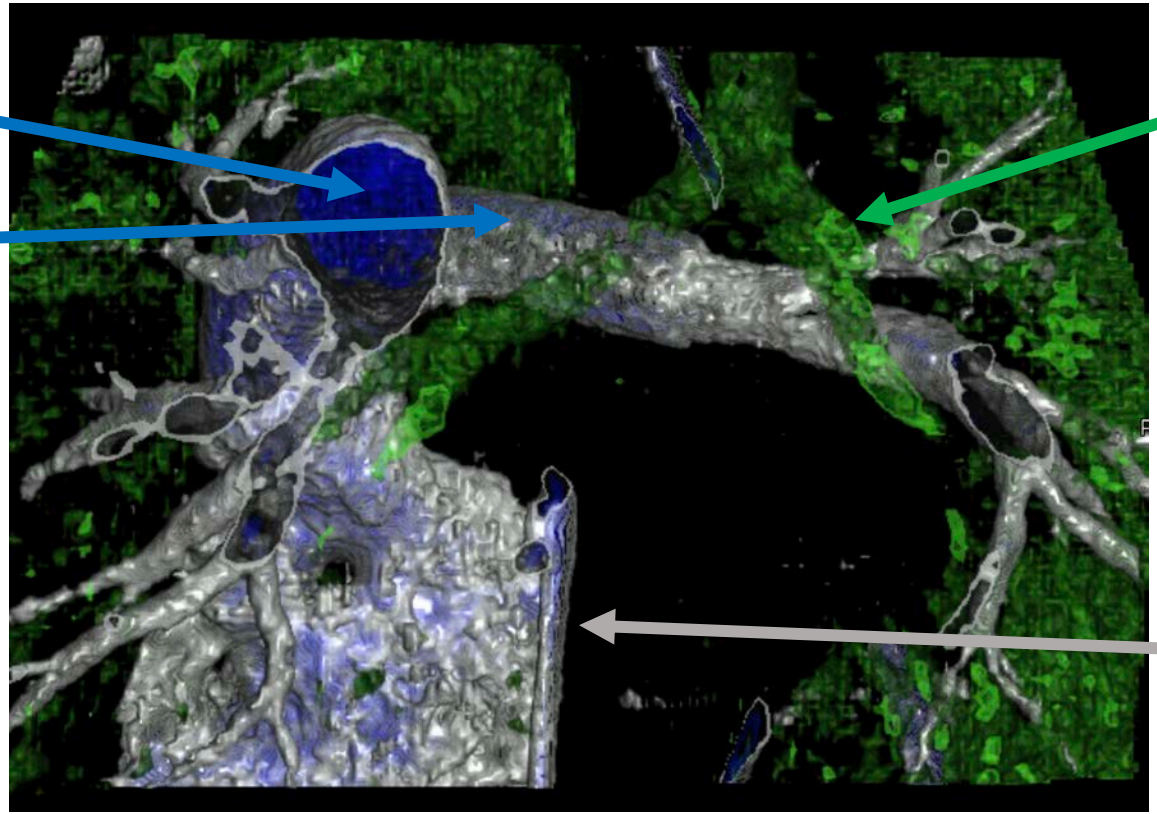
3D Rotational Angiography CTA at Cathlab

