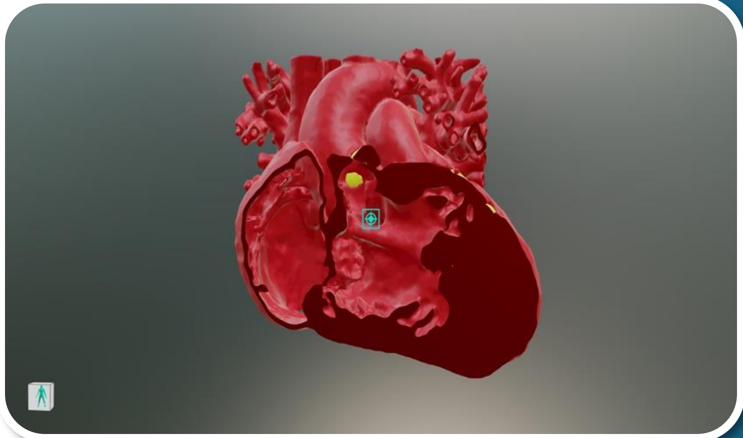
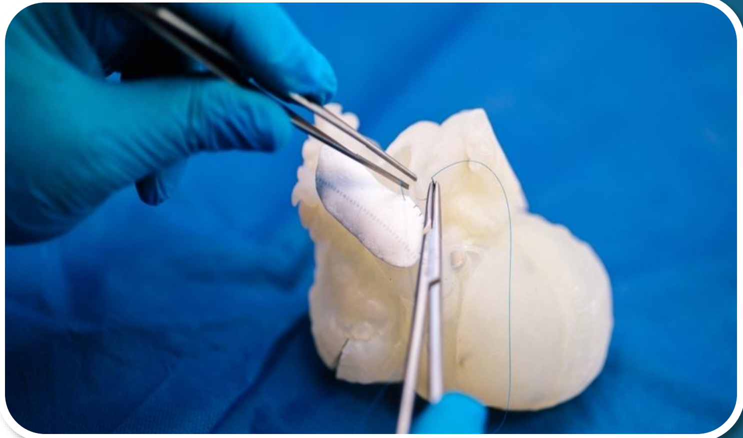




Silicone: the Surgeon's Best Friend (I guess...)

Nicola Viola MD

10th Utrecht Sessions
Utrecht 2025

SOUTHAMPTON Children's Hospital

Utrecht Sessions

University Hospital Southampton NHS
NHS Foundation Trust

Disclosure

- I am a Axial3D Key Opinion Leader and R&D Consultant, no financial interest

What is a "Best Friend" ?

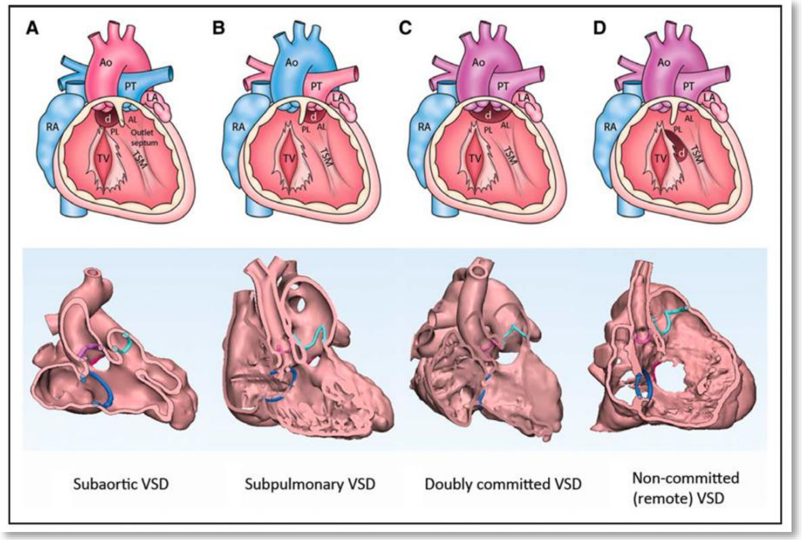
- In the least …. someone you like

- A best friend is most 'helpful'…
- A best friend is least demanding…
- The whole is greater than the sum of its parts

Advances in Cardiovascular Imaging

Essential Modifiers of Double Outlet Right Ventricle

Revisit With Endocardial Surface Images and 3-Dimensional Print Models



"Infundibular morphology, including the size and orientation of the outlet septum, relative to the margin of the ventricular septal defect"

"Extent of the muscular infundibulum as an additional modifier of the distance between the ventricular septal defect margin and the arterial valve or valves"

Circ Cardiovasc Imaging. 2018;11:e006891

RESEARCH Open Access

3D models improve understanding of congenital heart disease

Jonathan Awori*, Seth D. Friedman, Titus Chan, Christopher Howard, Steve Seslar, Brian D Soriano and Sujatha Buddhe

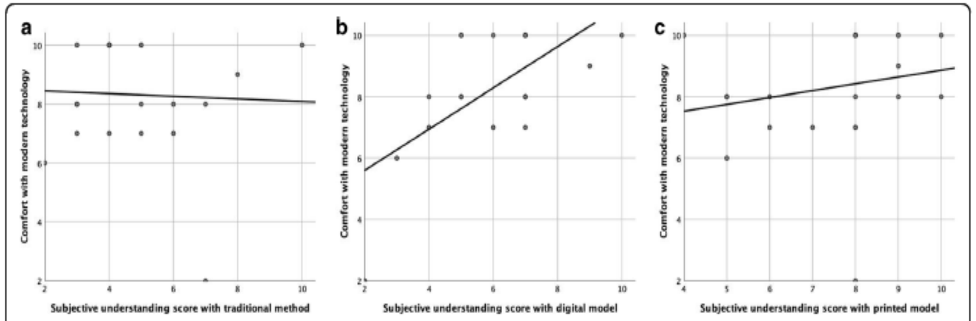


Fig. 6 a: Correlation between medical personnel's subjective level of understanding score using traditional method and their comfort with modern technology. **b:** Correlation between medical personnel's subjective level of understanding score using digital model and their comfort with modern technology . **c:** Correlation between medical personnel's subjective level of understanding score using printed model and their comfort with modern technology

- A mix of medical personnel and parents, and a mix of pathologies
- Parent and medical personnel perceived understanding with digital models was significantly higher than traditional ($p = 0.01$).
- Physical models were overall more useful than digital ones ($p = 0.001$)

Awori et al. 3D Printing in Medicine (2021) 7:26

Heartbeat

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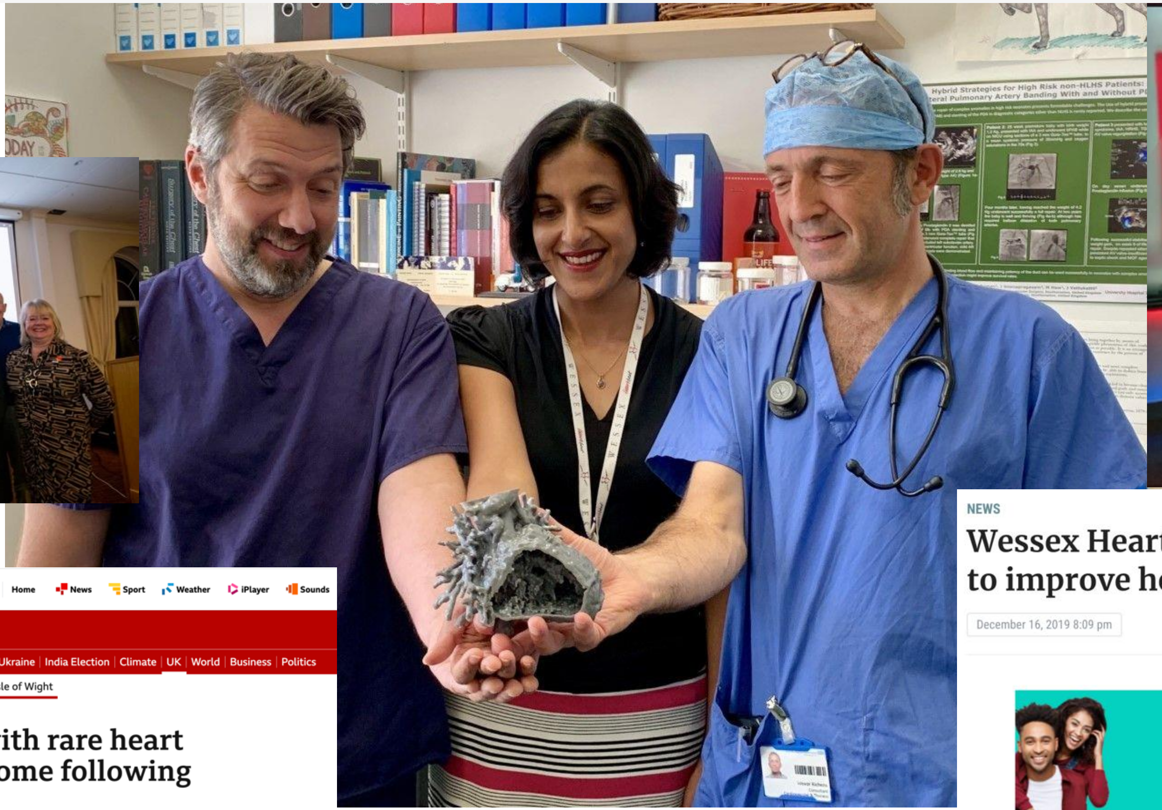
Big Impact for Little Hearts - 3D Modelling Software for Children with Congenital Heart Disease

Donate to this appeal

Start fundraising with JustGiving

Target
£250,000.00

Raised so far
£169,306.41



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Whiteley baby with rare heart condition goes home following surgery

22 February 2022

NEWS

Wessex Heartbeat funds 3D printing program to improve heart surgery for children

December 16, 2019 8:09 pm

SOUTHAMPTON Children's Hospital

University Hospital Southampton NHS Foundation Trust

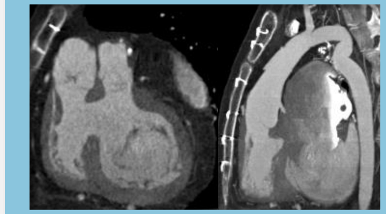
SEAMLESS

Integration of 3DM
In MDT Practice

ODN

First Presentation
Cardiology-led clinical presentation of the case, including Echo cardiography.

UHS

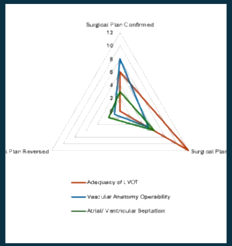


Interdisciplinary CHD Team
Query for Cardiac CT and 3DM agreed

Belfast

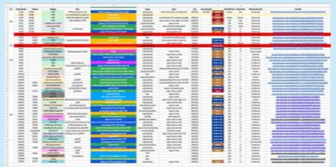
Upload to Axial3D
Completion of segmentation on-line using a clinician-led interface

UHS 2024



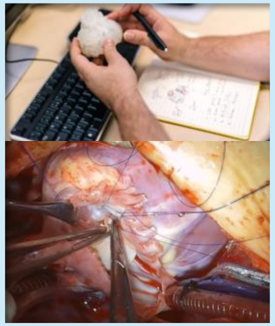
3DP Effect
Introducing outcome data analysis

2 Reviewers



Data Review
Cardiac CT queries and 3DM contribution classified and analysed

Op Theatre



Interventions
Planning and execution recorded

UHS

Delivery of 3DM
Repeat IDT meeting discussion and intervention plan agreed. Contribution of 3DM recorded

A best friend is most ‘helpful’…

- **Trustworthiness**:
  - 3D printing meets clinical expectations. The models are accurate enough to guide surgeries.