TAC : all in one RPA stent airway

TAC : all in one RPA stent airway



TAC : all in one RPA stent airway



high contrast
and
metal
+2000

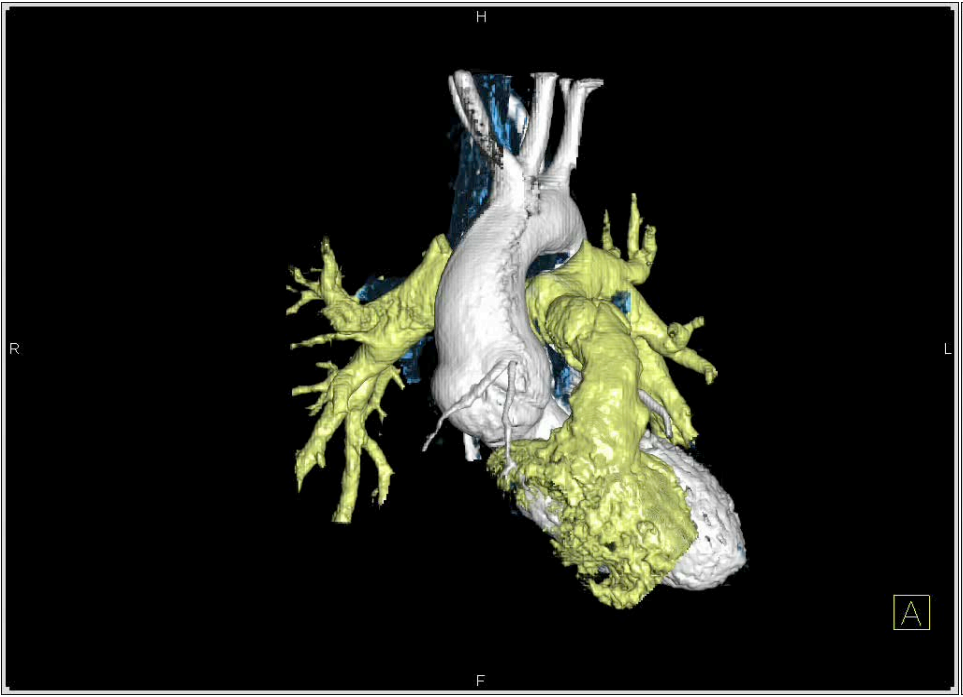
Airway
-500

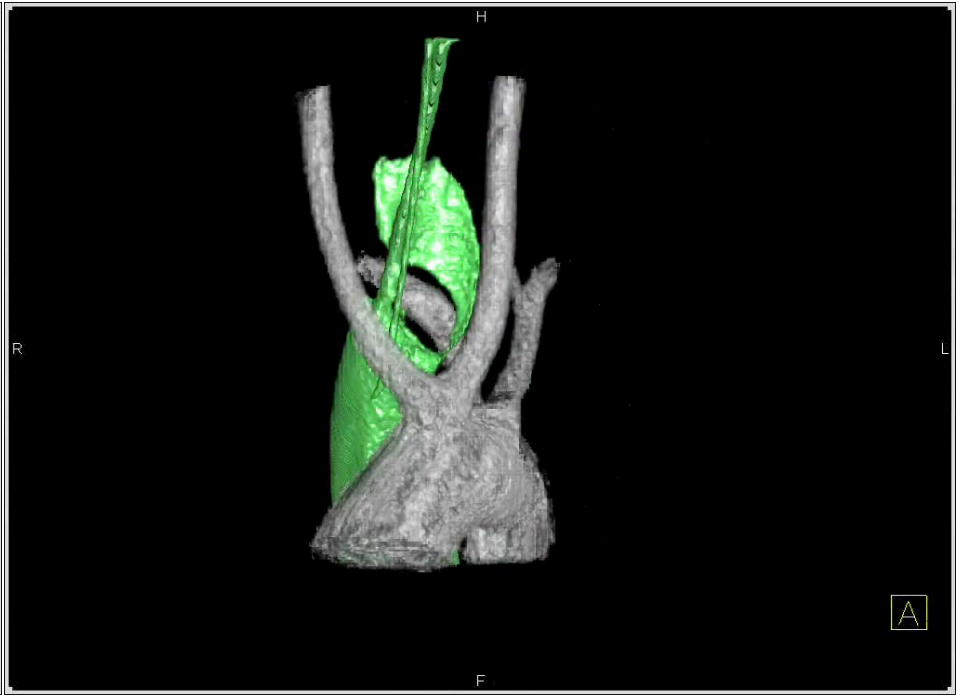
Vessel
„hollow“
trapezoid
+1000

AoArch – Airway / Oesophagus

congenital AoArch anomalies

PPVI … *“I can not swallow”*

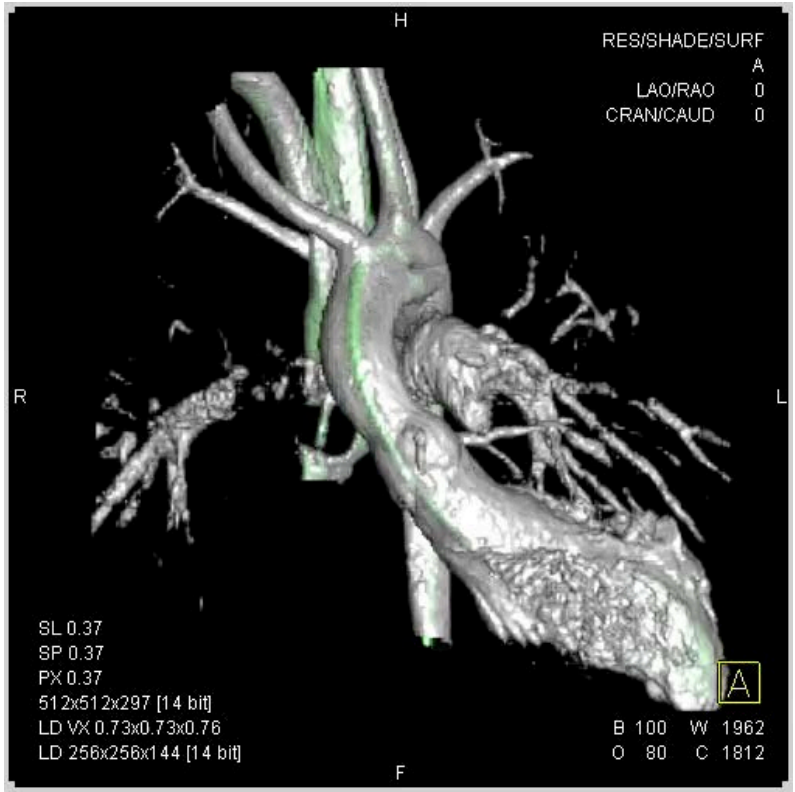




16 years old, problems to swallow since early childhood

6 month psychiatric hospital stay - to overcome fear to swallow

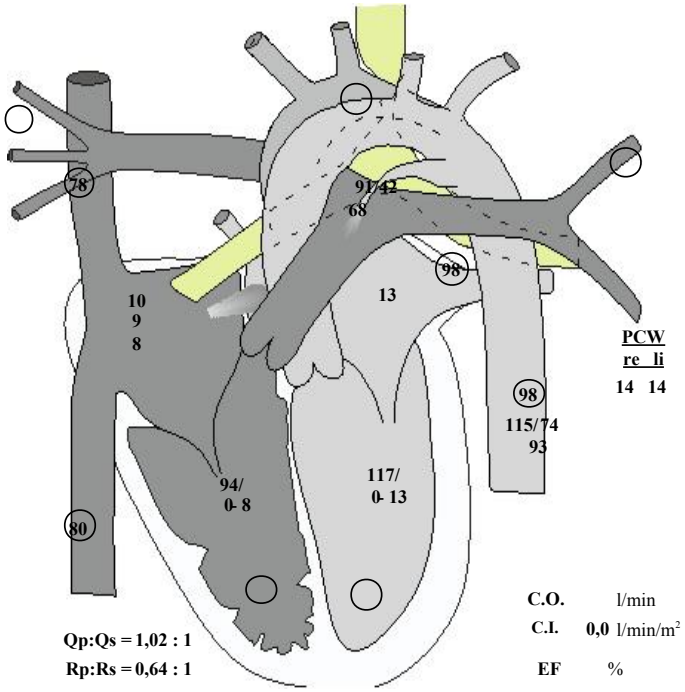
open duct : *let's close it ….*

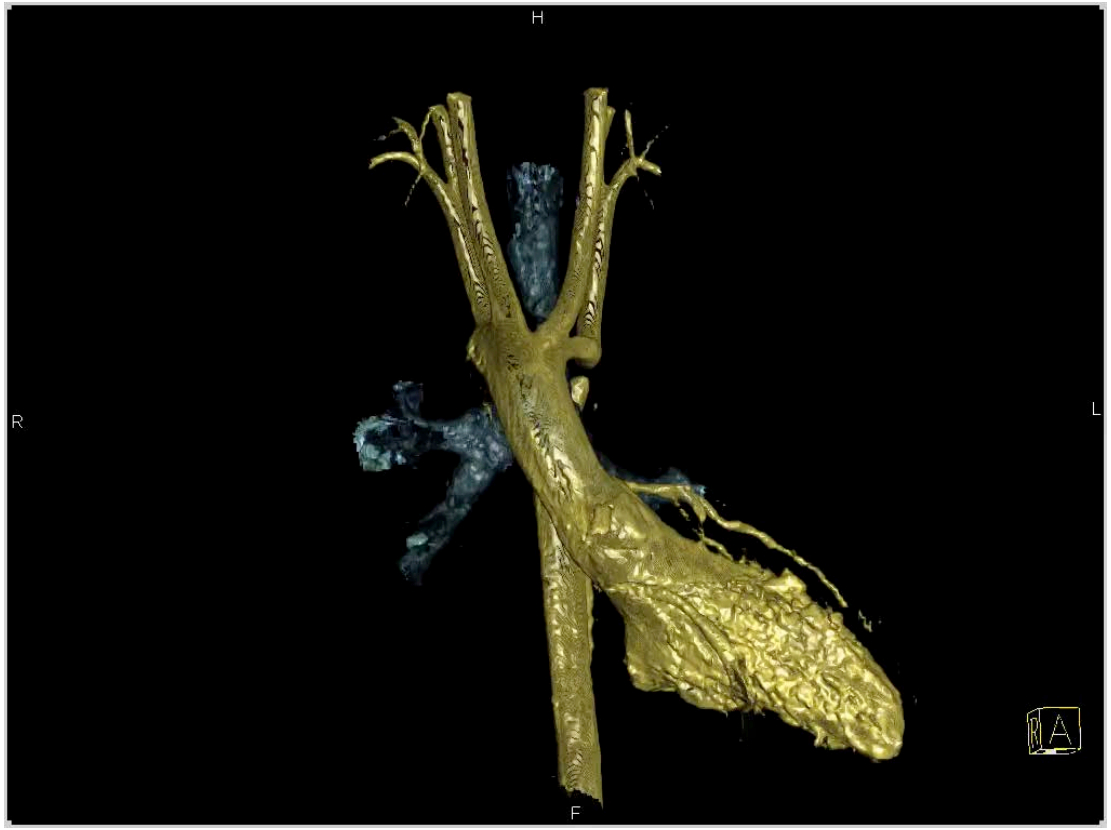


1 year old boy, Cath : PDA closure

CTA earlier : mild trachea obstruction

Pulmonary Hypertension Testing





7 years old,
PDA, trachea obstruction

Airway compression in Single Vemtricle

in LPA Stenosis after Norwood / DKS

Index Patient : DILV, LPA stenosis

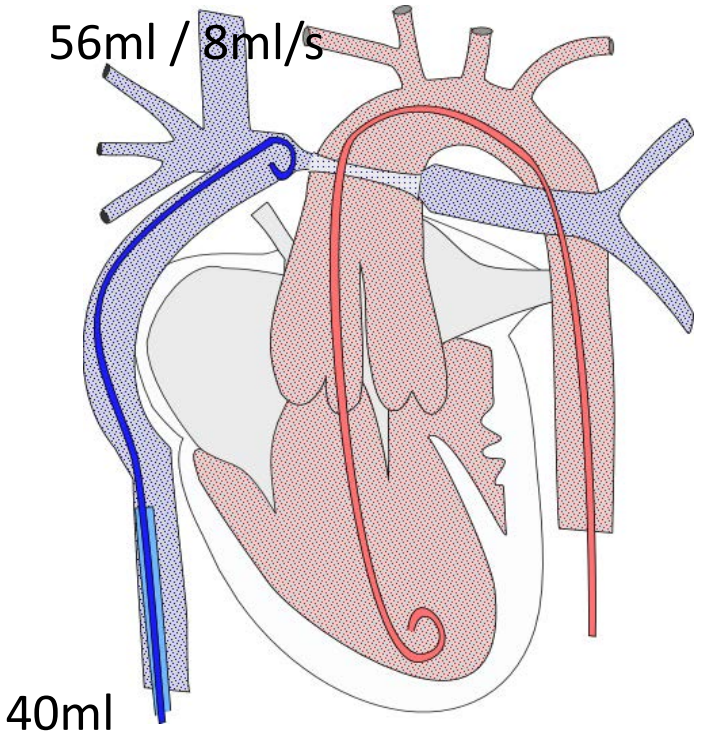
6 ½ y boy, 25kg

DILV, ccTGA, CoA, AV III.

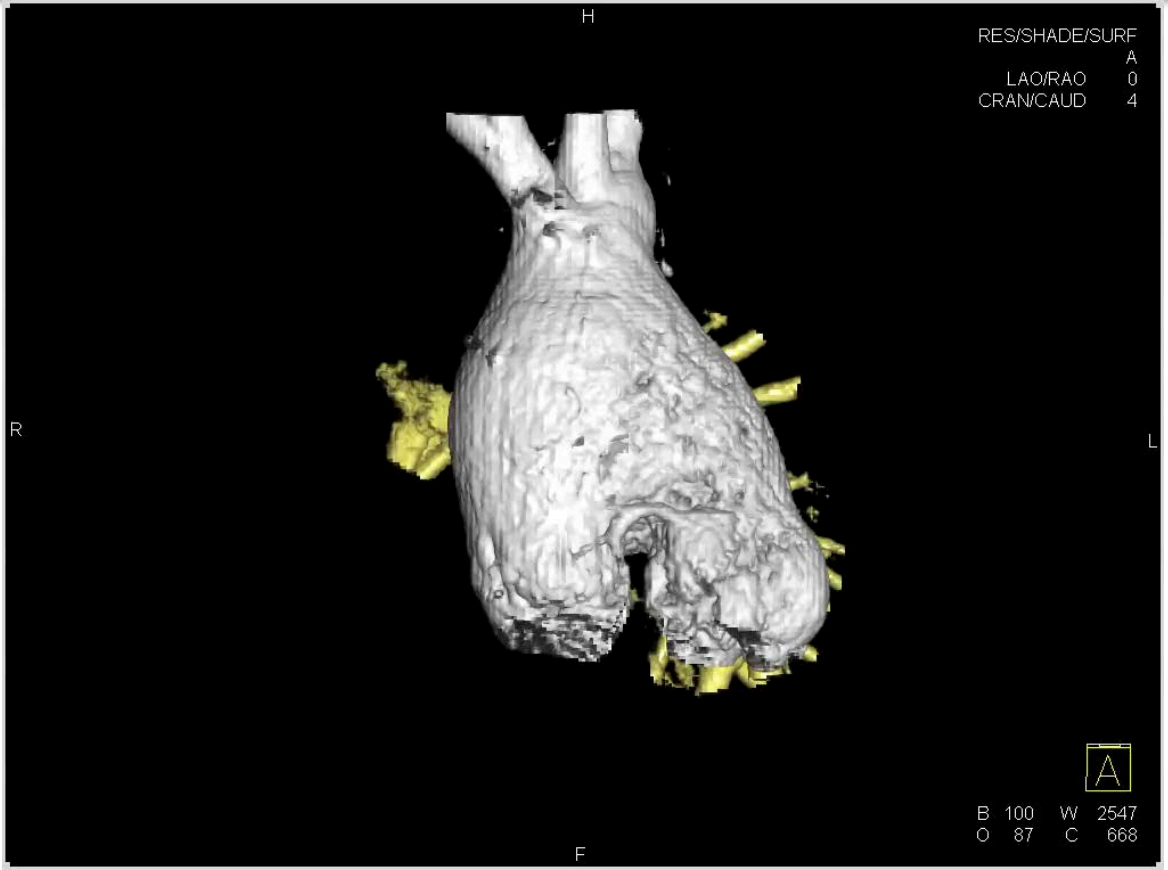
Stage I (with VVI PM)
pleuritis left => lobectomy left

Stage II PCPC
Stage III TCPC (with DDD PM)
2 month post Op : failing TCPC

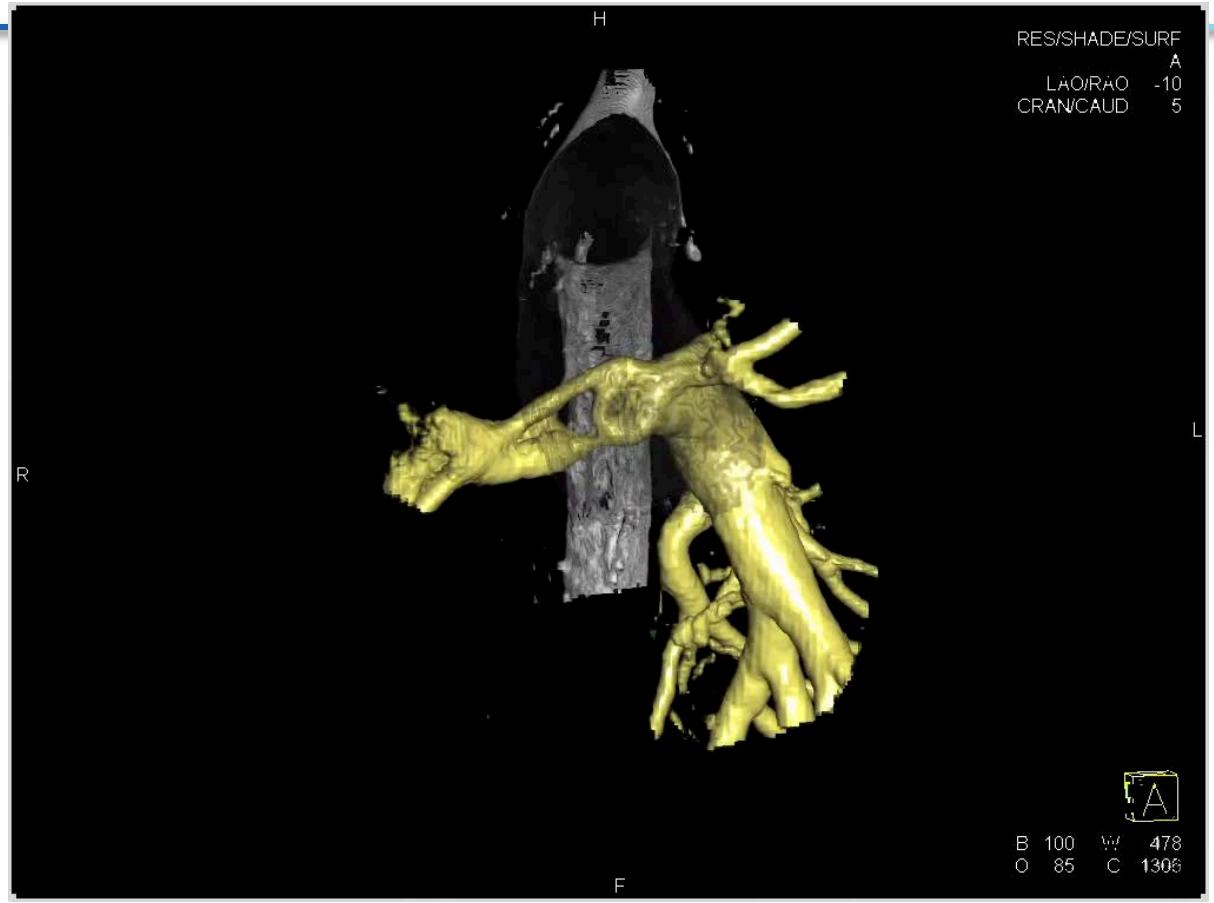
CMR : severe LPA stenosis



Index Patient : DILV, LPA stenosis



Index Patient : DILV, LPA stenosis



Index Patient : DILV, LPA stenosis

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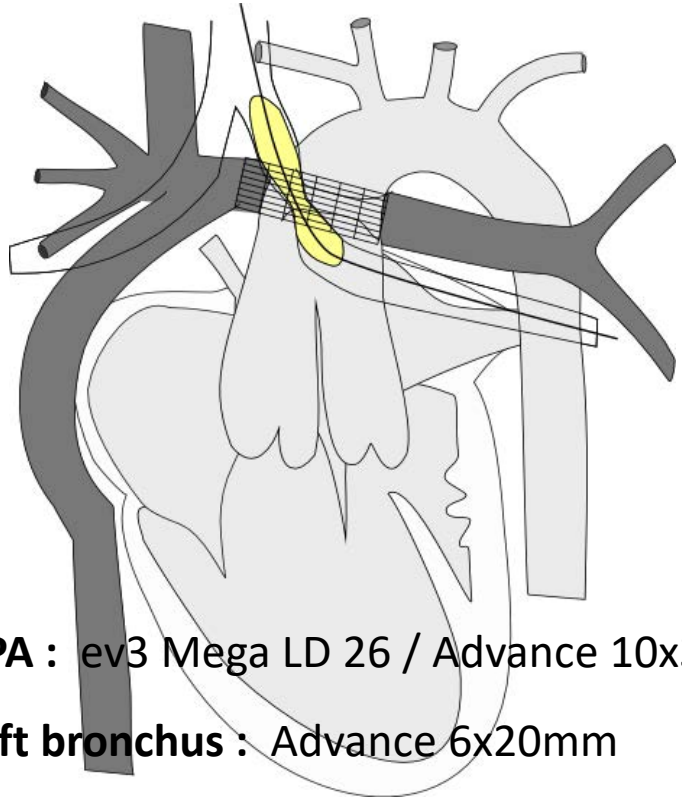
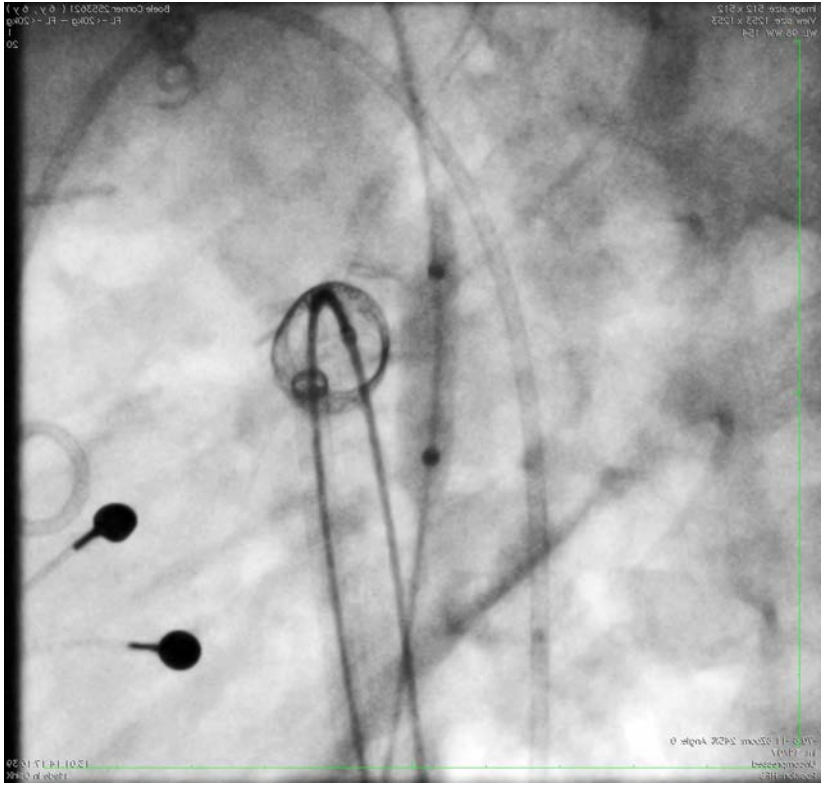
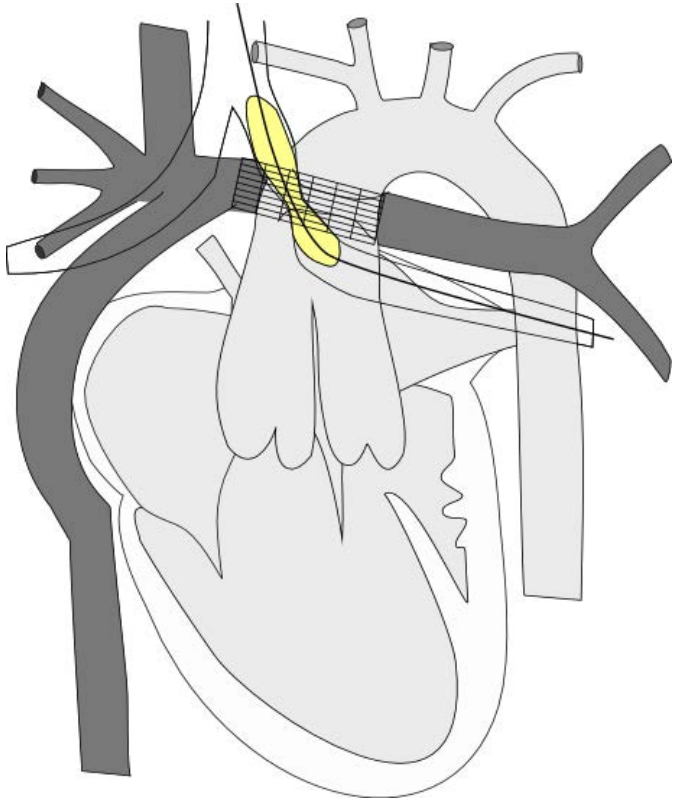


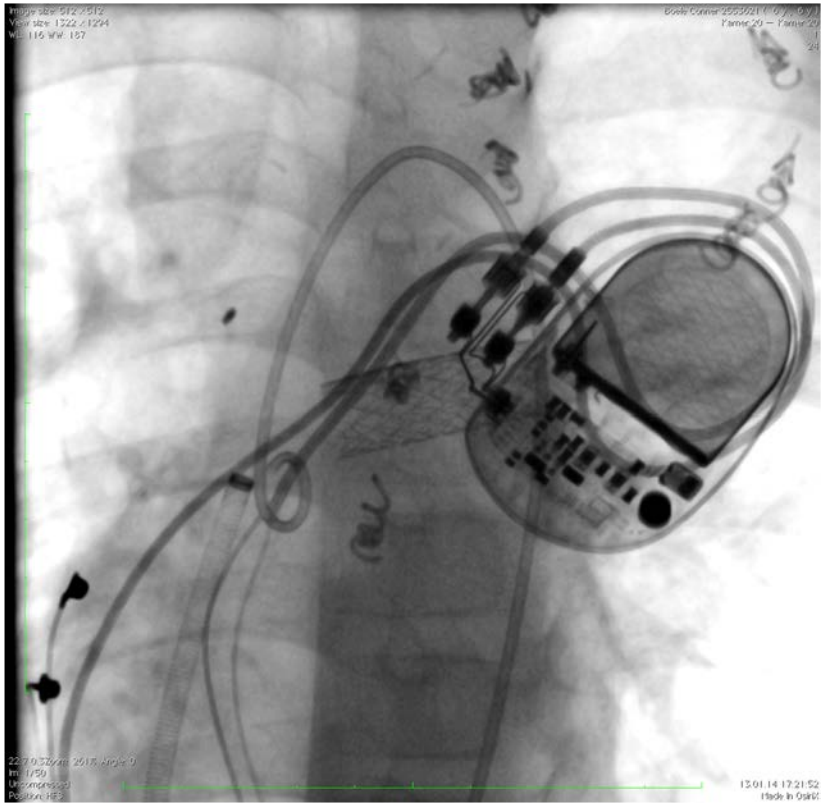
LPA : ev3 Mega LD 26 / Advance 10x30

left bronchus : Advance 6x20mm



Index Patient : DILV, LPA stenosis





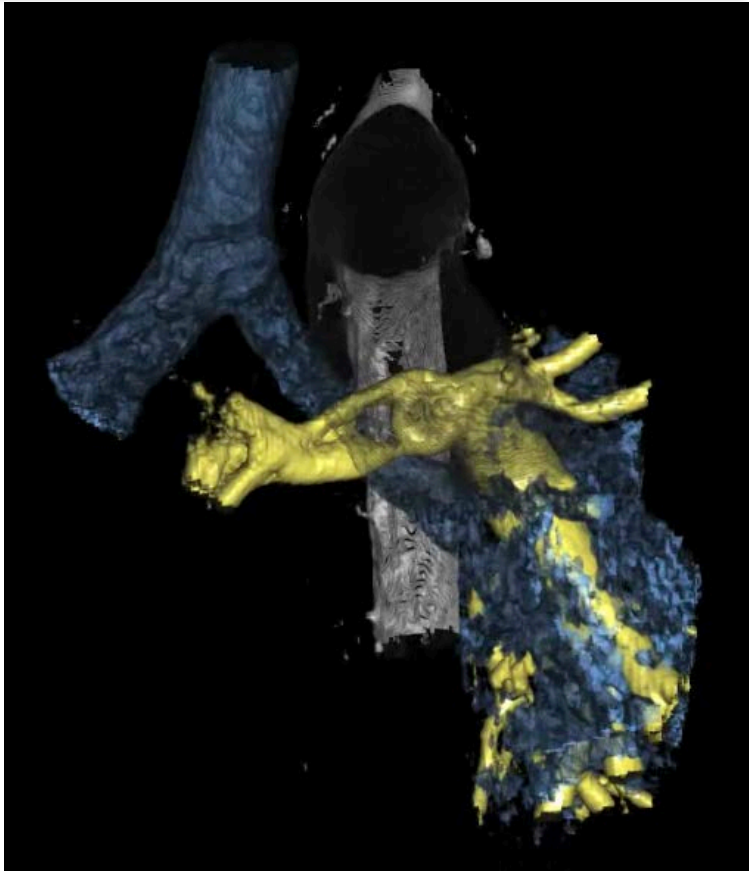
Index Patient : DILV, LPA stenosis

balloon interrogation properly

but round stent wasn't optimal

$\Rightarrow$ bronchus obstruction

how to prevent ?