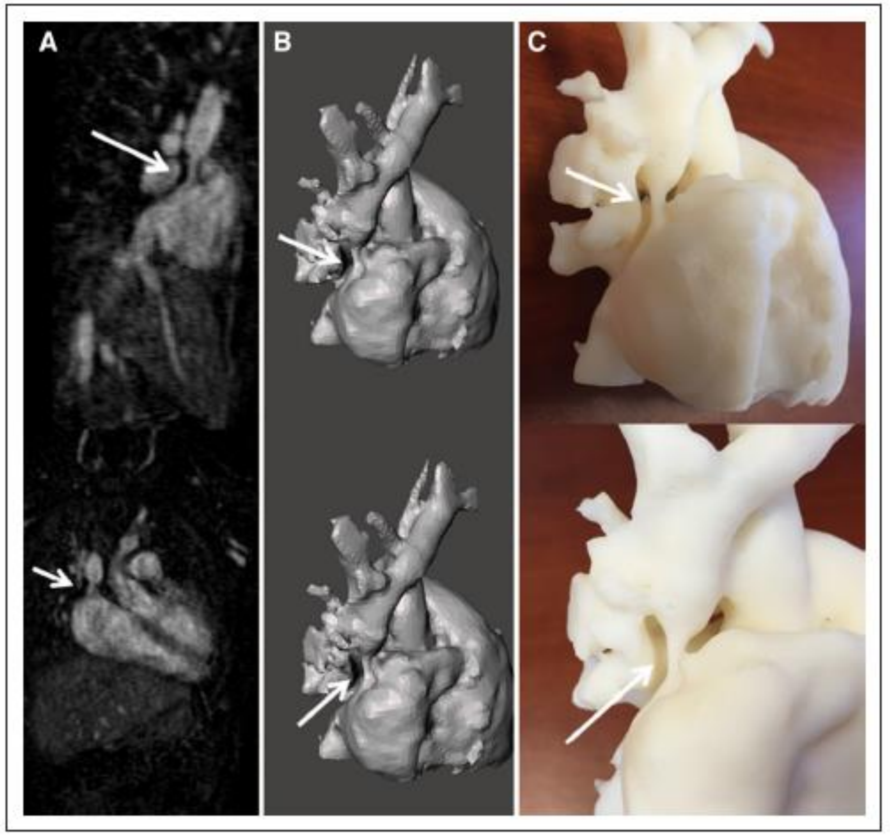
- **Non judgemental attitude**:
  - 3D printing complements existing technologies (e.g., echo, CT, MRI), creating a collaborative rather than competitive relationship

- **Unconditional Support:**
  - 3D printing is viable for both routine and complex cases, the general understanding and case-specific needs.

Impact of Three-Dimensional Printing on the Study and Treatment of Congenital Heart Disease

Matthew Bramlet, Laura Olivieri, Kanwal Farooqi, Beth Ripley, Meghan Coakley

- The workflow begins with image segmentation, during which a mask is layered over the desired anatomic details on each 2-dimensional slice of a 3D image data set. The masked data set is then converted into a meshed surface file, composed of edge-to-edge triangles or polygons
- 3D printers can create quality, high-resolution prints as accurate as the digital model can be
- Accuracy of the digital model is dependent on the segmentation steps and any editing of the meshed file that may occur, and it is entirely dependent on the file creator's interpretation of complex anatomy.
- A standardized peer review process of 3D modelling is needed.

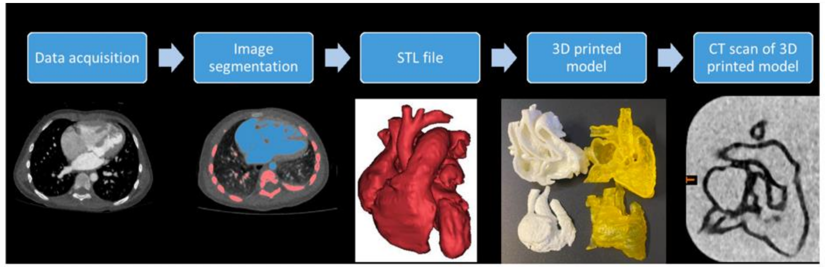


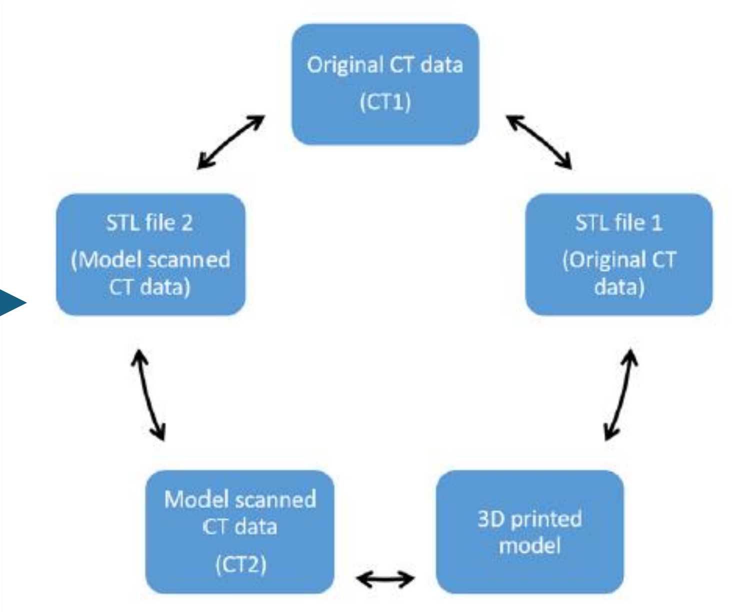
Circ Res. 2017;120:904-907. DOI: 10.1161/CIRCRESAHA.116.310546

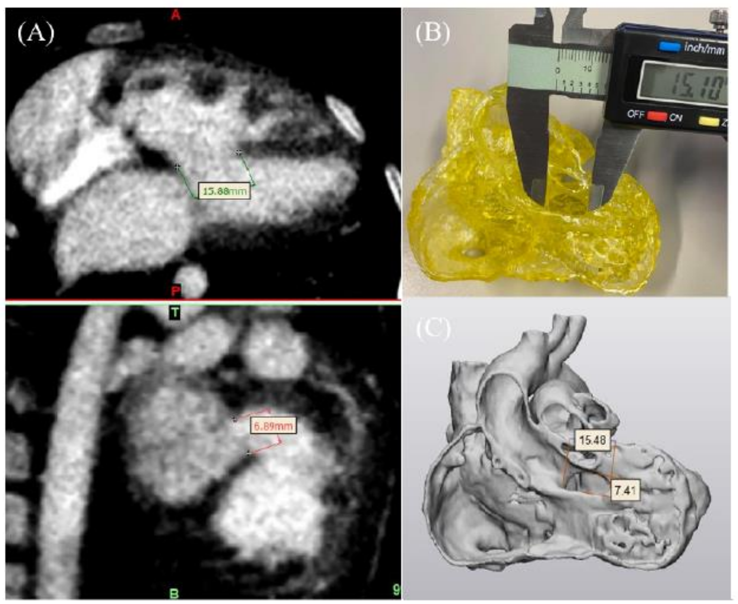
Article

Quantitative Assessment of 3D Printed Model Accuracy in Delineating Congenital Heart Disease

Shenyuan Lee [1], Andrew Squelch [2] and Zhonghua Sun [1,*]







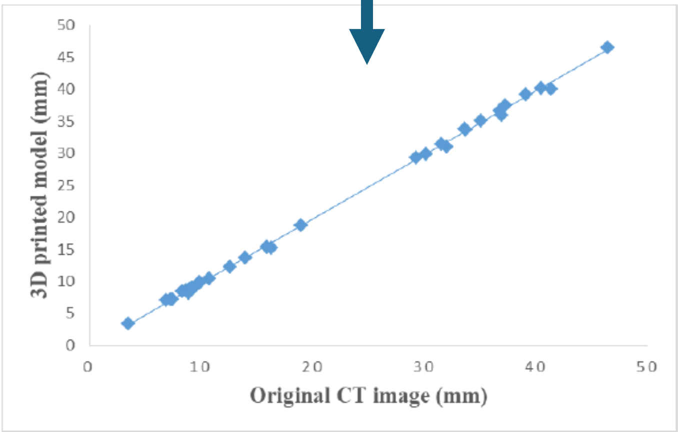
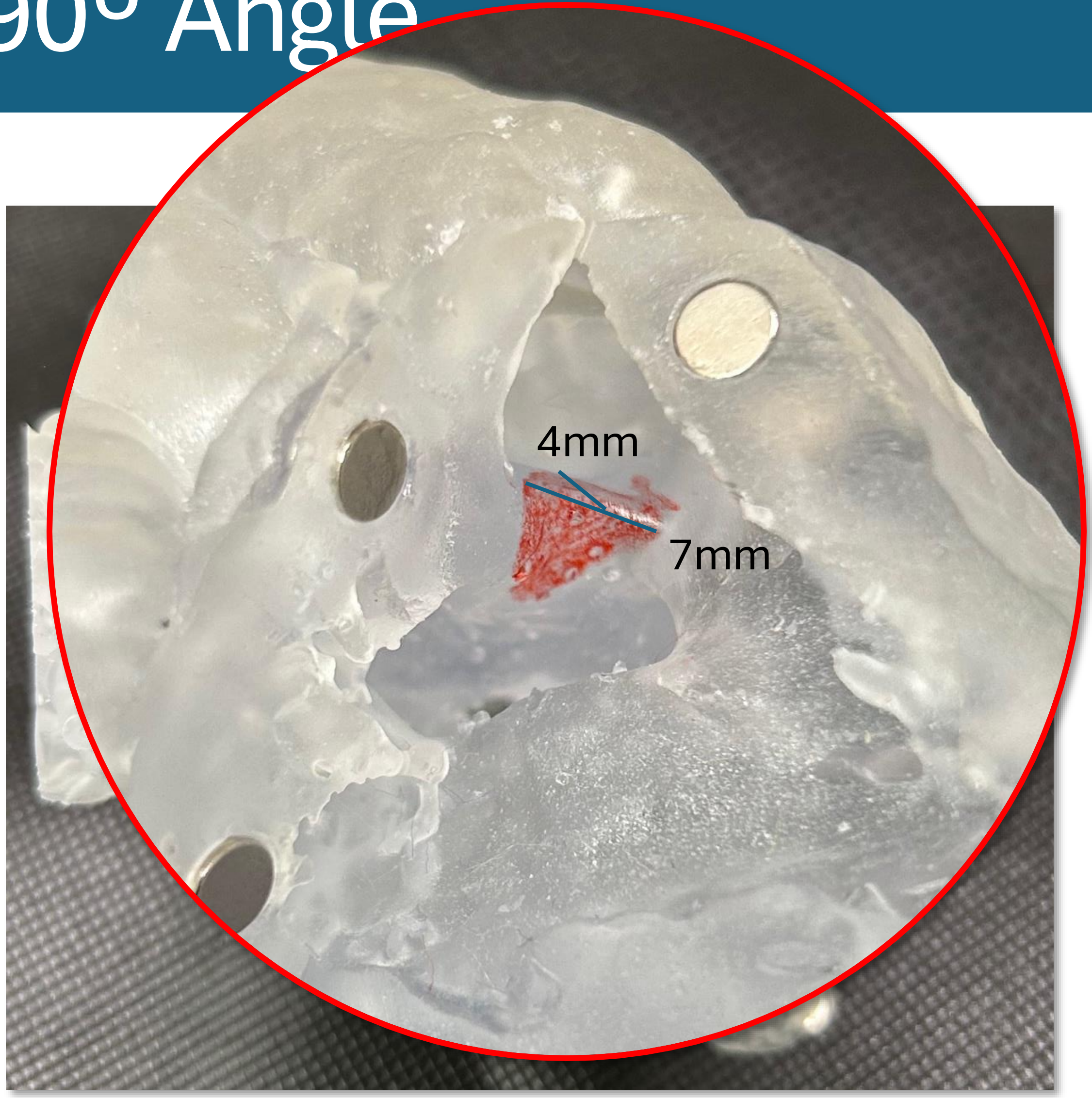


Figure 5. Scatterplot between original CT measurements and 3D-printed model measurements.

Biomolecules 2021, 11, 270. https: // doi.org/10.3390/biom11020270

DORV with restrictive VSD

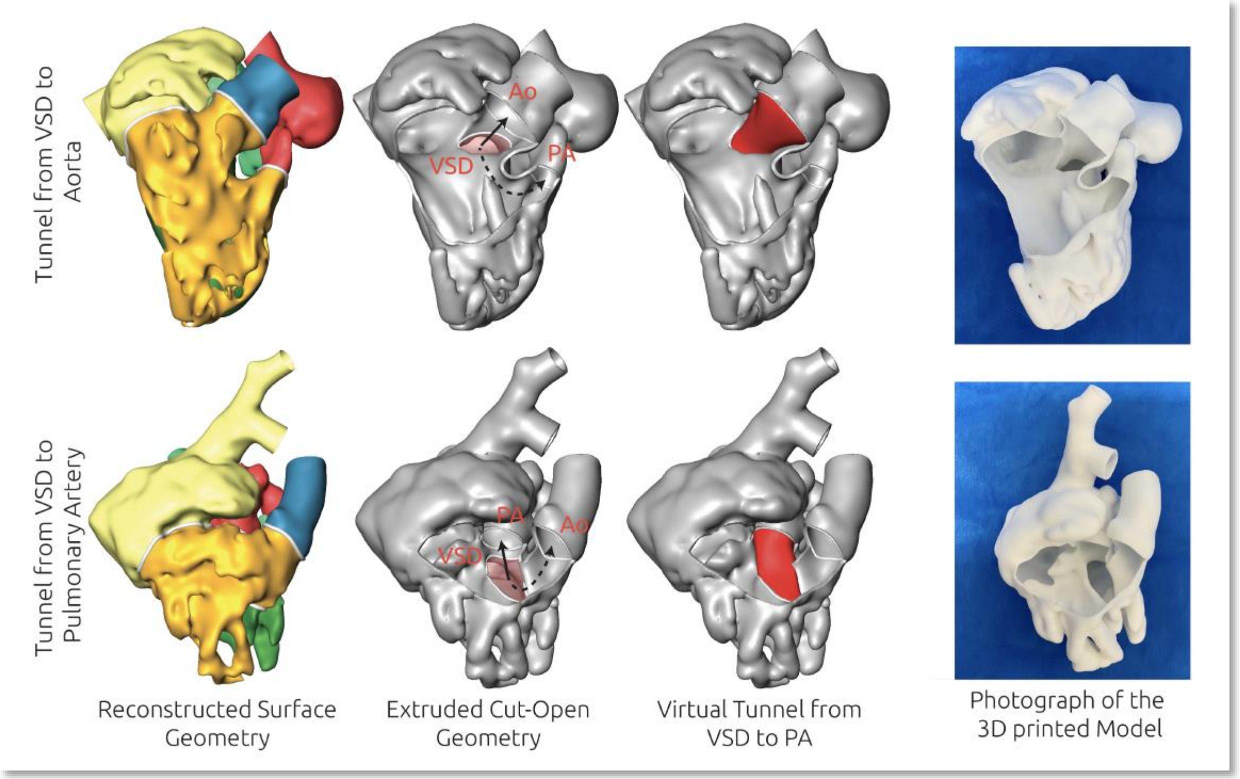
DORV – Tunnel with 90º Angle



3D modeling and printing for complex biventricular repair of double outlet right ventricle

Jan Brüning[1,2], Peter Kramer[3], Leonid Goubergrits[1,4], Antonia Schulz[5,6], Peter Murin[5], Natalia Solowjowa[7], Titus Kuehne[1,2,3], Felix Berger[2,3], Joachim Photiadis[5] and Viktoria Heide-Marie Weixler[2,5,6]*

- Five patients underwent BVR, four UVP.
- The question whether relevant measurements can also be performed directly using
- 3D reconstruction of the patient-specific anatomy and how these measurements compare against current gold-standard
- Methods cannot be answered sufficiently without additional prospective investigations.

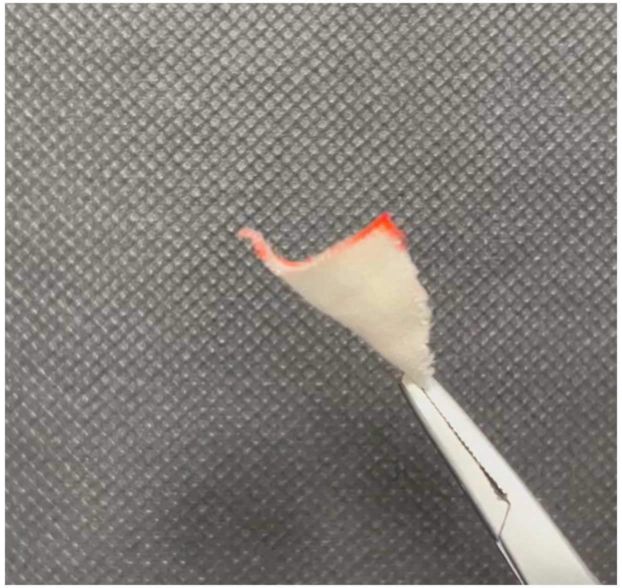


Brüning J, (2022) Front. Cardiovasc. Med. 9:1024053.

Simple DORV – Surgical Simulation

Unrestrictive LVOT assessment

‘Life-Size patch template’



Complex structure in three planes

‘non-cardioplegic patch implant’

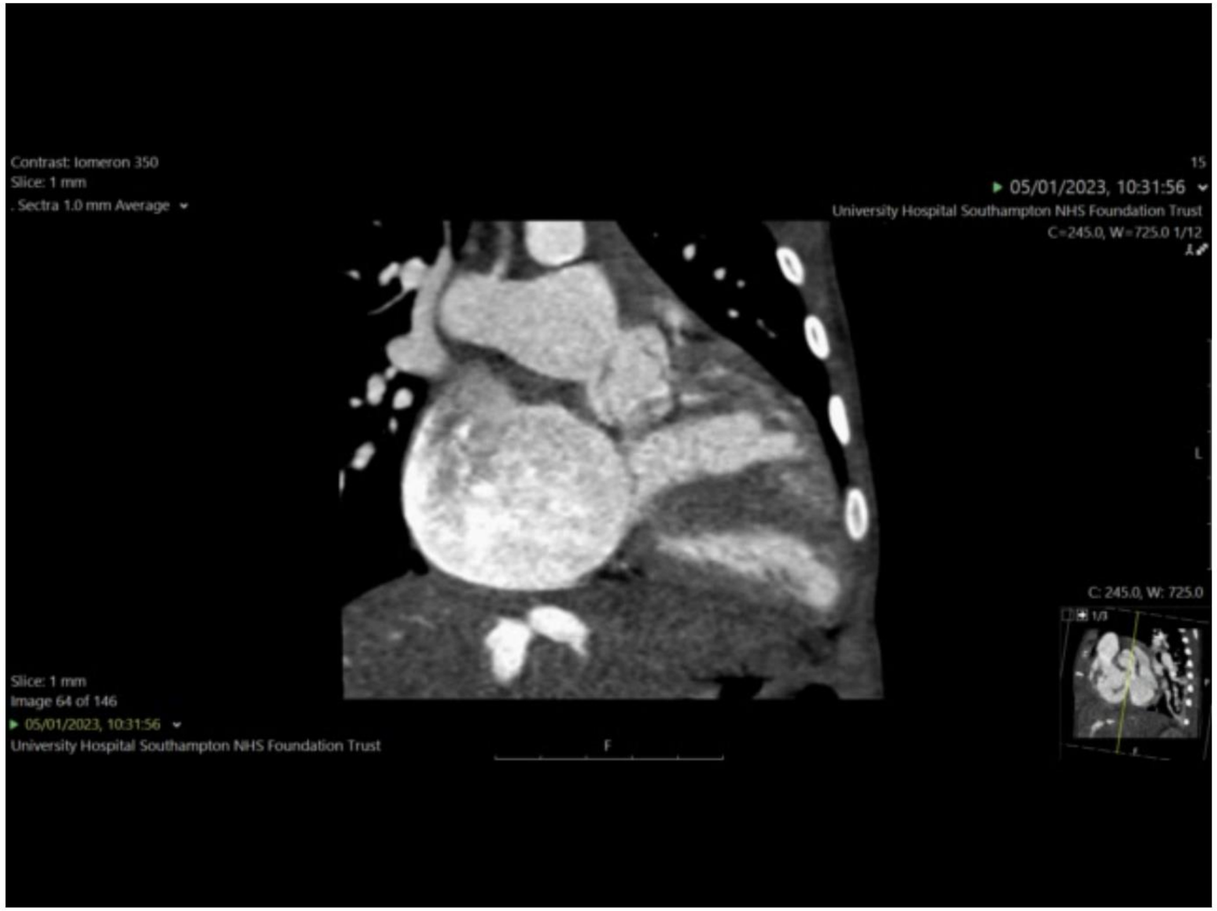
A best friend is most ‘helpful’…

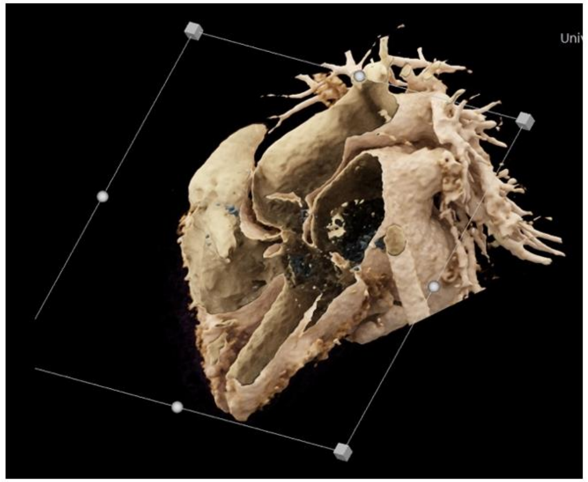
- **Trustworthiness**:
  - 3D printing meets clinical expectations. The models are accurate enough to guide surgeries.

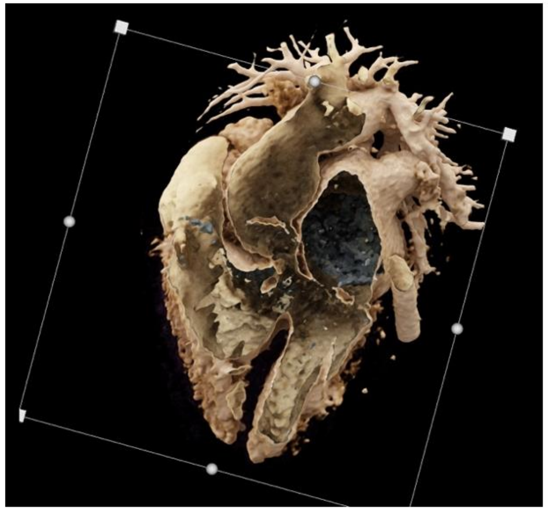
- **Non judgemental attitude**:
  - 3D printing complements existing technologies (e.g., echo, CT, MRI), creating a collaborative rather than competitive relationship

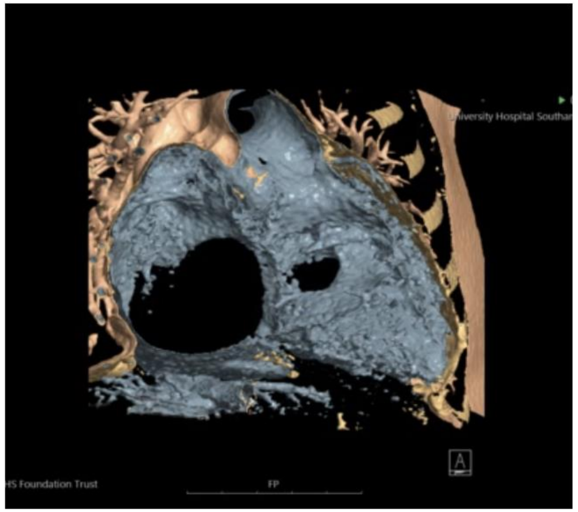
- **Unconditional Support:**
  - 3D printing is viable for both routine and complex cases, the general understanding and case-specific needs.