Literature on bronchus compression

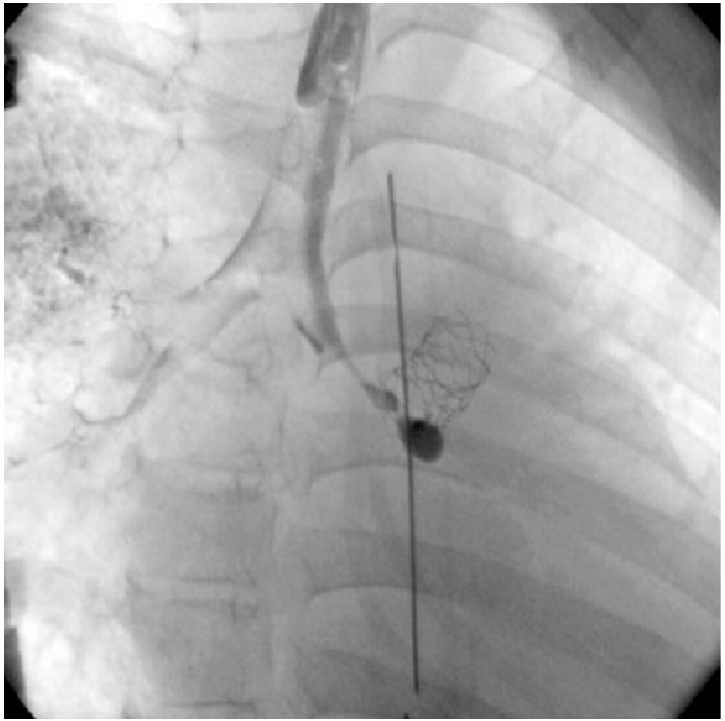
<u>Lodz (2009):</u>

Single case

5 year old, HLHS

LPA stent => bronchus compression

=> bronchus dilatation



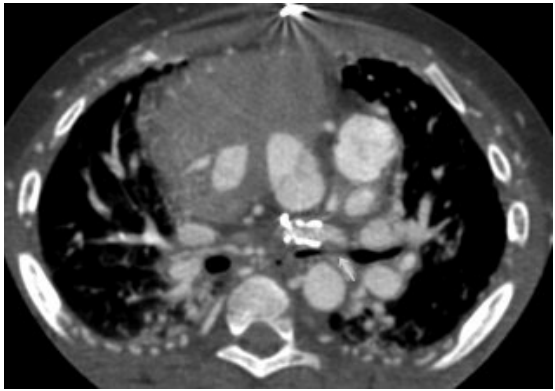
Moszura T, Mazurek-Kula A, Dryzek P, Sysa A. Bronchial compression as adverse effect of left pulmonary artery stenting in a patient with hypoplastic left heart syndrome. Pediatr Cardiol. 2010 May;31(4):530-3.

Literature on bronchus compression

Rady / San Diego (2009):

“Adverse Impact of Vascular Stent "Mass Effect" on Airways”

stenting	**120 patients, 147 stents** (2005-2007)
CTA	**21**
bronchus compression	**6 (29%)**
	2 Biventricle, AoArch surg
	4 Single Ventricle



Ferandos C1, El-Said H, Hamzeh R, Moore JW. Adverse impact of vascular stent "mass effect" on airways. Catheter Cardiovasc Interv. 2009 Jul 1; 74(1):132-6.

Literature on bronchus compression

Sick Children (2015):

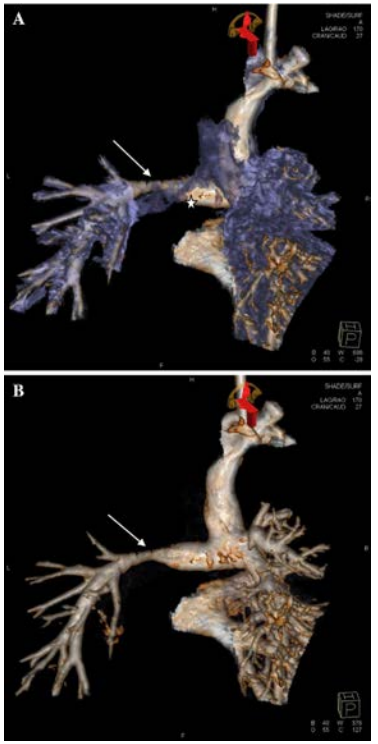
“Three-dimensional rotational angiography in the assessment of vascular and airway compression in children after a cavopulmonary anastomosis”

3DRA **25 patients**

12 LPA stenosis, 10 with bronchial stenosis

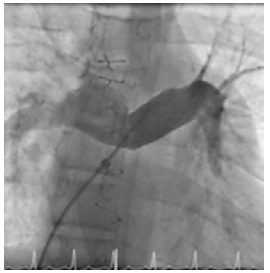
At risk :

Patients after Hybrid procedure and Damus-Kaye-Stansel



Borik S, Volodina S, Chaturvedi R, Lee KJ, Benson LN. Three-dimensional rotational angiography in the assessment of vascular and airway compression in children after a cavopulmonary anastomosis. Pediatr Cardiol. 2015;36:1083-1089.

Literature on bronchus compression


CHOP (2016) PCPC / TCPC (2005-2014)

LPA stenting	**65**
symptomatic	**1**
CTA (in 12%)	**1** bronchus compression
Bronchoscopy during LPA stent	**7**
	1 severe compression => no stenting
	6 mild-moderate compression => stenting

O'Byrne ML, Rome N, et al. Intra-procedural Bronchoscopy to Prevent Bronchial Compression During Pulmonary Artery Stent Angioplasty. Pediatr Cardiol. **2016** Mar;37(3):433-41.

Literature on bronchus compression

Freiburg (2016) TCPC (2011-2015)

LPA stenting	**19**
Age	**8,5 y**
Severe bronchus compression	**2** (balloon dil. bronchus + chest compression)

Strategy : identify patients at risk with intraprocedural bronchoscopy and CTA

Grohmann J, Stiller B, Neumann E et al. Bronchial compression following pulmonary artery stenting in single ventricle lesions: how to prevent, and how to decompress. Clin Res Cardiol. 2016 Apr;105(4):323-31.

time to identify

and treat

patients at risk

Utrecht approach

Oval LPA Stenting : Utrecht approach

oval LPA stenting **18**

1 stent implantation on double balloon

17 stent re-shaping to oval geometry with double balloon

Strategy

carefully check previous 3DRA / CTA with 3D airway reconstruction (Horos)

perform 3DRA in all patients at risk for bronchus compression

identify AoAsc – LPA – Bronchus – AoDesc geometry

apply ideal double balloon setting (double wire, steerable sheath)

Krings, Stelt, Molenschot, Breur. Oval stenting in left pulmonary artery stenosis: a novel double balloon technique to prevent airway compression in single ventricle. accepted March 2019, EuroIntervention

how to ovalize LPA stent

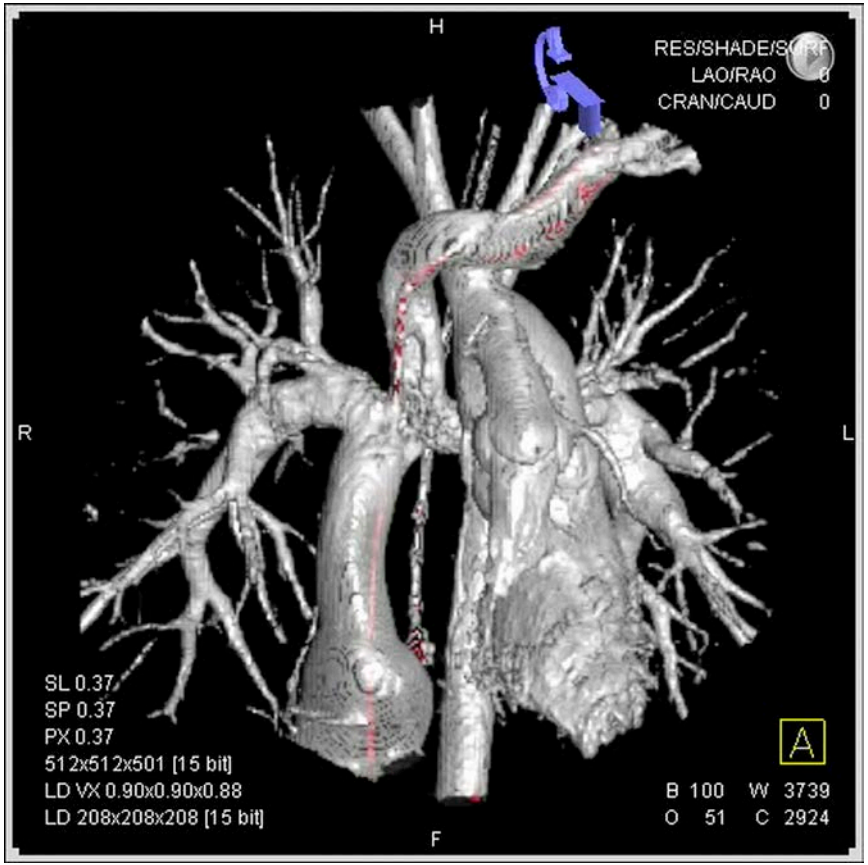
round stent in place

double long sheath

(steerable + standard)

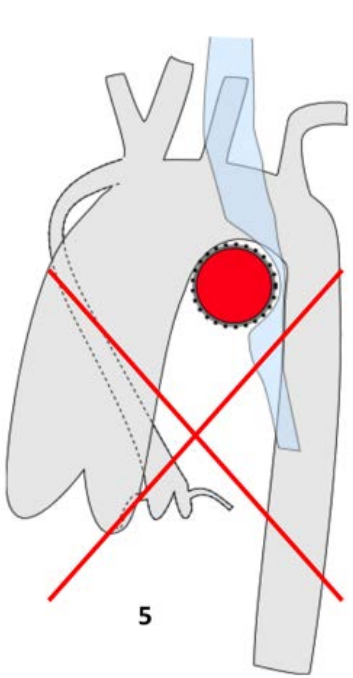
double wire in same lower lobe

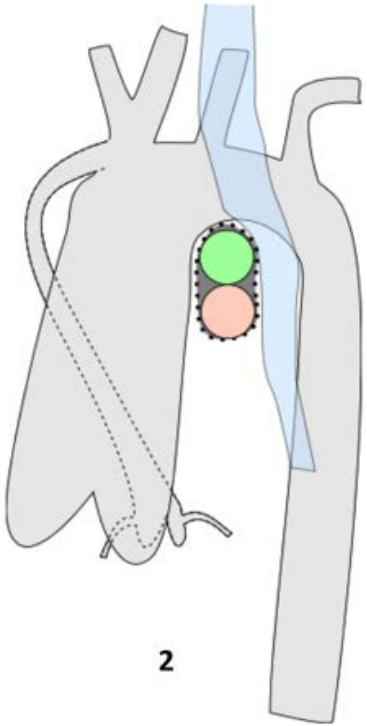
first inflate non-steerable sheath balloon