From Echo to CT – Mind the Gap

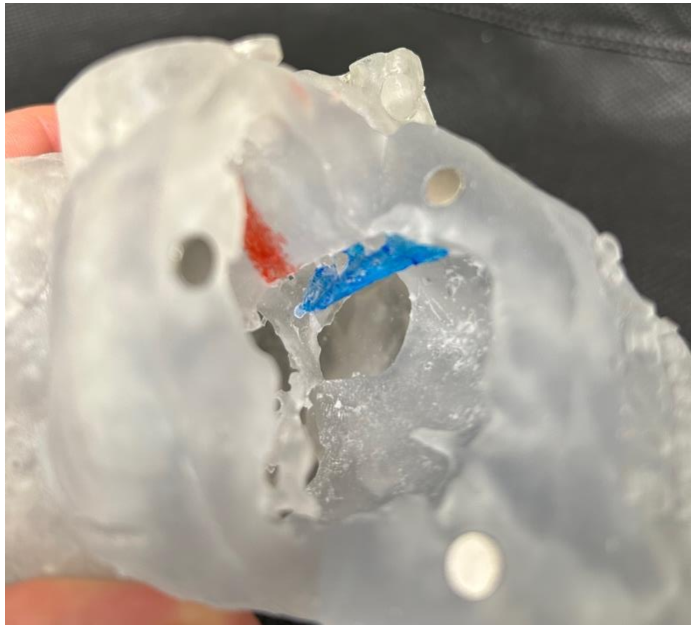


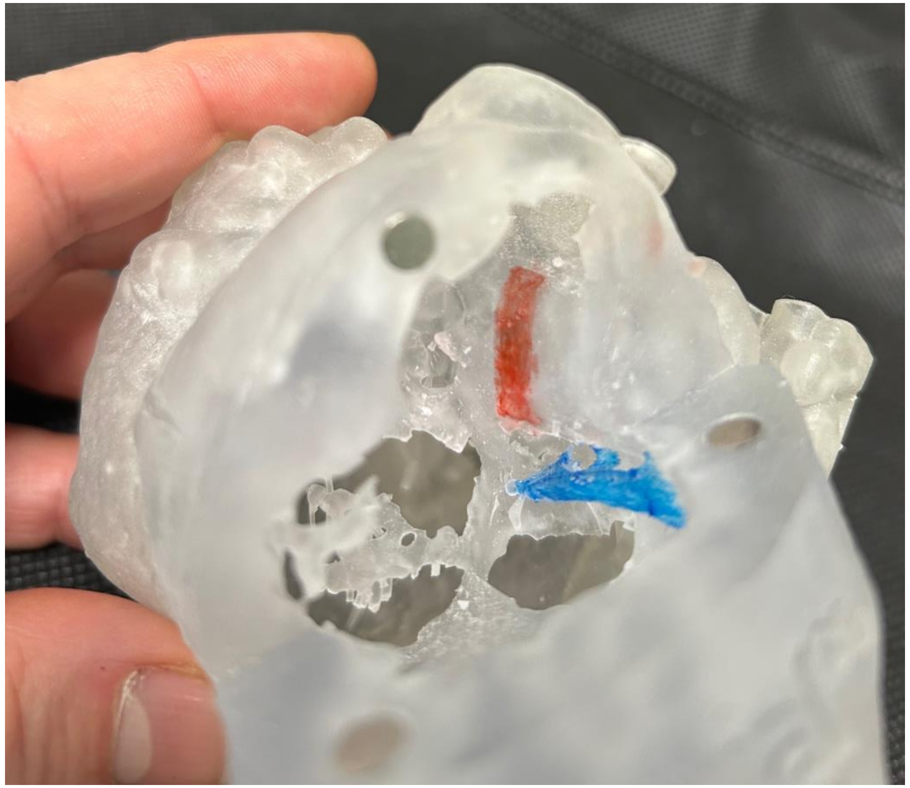


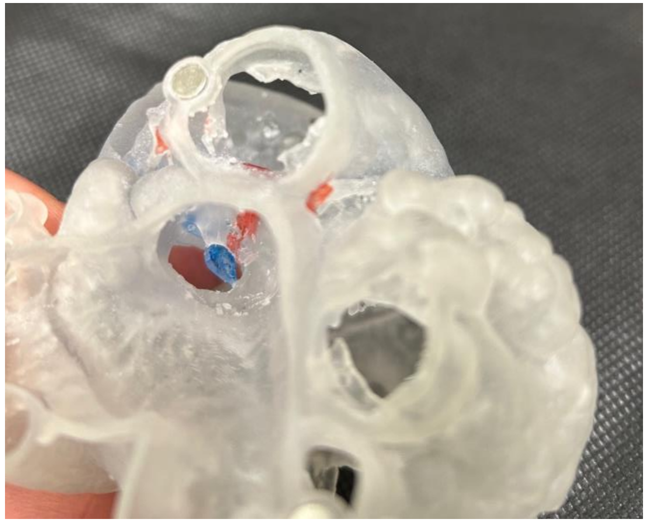




DORV to Nikaidoh Operation – Gap Closed





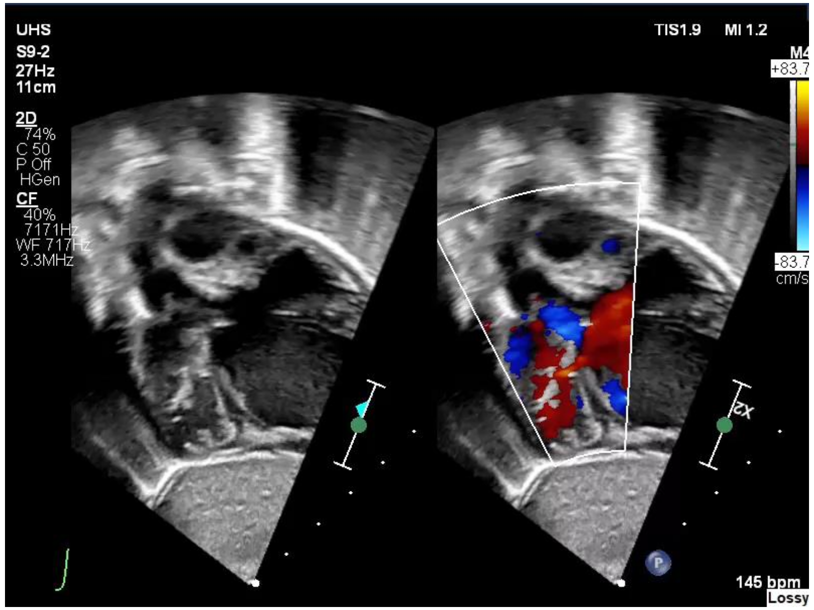


A best friend is 'least demanding'...

- **Empathy**:
  - 3D printing is a tool that makes complex tasks more manageable, giving teams greater confidence and reducing stress

- **Forgiveness**:
  - 3D-printed models help surgeons anticipate challenges, reducing the risk of residual lesions and complications

An Unusual Diagnosis



DORV

DOLV

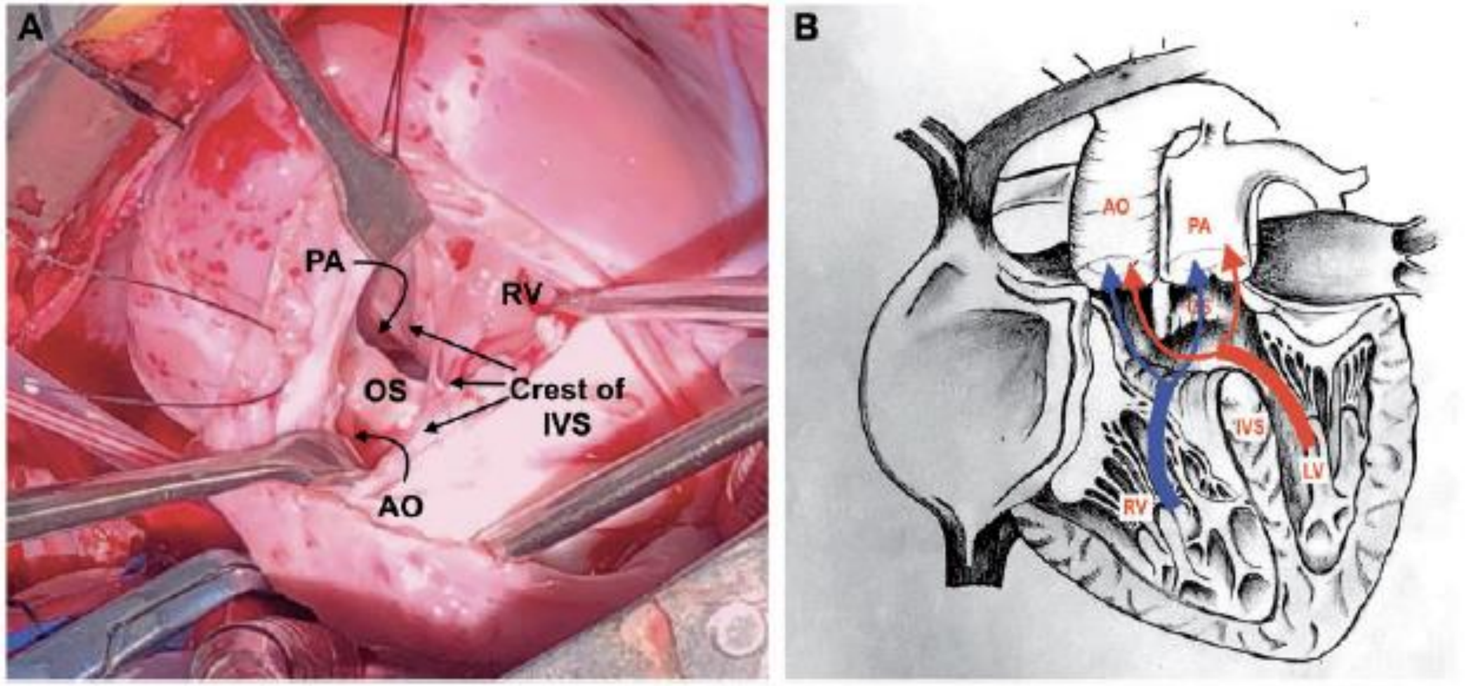
Double outlet of both ventricles: morphological, echocardiographic and surgical considerations

Krishna Subramony Iyer [a,*], Ankit Garg [b], Sumir Girotra[a], Robert H. Anderson [c], Sushil Azad[b], Sitaraman Radhakrishnan[b] and Parvathi U. Iyer[a]