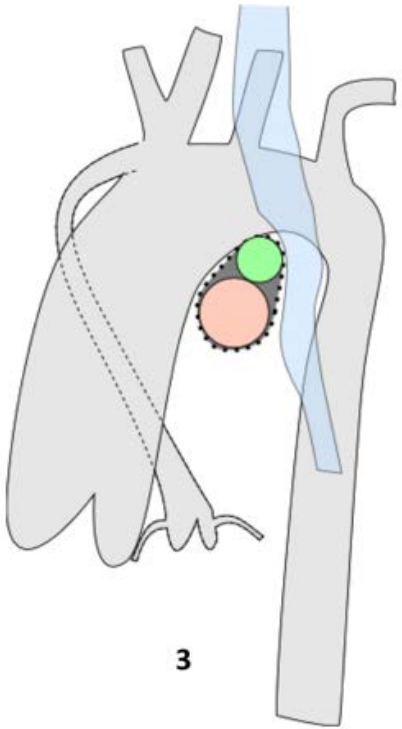


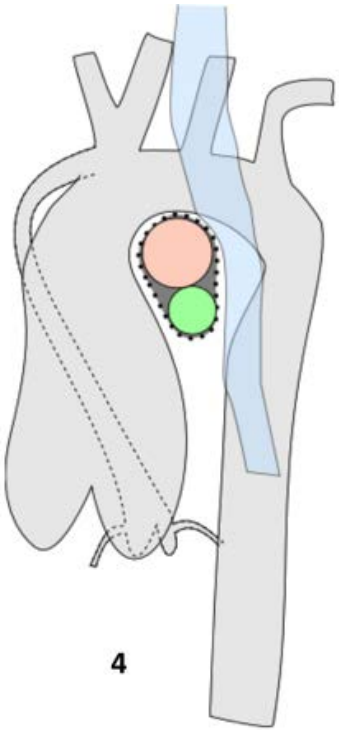
RPA stent – LCA

Strategy to avoid bronchus compression

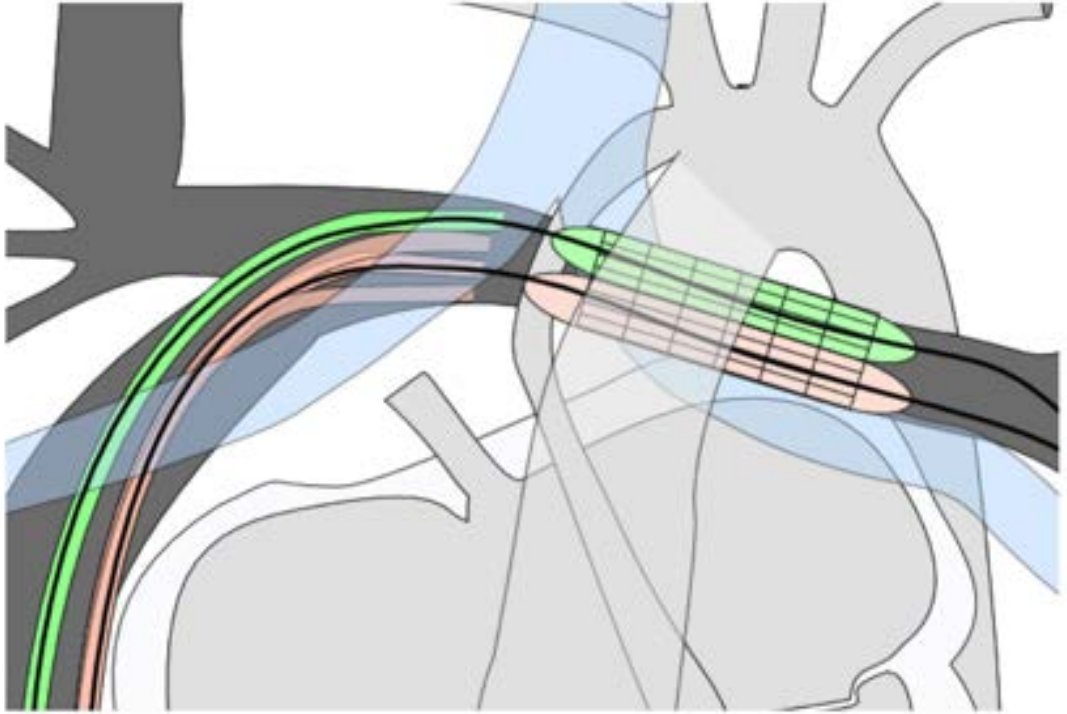




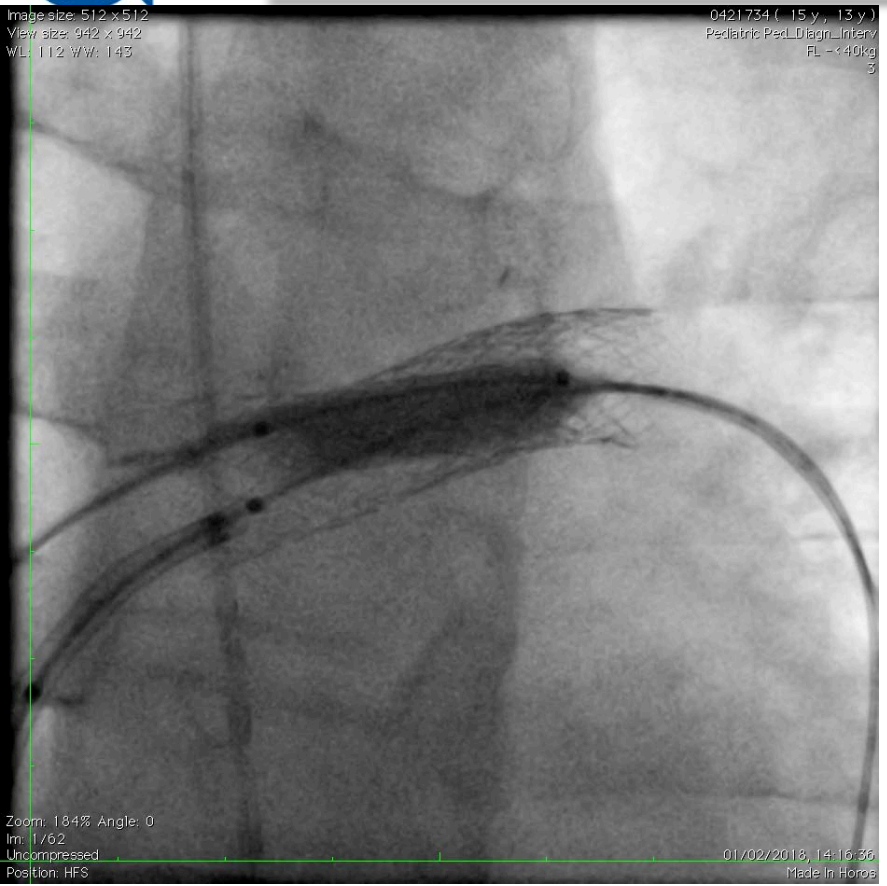


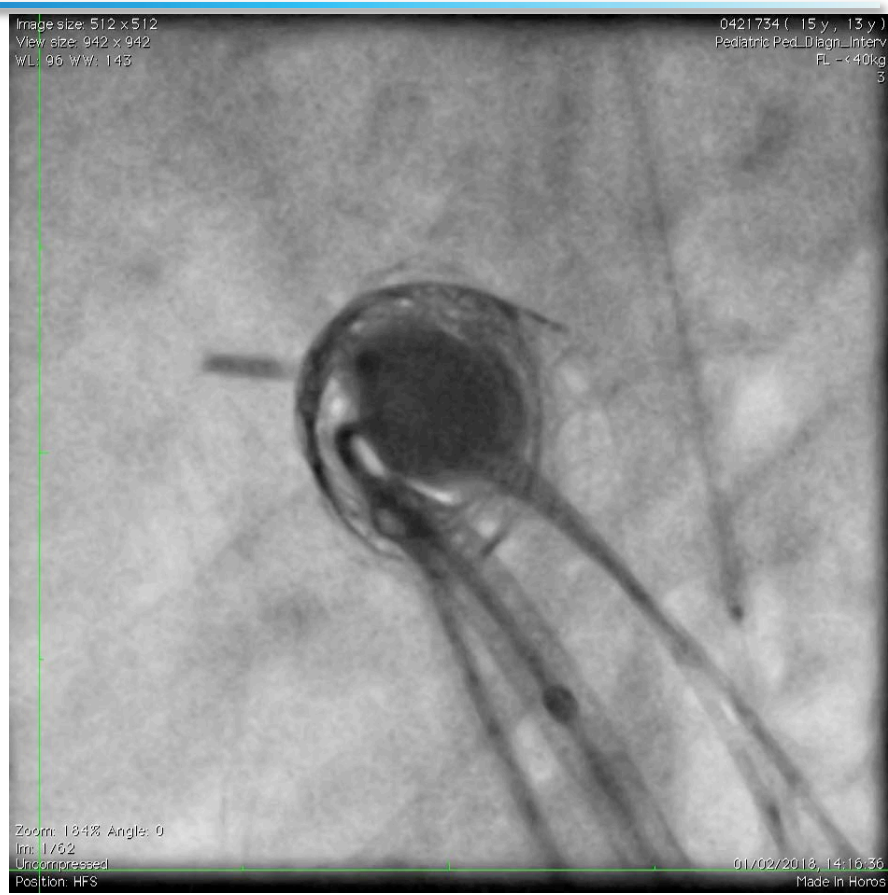


Strategy to avoid bronchus compression



Strategy to avoid bronchus compression