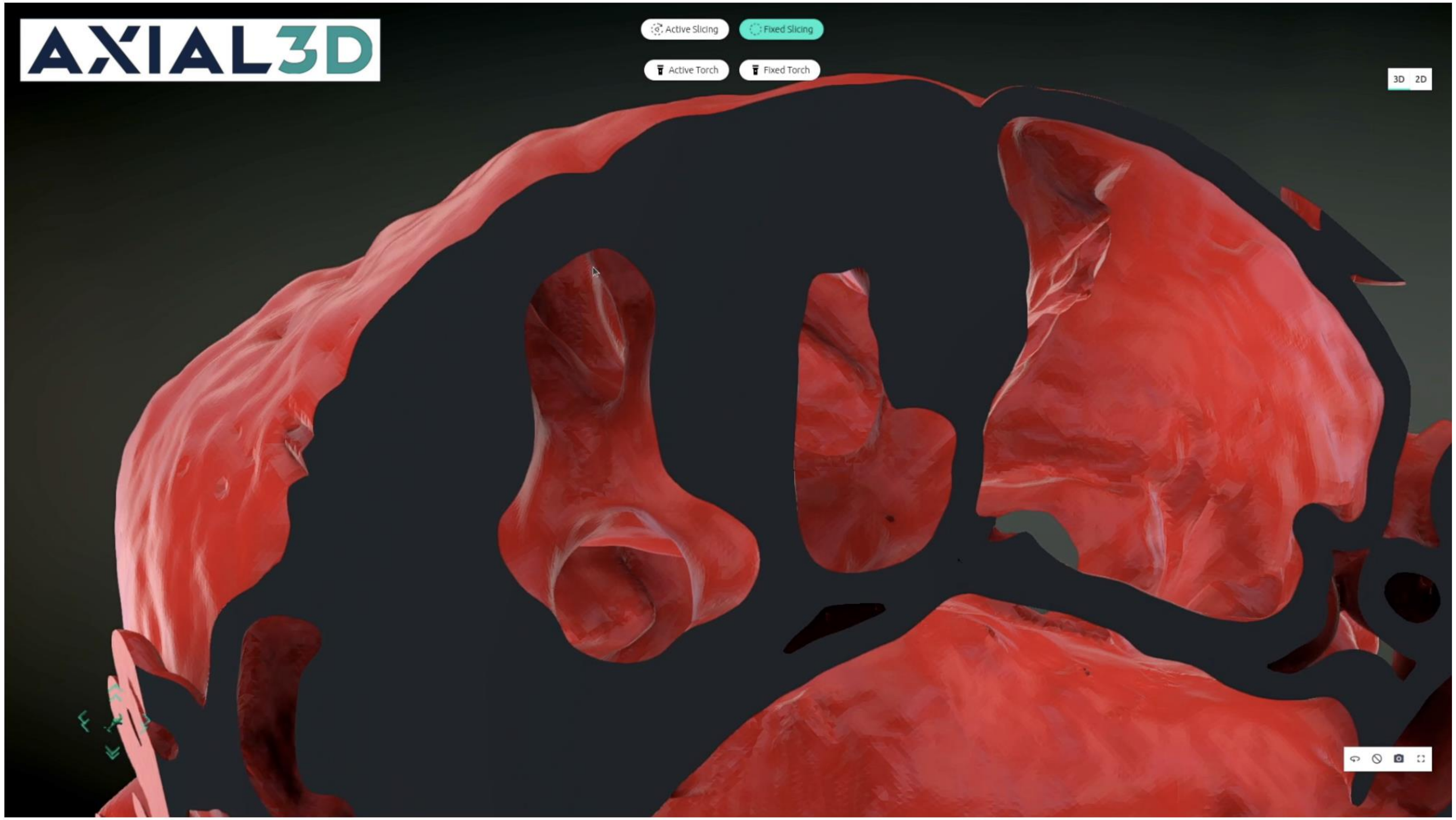
Both arterial roots override the crest of the apical muscular ventricular septum in equal measure,

The term double-outlet both ventricles, was first used by Brandt et al. [1], and subsequently mentioned in the reviews of Aiello et al. [2] and Ueda and Becker [3].

No further description of this entity has been published.




MIND THE GAP


AXIAL3D
Active Slicing
Fixed Slicing
Active Torch
Fixed Torch
3D
2D

Septation – Is it Possible?

DORV - UHS Experience 2019-2024

Product Number	Congenital Lesion	Notes	Question for the print	Answer	Impact
UKP01384	ASD, non committed VSD, Large subarterial infundibulum, DORV, Side-by-side arrangement, Ao rightward.	S/P PAB, atrial septectomy	Position VSD, Adequacy of LVOT, Presence of subAS (VSD enlargement?)	Sub AS confirmed, VSD commitable, Sub Ao resection, appropriate tunneling of LVOT	Plan confirmed
UKP01395	Multiple VSDs, larger non committed VSD, small PM VSD, DORV, Side-by-side arrangement, Ao rightward, IAA	S/P arch repair, PAB, Glenn	Septation possible		Plan Reversed: TCPC
UKP01504	Multiple VSDs, larger non committed VSD, small PM VSD, DORV, Side-by-side arrangement, Ao rightward, IAA	S/P IAA repair, s/p BCPS	Late septation possible	precise illustration of IVS: septation not posssible	Plan confirmed
UKP01664	Multiple VSDs, larger subpulmonary VSD, several apical VSD, DORV, Side-by-side arrangement, Ao rightward	S/P PAB	Sub AS, position of VSDs, Rastelli vs Switch-VSD		Plan Reversed: BCPS
UKP01900	Small subpulmonary VSD, DORV, Side-by-side arrangement, Ao rightward and anterior, severe PS.		Position of VSD, Adequacy of LVOT, Rastelli?	VSD not suitable for LVOT	Plan confirmed
UKP02161	Situs inversus, LAI, Rt + Lt SVC (to CS), common atrium, AVSD, double inlet ventricle, large VSD. Right and anterior LV, left posterior RV. DORV with aorta to the left and posterior, RAA with mirror image branches. Severe supravalvar PS.		Systemic and pulmonary venous connection; septation possible	surgery chosen on model	Plan chosen
UKP03039	Large subaortic VSD, DORV, Side-by-side arrangement, Ao rightward, persistent Azygos		Rastelli vs Switch-VSD	surgery chosen on model	Plan chosen
UKP03077	Large subaortic VSD, DORV, small PV, Narrow LVOT, AP arrangement, Ao anterior.		Adequacy of LVOT, size of VSD, Rastelli vs Switch-VSD	surgery chosen on model	Plan chosen
UKP03537	Large subaortic VSD, DORV, large PV, AP arrangement, Ao anterior.	S/P PAB	Relationship of GAs to VSD, size of VSD. ASO + VSD Closure?	surgery chosen on model	Plan chosen
UKP03540	Large perimembranous non-committed VSD. Muscular subarterial infundibulum. DORV. Left sided aortic arch with previous coarctation repair.	S/P coarctation repair, PA band RCA infarct	Size and position of VSD, LVOT and RVOT	surgery chosen on model	Plan chosen
UKP03592	DORV with large perimembranous VSD. Complex orientation of the IVS, multiple VSD? AP position of the GA, PA anterior and leftward. Hypoplastic RPA.	S/P PAB, atrial septectomy, VSD enlargement	Size and position of VSD, LVOT and RVOT	surgery chosen on model	Plan chosen
UKP03736	DORV, small VSD. Side-by-side arrangement with aorta leftward. Single coronary artery from R coronary sinus. Juxtaposed AAs.	S/P repair: VSD enlargment, Rastelli, RV tp PA conduit. Large residual VSD	Anatomy of new shunt and suitability for device closure	intervention vs Surgery	Plan chosen
UKP03785	Single left SVC Tto CS. Concordant AV connection, balanced AVSD. Large VSD. DORV with PA anterior and to the right. Severe RVOTO, PS. Rotational abnormality of the aortic root	S/P Rt BTS	Size and position of VSD, LVOT and RVOT	surgery chosen on model	Plan chosen
UKP03903	DORV with prominent outlet infundibulum, Large perimembranous VSD with muscular extensions. Side-by-side arrangement, aorta leftward and anterior. Arch hypoplasia and CoA, RAA, Juxtaposed Aas.	S/P PDA stent	Adequacy of LVOT, size and position of VSD	surgery chosen on model	Plan chosen
UKP03761	DORV with prominent outlet infundibulum, large VSD with muscular extensions. Aorta anterior, large papillary muscle across the VSD.		Adequacy of VSD, adequacy of LVOT	VSD and LVOT adequate for Nikaidoh, TV papillary muscle not obstructive	Plan chosen

Morphology	**15**
Simple	4
Complex	11
Non-committed/multiple VSDs	4
Heterotaxi	1
AVSD	2
PS, narrow LVOT	4
CoA, Hypoplastic arch	2
Juxtaposed Atria	2
Previous Interventions	**10**
Limiting Blood Flow	6
Securing Blood Flow	3
Repair	4
Query	
Position of VSD / Adequacy of neo-LVOT	11
Septation: A or V	4
Impact	
Plan Chosen	10
Plan Confirmed	3
Plan Reversed	2

The whole is greater than the sum of its parts

- **“Mutual Respect”**
  - 3D printing allows for patient-specific customization, making it a tool that "respects" the uniqueness of each case.
- **Encourages Growth**
  - 3D printing fosters accelerating learning curves for new surgeons and in fostering technological advancements in surgical planning, has increased our referral
- **Fun to Be Around**
  - 3D models might make teaching and learning more interactive, encouraging collaboration and innovation (new tool, new research, library, relations with industry)

The whole is greater than the sum of its parts

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3D Printing - Added Value

Medical Education

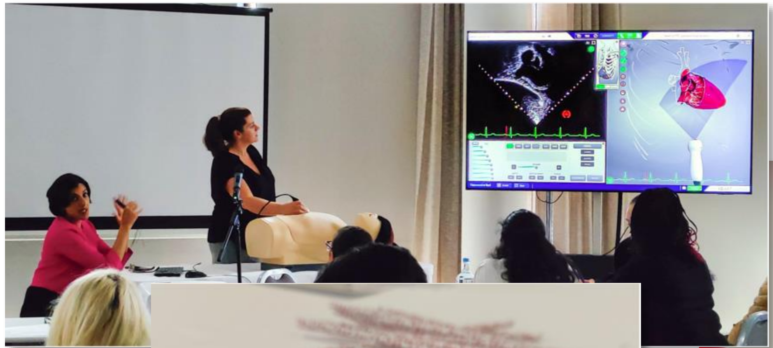
Surgical Education

Research

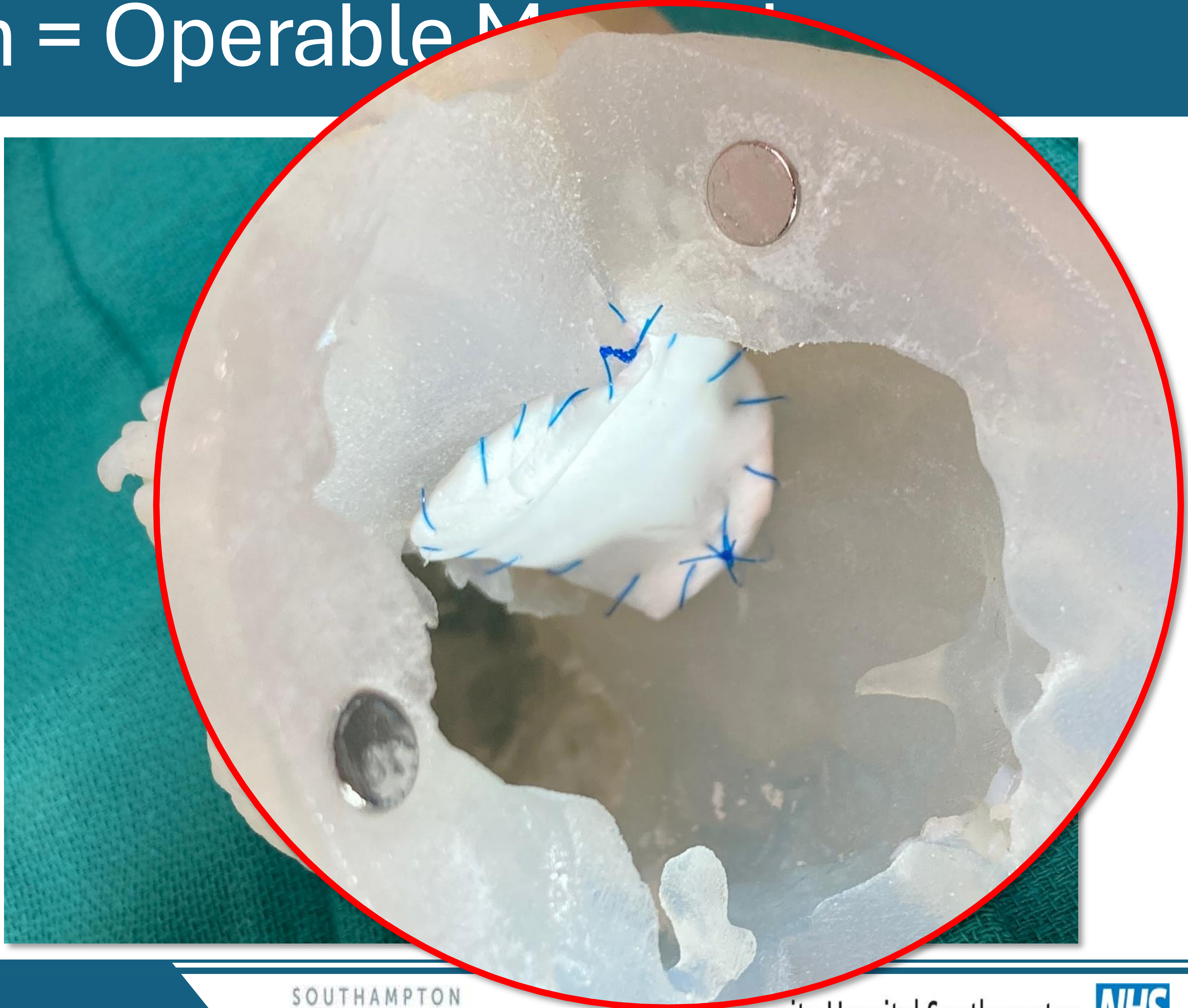
UHS - Education

- Superior engagement with learning opportunities
- Enhanced understanding of intracardiac anatomy
- Improved understanding of surgical requirements
- https://www.congenitalecho.co.uk

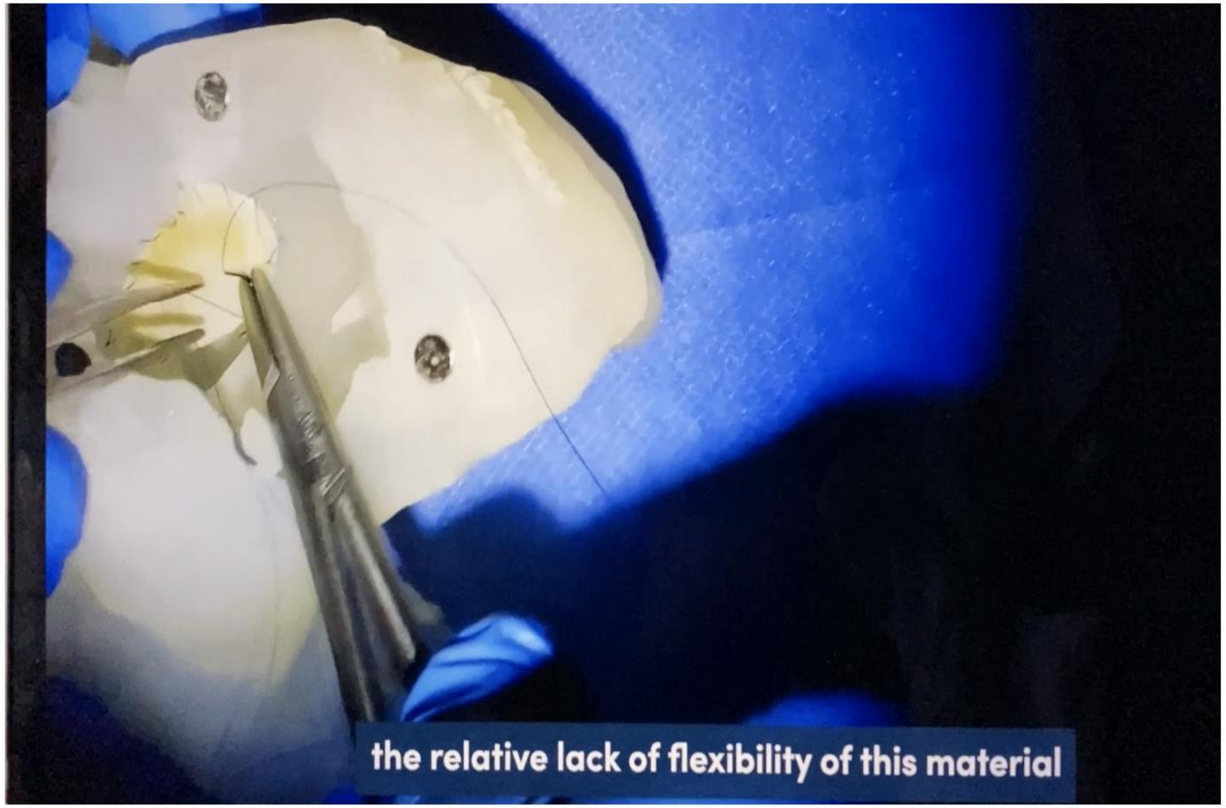


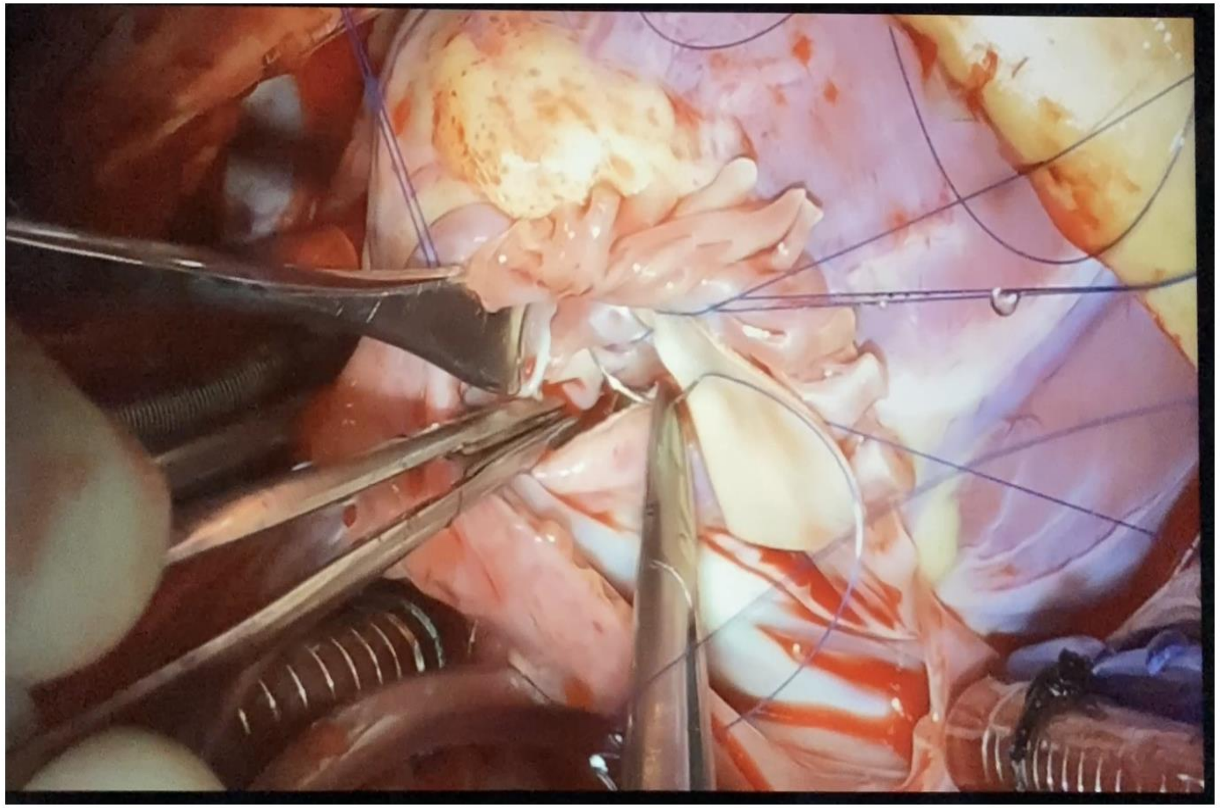



Surgical Education = Operable M

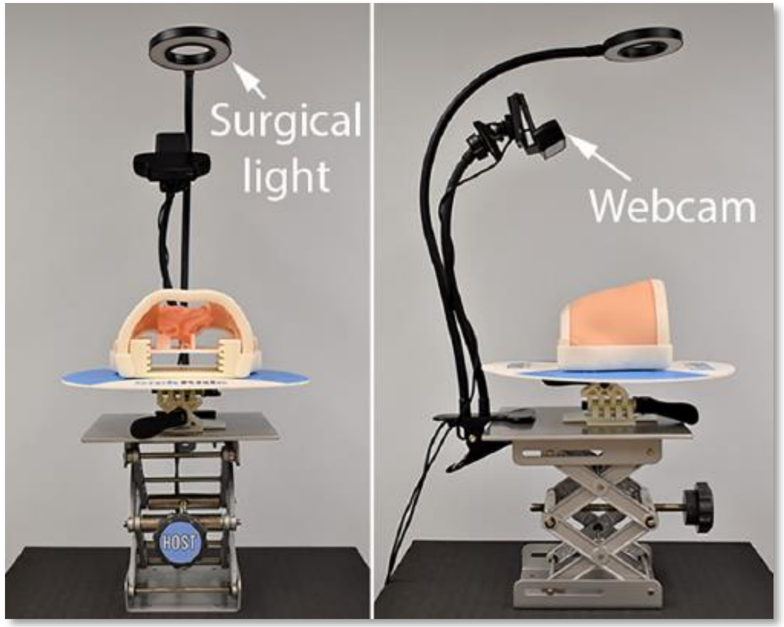


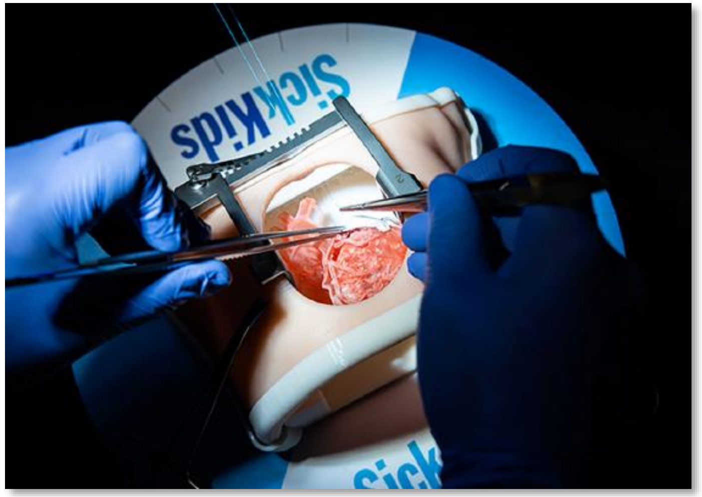
Surgical Education = Practicing Repairs





Advanced Surgical Education = Practicing Repairs via Surgical Views



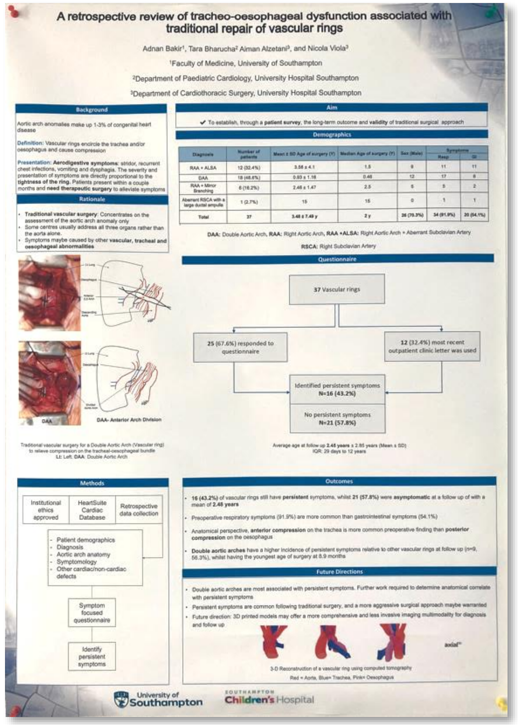


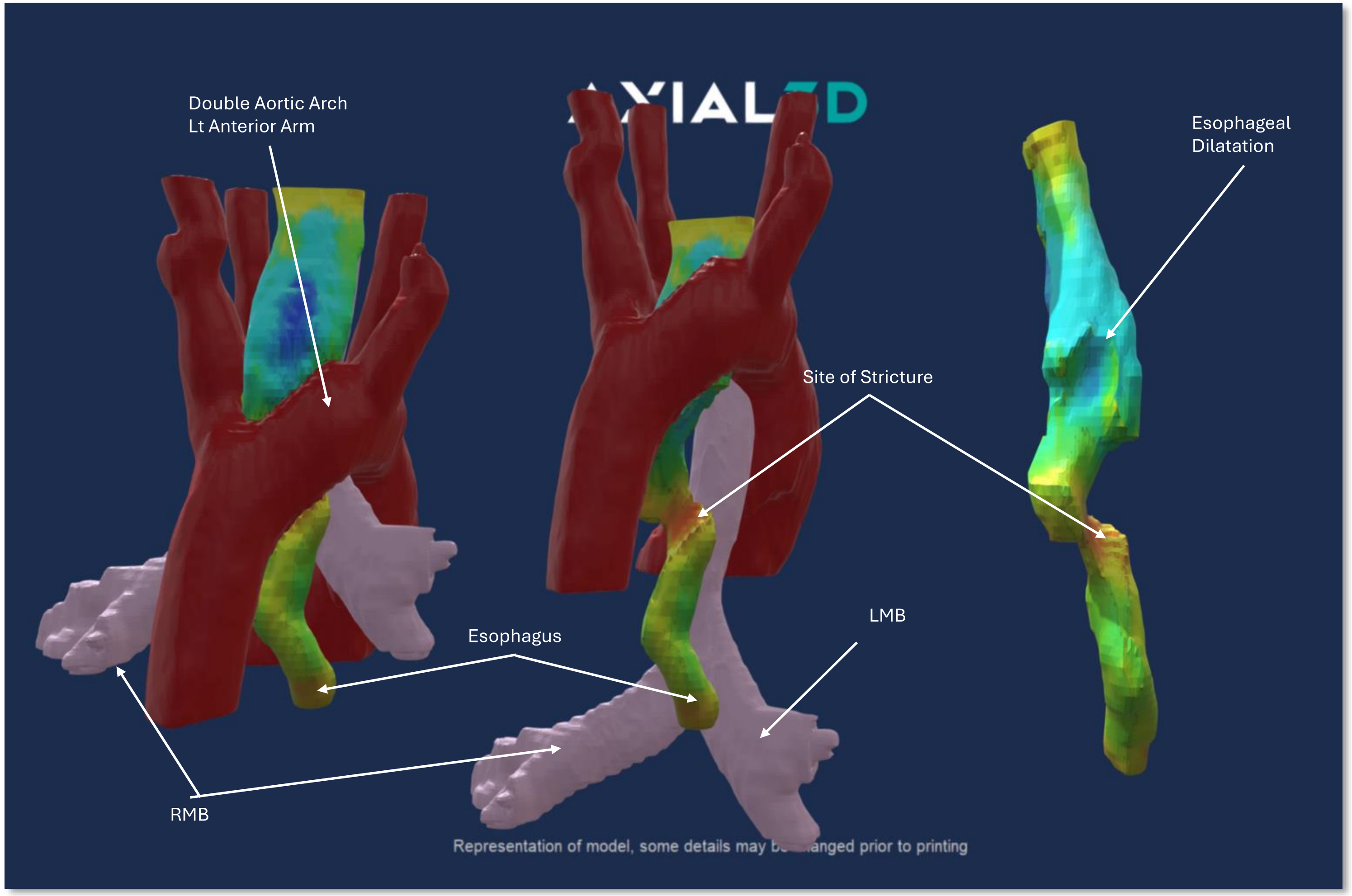
February 2021 | Volume 9 | Article 621672 Frontiers in Pediatrics | www.frontiersin.org

(Re)-Modelling the Broncho-Esophageal Bundle in Vascular Rings. Can 3D Modelling Replace Functional Analysis?

Viola N[1], Bharucha T[2], Hall N[3], T Shwartz[4]

[1] *Department of Congenital Cardiac Surgery, UHS, Southampton*
[2] *Department of Pediatric Cardiology, UHS, Southampton*
[3] *Department of Pediatric Surgery, UHS, Southampton*
[4] *Department of Creative Development, Axial 3D, Belfast*





A best friend is 'least demanding'...

- **Forgiveness**:
  - 3D-printed models help surgeons anticipate potential challenges, reducing the risk of residual lesions and complications
- **Empathy**:
  - 3D printing is a tool that makes complex tasks more manageable, giving teams greater confidence and reducing stress. It is incomplete
- **High Maintenance**
  - 3D printing is primary data dependent: CT/MRI.
  - It often requires anesthesia
  - It does not produce implantable devices/materials

Cardiac CT in CHD: An Essential Tool in Need of Education Expertise

Obstacles, Opportunities and a Proposed Way Forward

- Advanced imaging in CHD is time consuming and current reimbursement is not consistent with workload per case
- There are knowledge gaps at the intersection of adult and pediatric cardiology and radiology [and SURGERY n.d.r.]
- However, excellence in congenital CT imaging may be possible if we incorporate the following recommendations:
    - Cardiologists and radiologists may perform congenital CCT, but standards need to be established.
    - Standards for clinical expectations including 3D reconstructions and post-processing need to be established
    - The establishment of a multi-institutional and multi-modality diagnostic research platform is needed to inform the optimal use of imaging modalities in CHD.
    - Diagnostic accuracy and refinement of CCT for CHD through the establishment of training guidelines will have important quality implications.

Utility of 3D printed cardiac models in congenital heart disease: a scoping review

Caroline F Illmann ,[1,2] Rouzbeh Ghadiry-Tavi,[3] Martin Hosking,[1,2] Kevin C Harris[1,2]

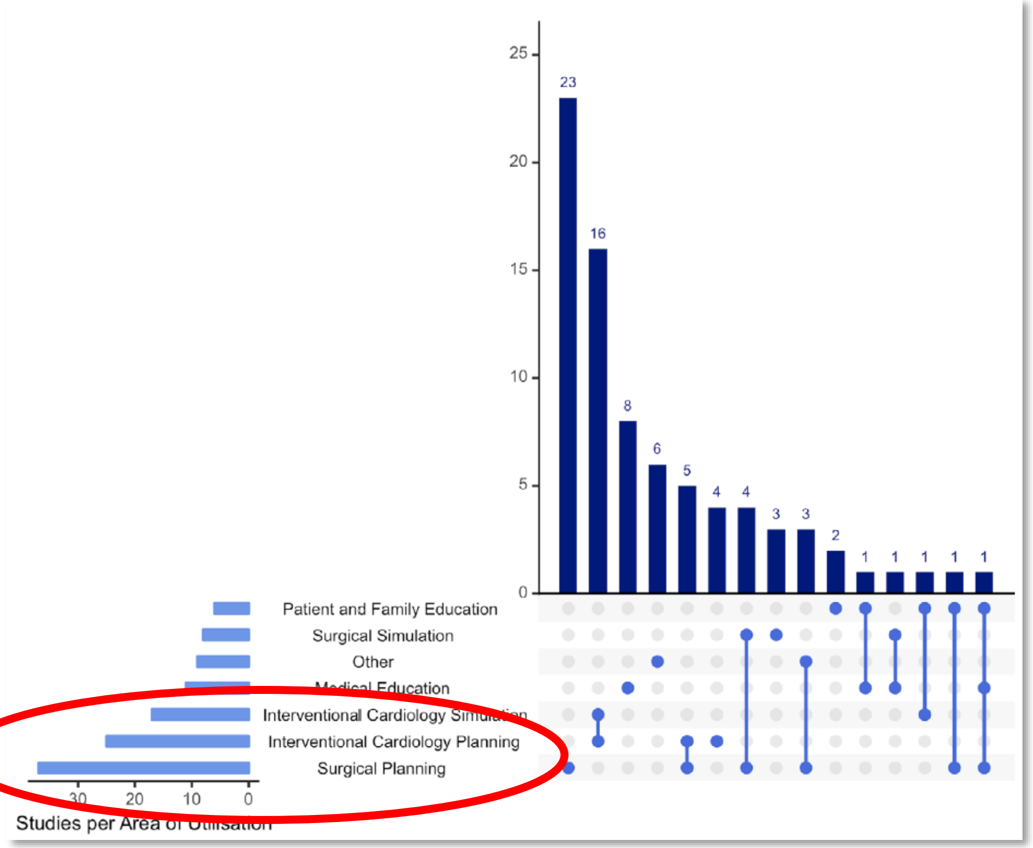


Table 2 Knowledge gaps and areas for future research in 3D printing for CHD

Spectrum of use*		What do we know?†	Gaps and limitations†