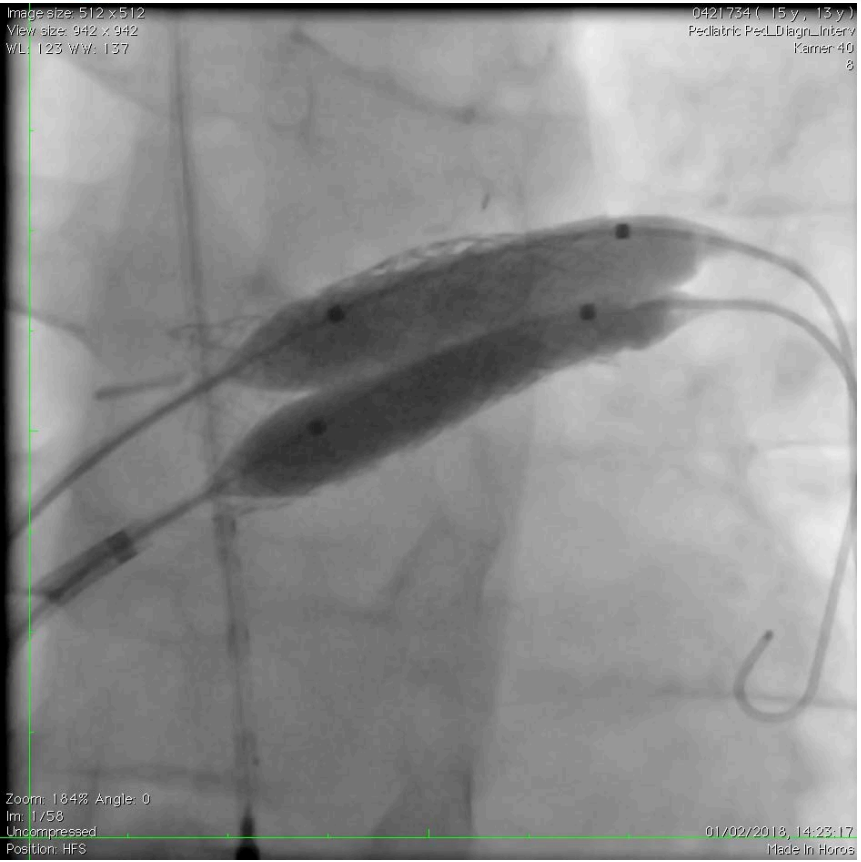


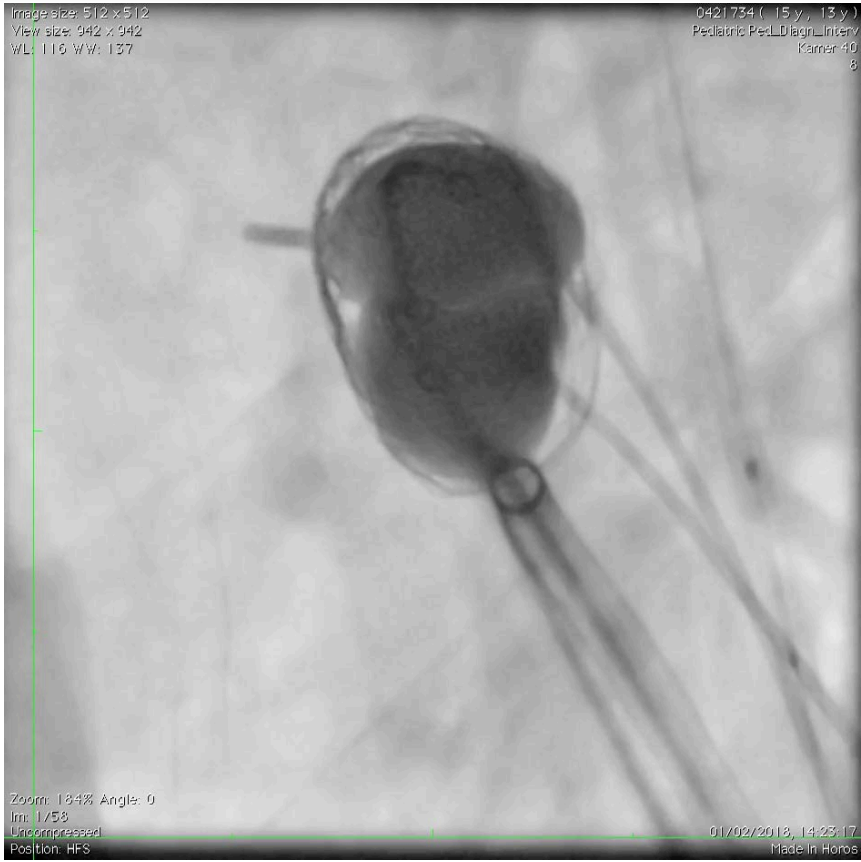


Strategy to avoid bronchus compression

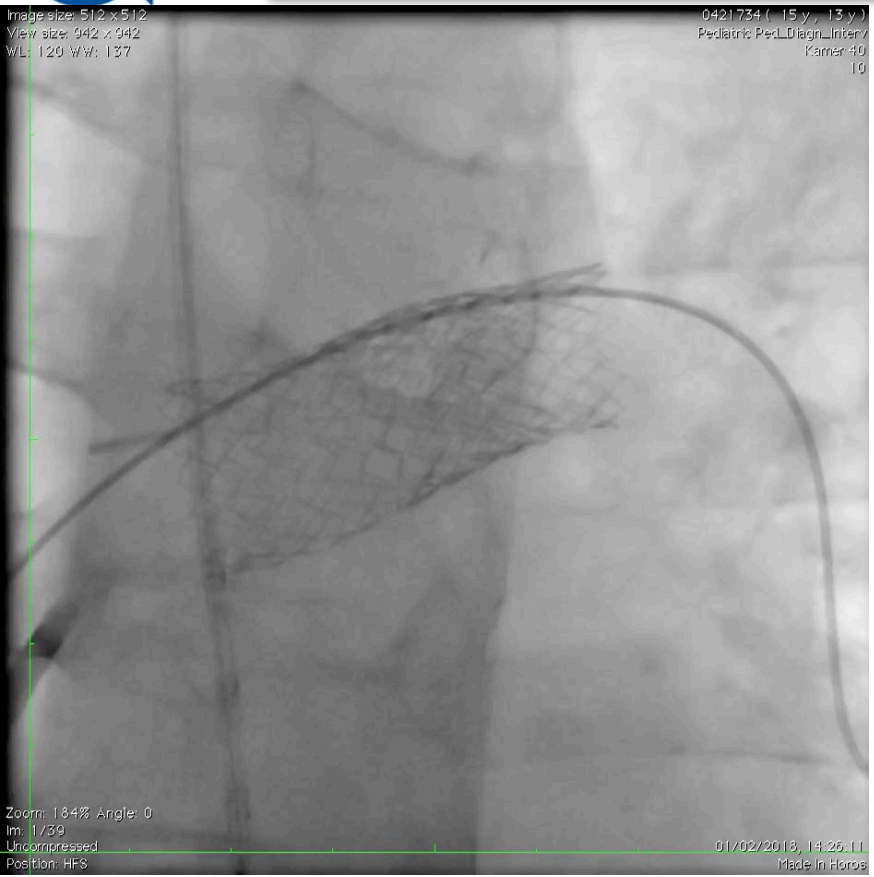
Strategy to avoid bronchus compression

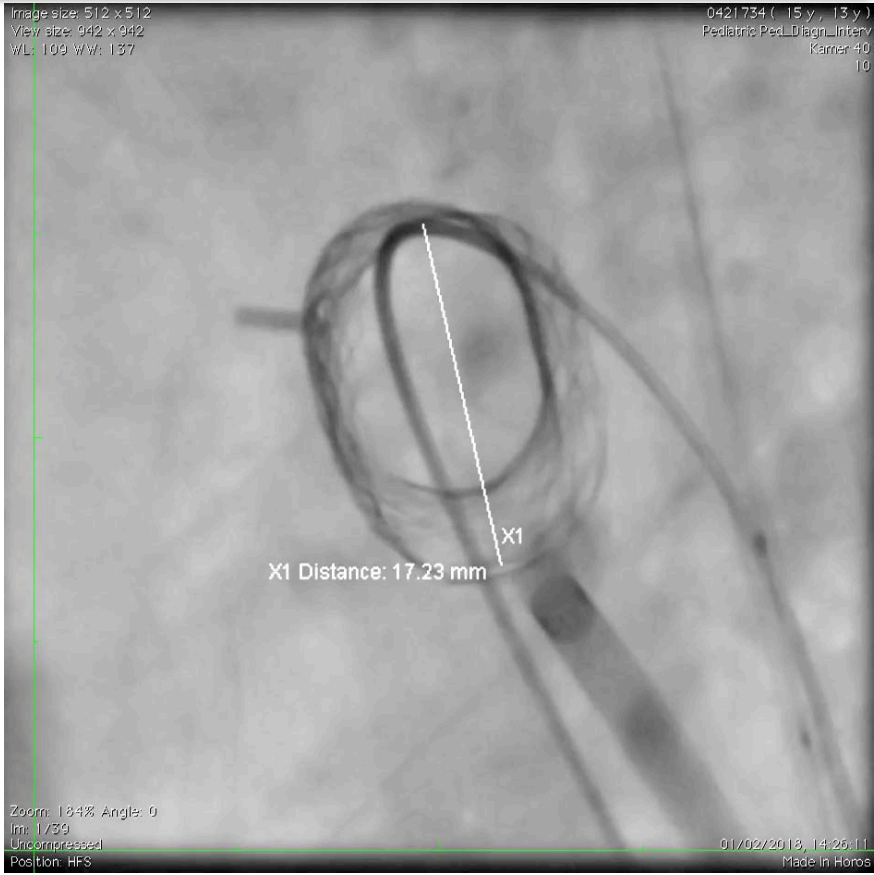
Strategy to avoid bronchus compression



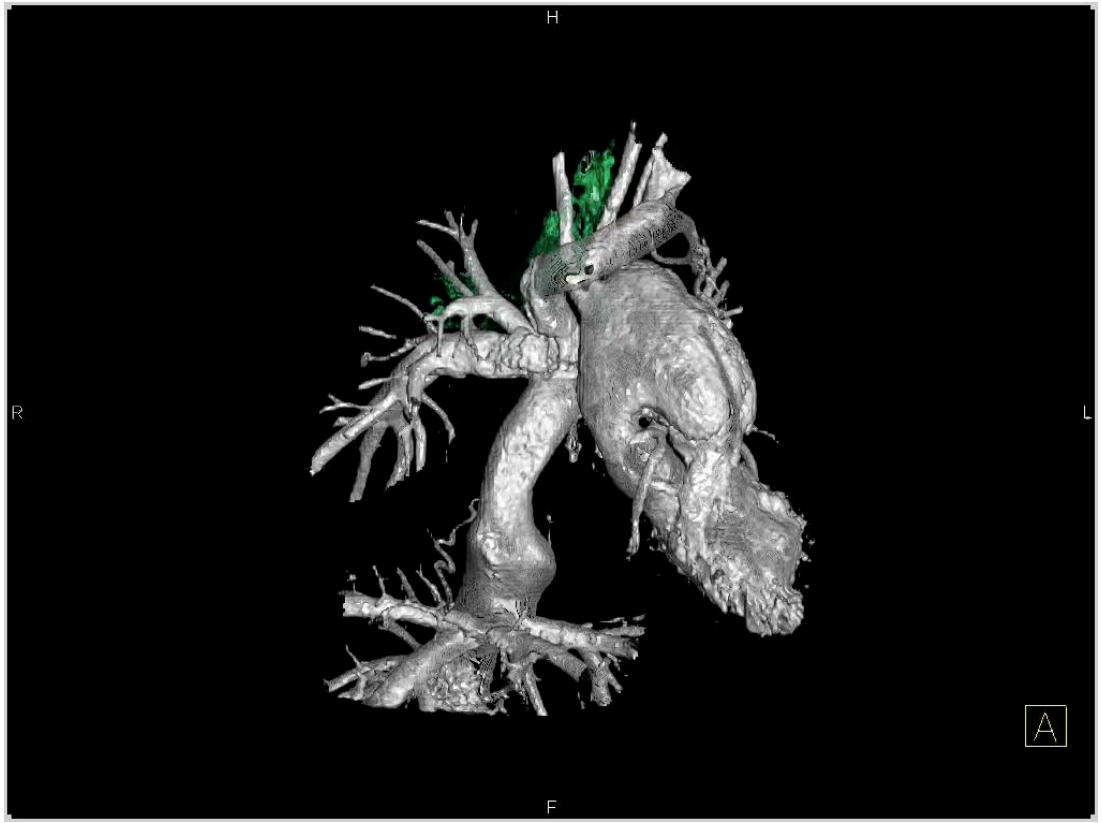


Strategy to avoid bronchus compression