Plan	Surgical planning (n=37)	▶ 3D models are useful to appreciate the spatial complexity between intracardiac structures (online supplementary material 3; 2, 3, 6, 7, 10, 11, 19, 22, 31). ▶ Use of 3D models can influence a change in procedural plan (surgical vs conservative management) (online supplementary material 3; 33).	▶ Unclear if procedural planning with 3D models can improve clinically meaningful outcomes such as reduction in operative time (online supplementary material 3; 34–35), readmission (online supplementary material 3; 35), procedure-related radiation exposure (online supplementary material 3; 60) or mortality rate (online supplementary material 3; 35). ▶ Models cannot accurately depict valves and chordae (online supplementary material 3; 21, 26). ▶ Need for appropriately powered prospective research.
	Interventional cardiology planning (n=25)	▶ 3D models can be used in clinical decision-making for optimal procedural management (online supplementary material 3; 14, 17, 22, 24, 25, 55).	
Practice	Surgical simulation (n=8)	▶ Surgical simulation has been used in conjunction with surgical planning (online supplementary material 3; 5, 6, 16, 23) and surgical training (online supplementary material 3; 38). ▶ Models aided understanding of 2D anatomy and can be used to	▶ Print material consistency differs from human myocardium (online supplementary material 3; 38). ▶ Cardiac valves were poorly represented (online supplementary material 3; 38).
Educate			

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Gaps and limitations†

- ▶ Unclear if procedural planning with 3D models can improve clinically meaningful outcomes such as reduction in operative time (online supplementary material 3; 34–35), readmission (online supplementary material 3; 35), procedure-related radiation exposure (online supplementary material 3; 60) or mortality rate (online supplementary material 3; 35).
- ▶ Models cannot accurately depict valves and chordae (online supplementary material 3; 21, 26).
- ▶ Need for appropriately powered prospective research.

Illmann CF, et al. Heart 2020;106:1631–1637

Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study

Mark S Pearce, Jane A Salotti, Mark P Little, Kieran McHugh, Choonsik Lee, Kwang Pyo Kim, Nicola L Howe, Cecile M Ronckers, Preetha Rajaraman, Sir Alan W Craft, Louise Parker, Amy Berrington de González

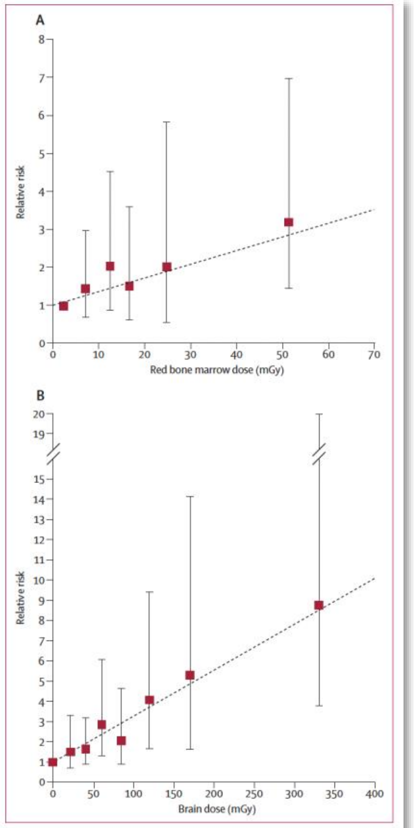


Figure: **Relative risk of leukaemia and brain tumours in relation to estimated radiation doses to the red bone marrow and brain from CT scans**
(A) Leukaemia and (B) brain tumours. Dotted line is the fitted linear dose-response model (excess relative risk per mGy). Bars show 95% CIs.