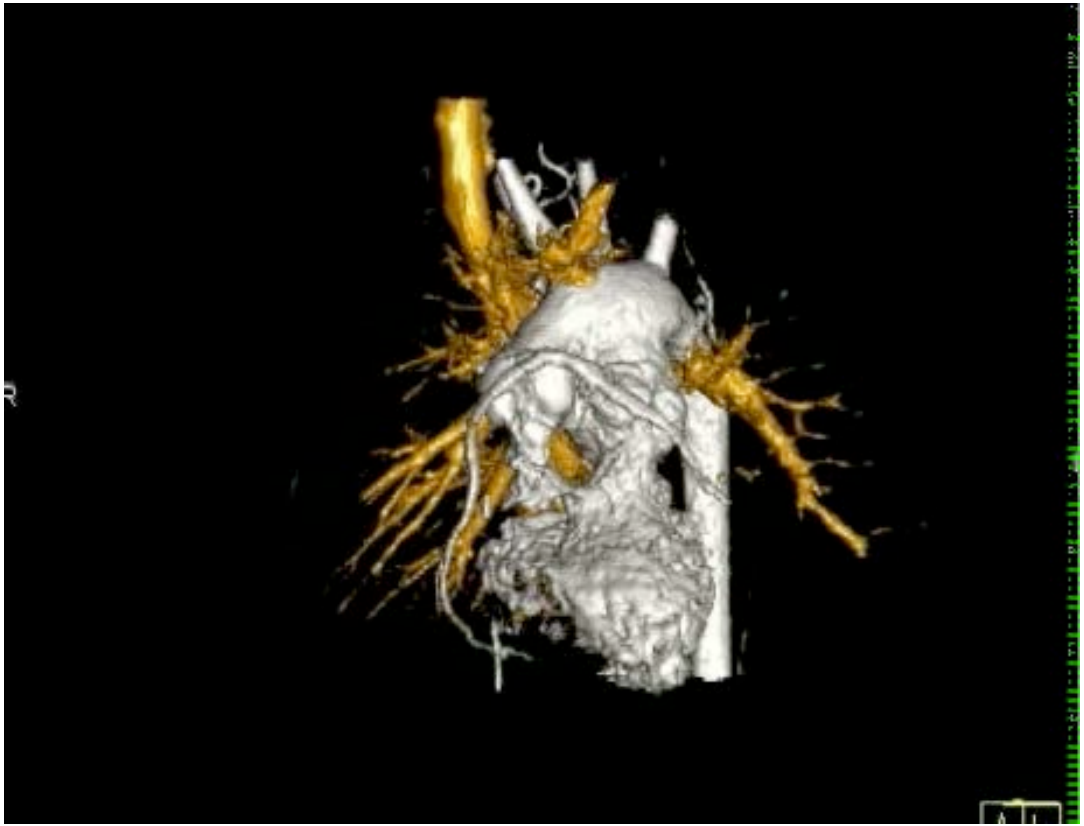




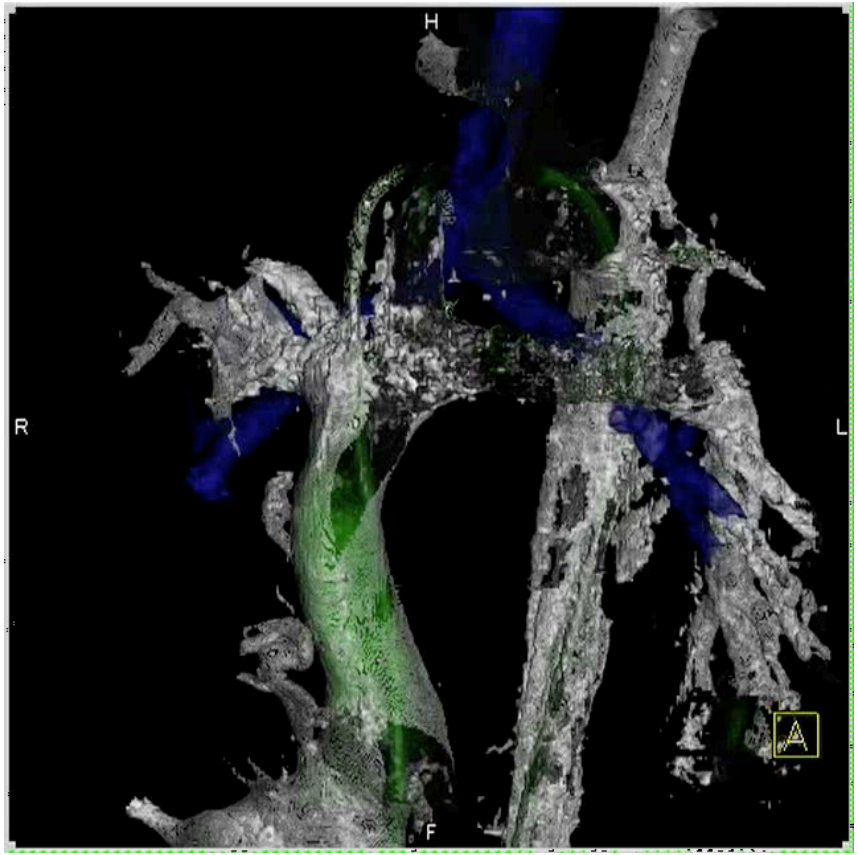
Oval stenting – 3DRA guidance



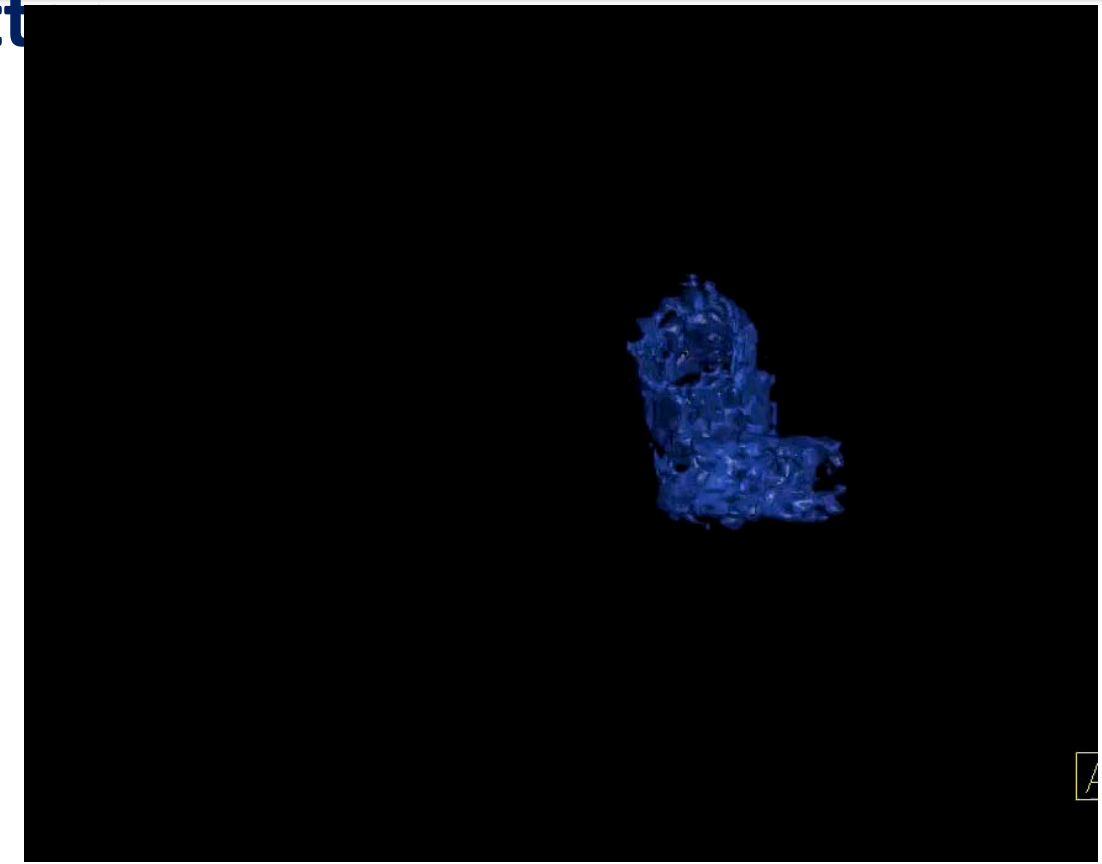
Primary implantation oval / double balloon



Oval stenting in TA TGA : TCPC small aorta



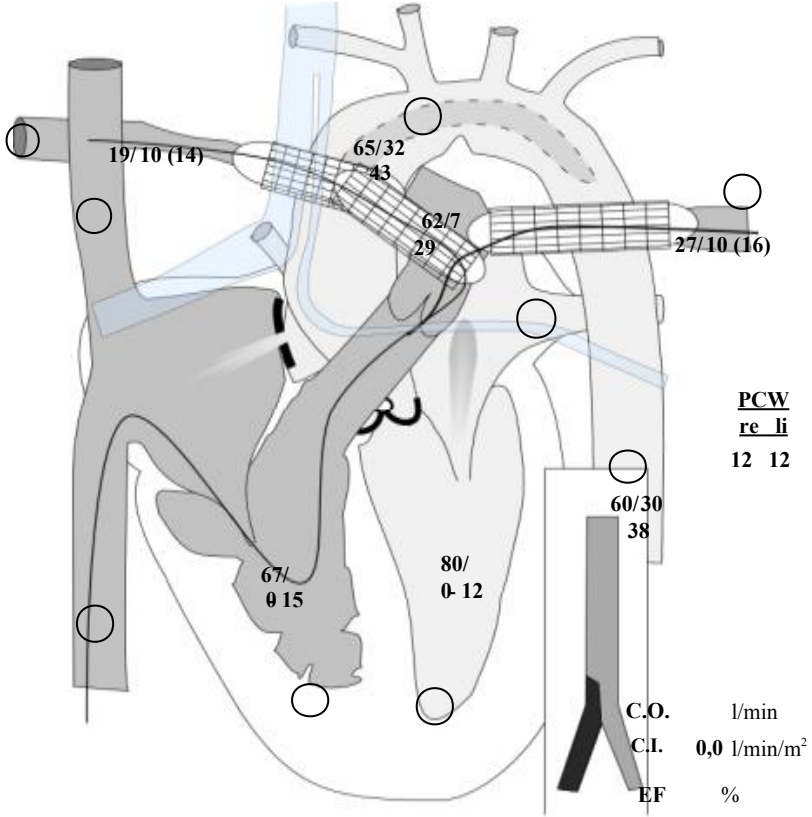
CoA + LPA stent: oval would have been bett

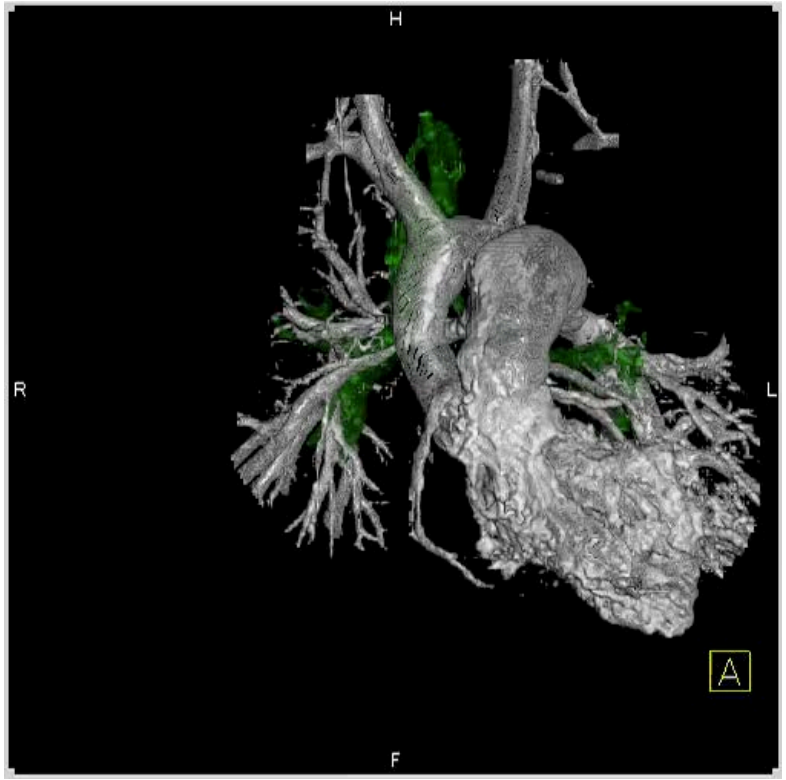


Airway compression in Bi Ventricle

after complex AoArch surgery

Kabuki Syndrome complex AoArch plasty, 3,5 kg





Ross Konno : stent AoArch

IAA_B , lusoric artery, LVOTO, VSD

neonatal Ross Konno

Arch plasty, Homograft 13mm

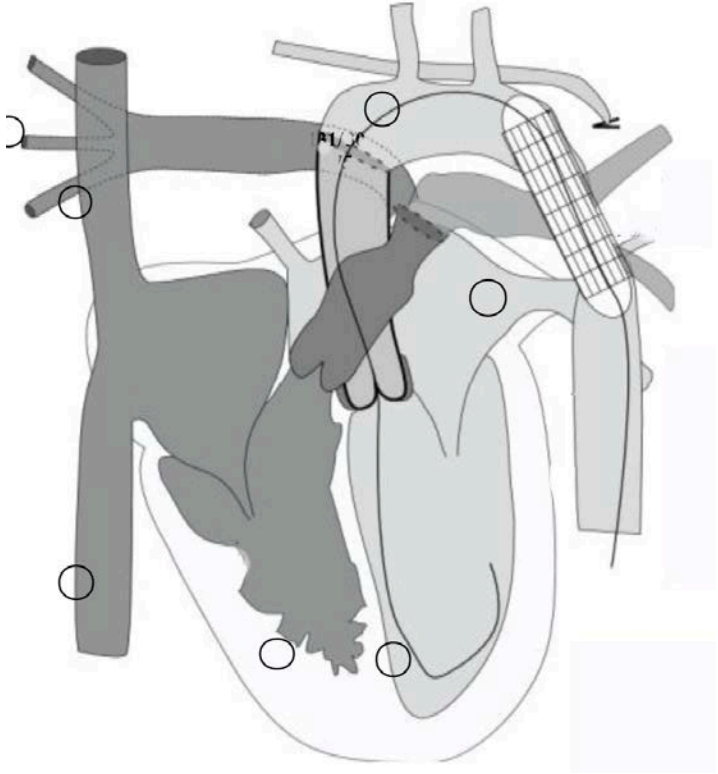
3 months post Op, 5kg

CoA => Formula stent

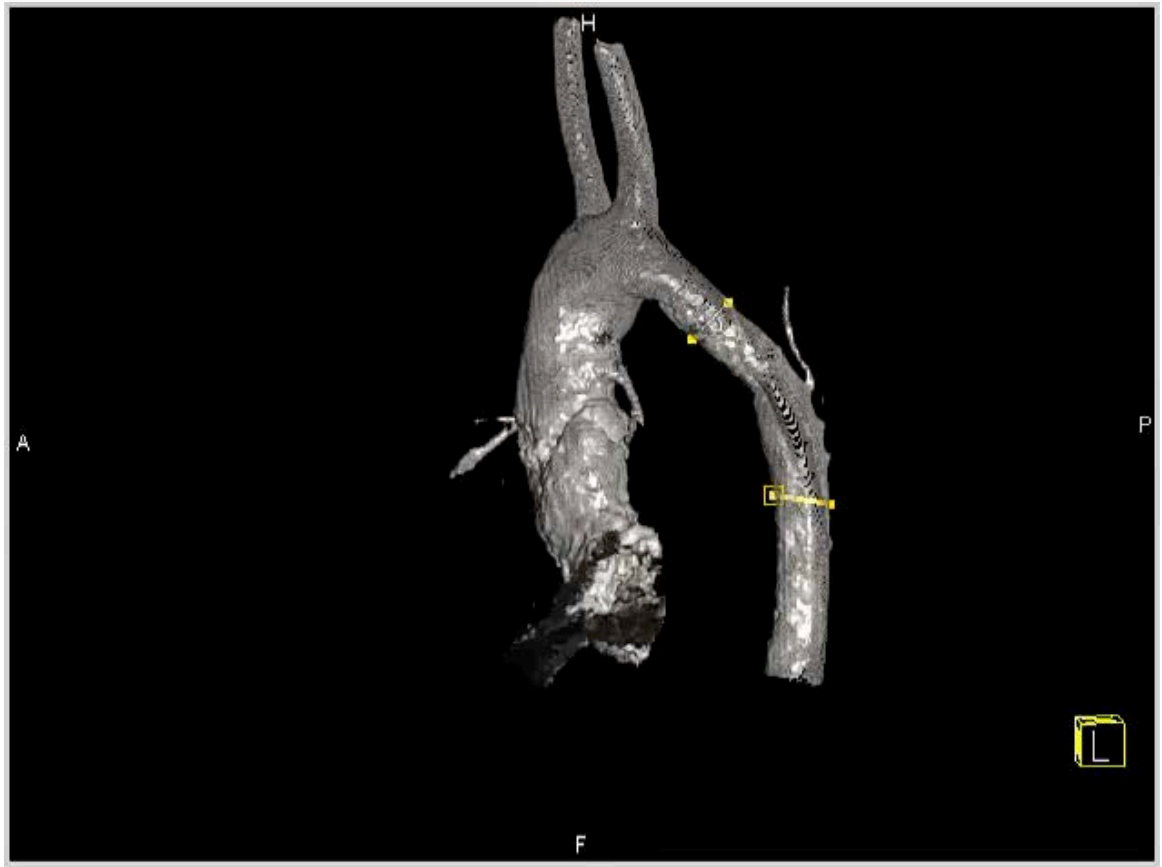
2 years later, 17 kg

CoA : 25mmHg => balloondilatation

RV pressure 2/3 systemic, RPA : 20mmHg



Ross Konno : AoArch and RPA stenosis … Let's Stent !



Ross Konno stent AoArch

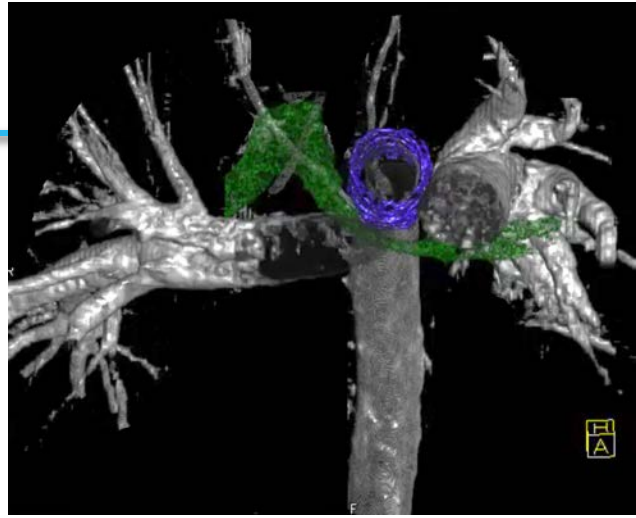
AoArch stent – left bronchus

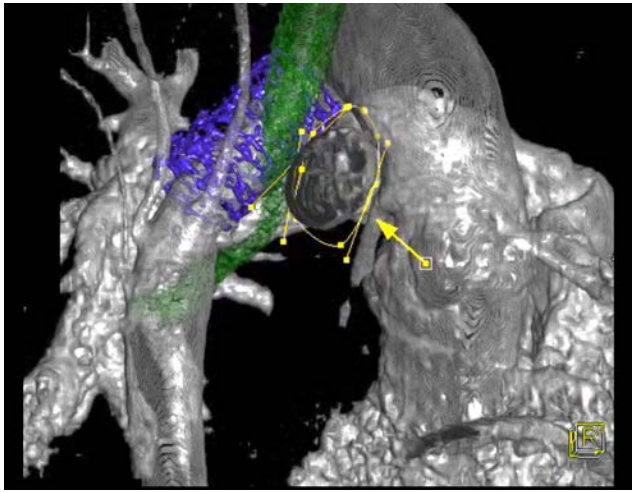
oval would have been better

RPA stent – LCA

no way round stenting ! … LCA and left bronchus

oval RPA stent if the RVSP further increases





conclusion

SV LPA stenting after DKS / Norwood

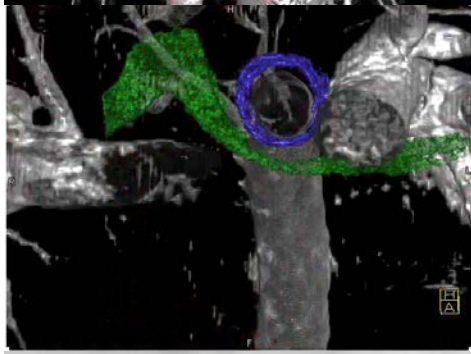
risk for bronchus compression

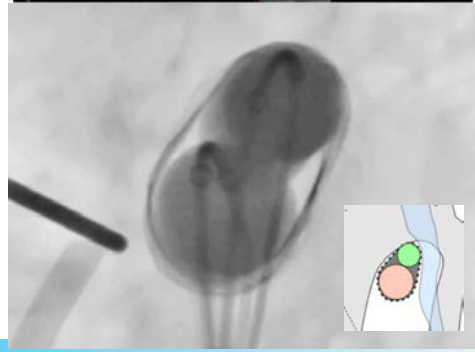
BiV LPA / RPA / AoArch stent after major aortic surgery

risk for bronchus and coronary compression

visualize => understand => prevent compression

oval stenting is a smart option





conclusion

We are no surgeons

We can not improve airway / oesophagus problems

But at least we should try not to make things worse