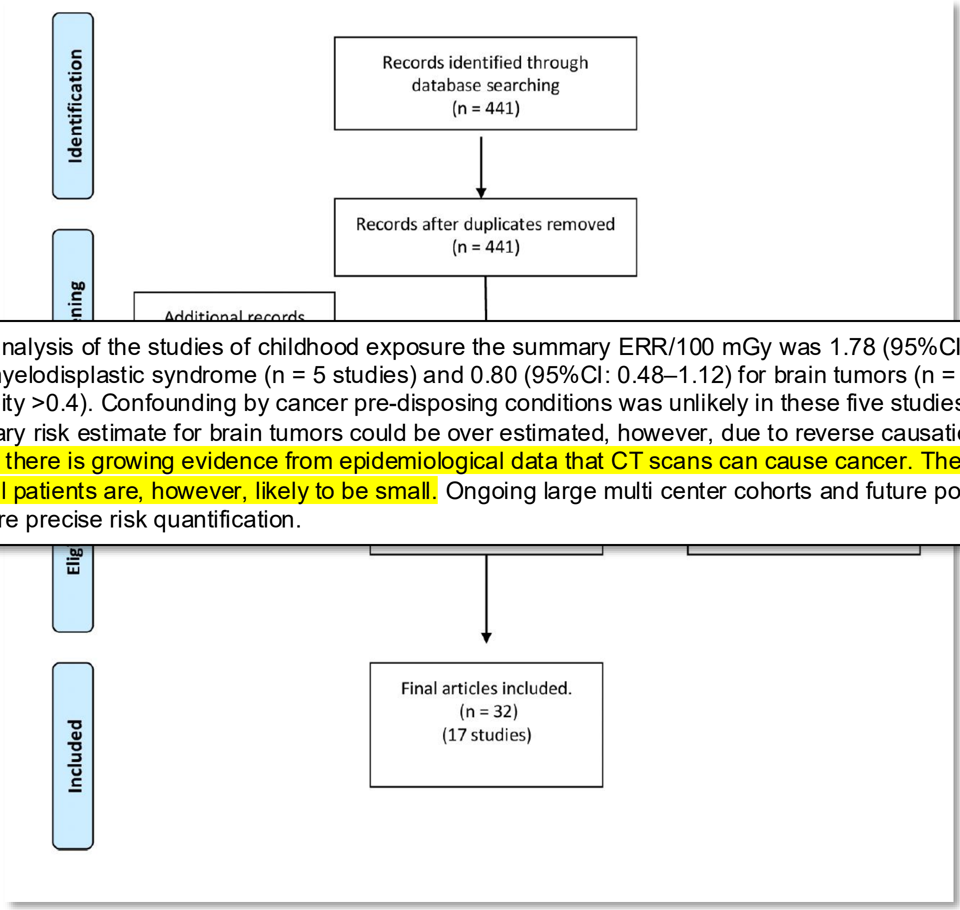
Interpretation Use of CT scans in children to deliver cumulative doses of about 50 mGy might almost triple the risk of leukaemia and doses of about 60 mGy might triple the risk of brain cancer. Because these cancers are relatively rare, the cumulative absolute risks are small: in the 10 years after the first scan for patients younger than 10 years, one excess case of leukaemia and one excess case of brain tumour per 10 000 head CT scans is estimated to occur. Nevertheless, although clinical benefits should outweigh the small absolute risks, radiation doses from CT scans ought to be kept as low as possible and alternative procedures, which do not involve ionising radiation, should be considered if appropriate.

www.thelancet.com Vol 380 August 4, 2012

Epidemiological studies of CT scans and cancer risk: the state of the science

AMY BERRINGTON DE GONZALEZ, DPhil, **ELISA PASQUAL**, PhD and **LENE VEIGA**, PhD

Radiation Epidemiology Branch, Division of Cancer Epidemiology & Genetics, National Cancer Institute, Bethesda, MD, USA



In a meta-analysis of the studies of childhood exposure the summary ERR/100 mGy was 1.78 (95%CI: 0.01–3.53) for leukemia/myelodisplastic syndrome (n = 5 studies) and 0.80 (95%CI: 0.48–1.12) for brain tumors (n = 4 studies) (p-heterogeneity >0.4). Confounding by cancer pre-disposing conditions was unlikely in these five studies of leukemia. The summary risk estimate for brain tumors could be over estimated, however, due to reverse causation. In conclusion, there is growing evidence from epidemiological data that CT scans can cause cancer. The absolute risks to individual patients are, however, likely to be small. Ongoing large multi center cohorts and future pooling efforts will provide more precise risk quantification.

Berrington de Gonzalez A. Br J Radiol 2021; 94: 20210471

Multi-institution assessment of the use and risk of cardiovascular computed tomography in pediatric patients with congenital heart disease

PROSPECTIVE Study

Four centers
1045 consecutive pediatric CHD patients

Median age	1.7yrs
Prevalence varied significantly inter-center	
Risk categories and prevalence	
Sedation and anesthesia use	11%
Vascular access	93%
Contrast exposure	2ml/Kg
Cardiovascular medication	2-11%
Minor adverse events (AEs)	0.7%
Major Aes	0%
Median radiation dose	20 mGy*cm

Diagnosis	No.
Great Arteries Abnormalities	264 (25)
Coarctation of aorta	126
Vascular ring	88
Truncus	23
Interrupted aortic arch	14
Aortic aneurysm	11
AP Window	2
Coronary artery anomaly	184 (18)
Single ventricle	165 (16)
TOF/PA	159 (15)
Pulmonary atresia	81
Tetralogy of Fallot	78
Transposition Complex	133 (13)

Diagnosis	No.
d-TGA	70
DORV	59
L-TGA	4
Valve Disease	74 (7)
Aortic valve, LVOT	42
Pulmonary valve, RVOT	27
Mitral valve disease	3
Tricuspid valve anomalies	2
Other Vascular anomalies	67 (6)
PAPVR	29
TAPVR	29
Pulmonary vein stenosis	8
Systemic Venous Anomalies	1
Intracardiac shunt lesions	49 (5)
AVC	20
ASD	16
VSD	13
Other	28 (3)
Other left side obstructive lesions	11 (1)
Shones syndrome	7
Cor triatriatum	4

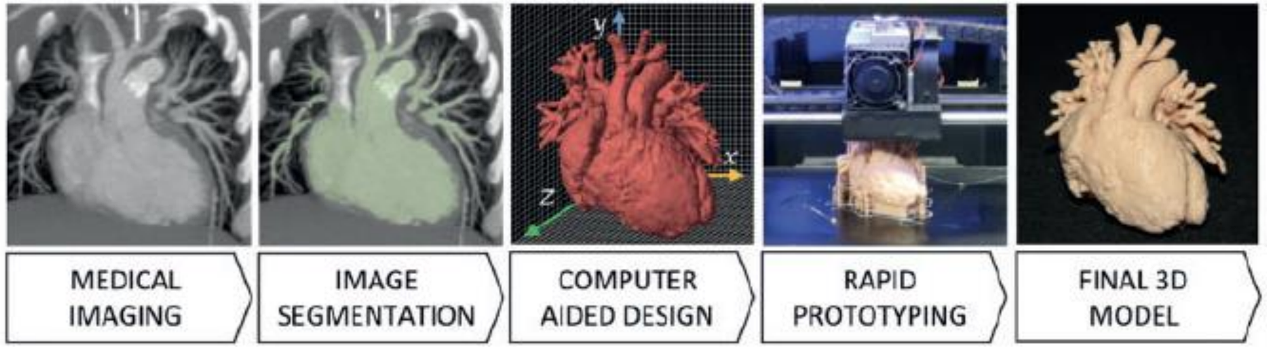
Mariana De Oliveira Nunes, et al. *J Cardiovasc Comput Tomogr. 2021 ; 15(5): 441–448*

Three-dimensional printed models for surgical planning of complex congenital heart defects: an international multicentre study

Israel Valverde[a,b,c,d,*], Gorka Gomez-Ciriza[a], Tarique Hussain[c,e], Cristina Suarez-Mejias[a],

Table 1: Demographic and clinical characteristics

Patient demographics	
Patients (*n*)	40
Age (years)	3 (1 month–34 years)
Weight (kg)	13 (2.9–82)
Height (cm)	90 (50–182)
Body surface area (m^2)	0.6 (0.2–2)
Female:male (*n*)	22:18
Congenital heart disease (*n*)	
DORV	19
Complex TGA	6
UVH physiology	4
Large VSD	5
Criss-cross heart	3
LVOTO	1
Heterotaxy syndrome	1
Discordant AV and VA connections	1
Imaging modality characteristics	
MRI (*n*)	28
In-plane resolution (mm)	1.51 ± 0.66
Thickness (mm)	2.33 ± 0.78
Slices (*n*)	116 ± 81
CT (*n*)	12
In-plane resolution (mm)	0.33 ± 0.08
Thickness (mm)	0.65 ± 0.0.22
Slices (*n*)	397 ± 65
3D printing	
Segmentation time (min)	75 ± 32
Printing time (h)	35 ± 26



European Journal of Cardio-Thoracic Surgery 52 (2017) 1139–1148

Axial3D - 2024

Three-dimensional printed models for surgical planning of complex congenital heart defects: an international multicentre study

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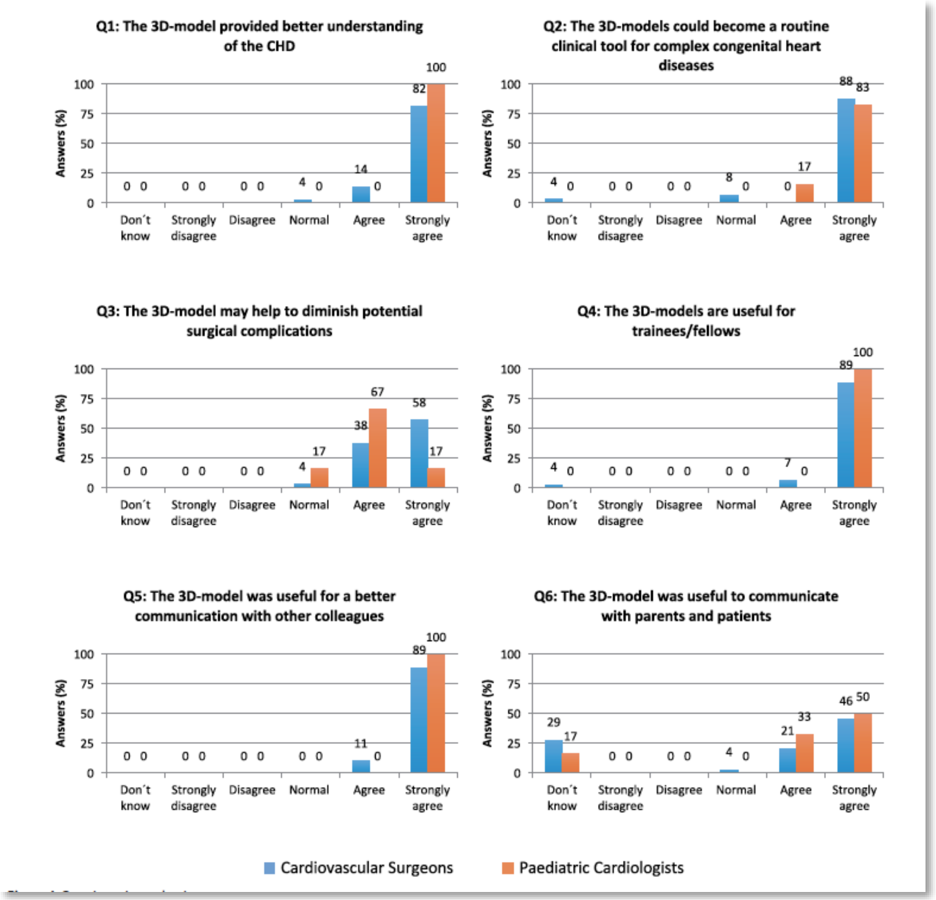
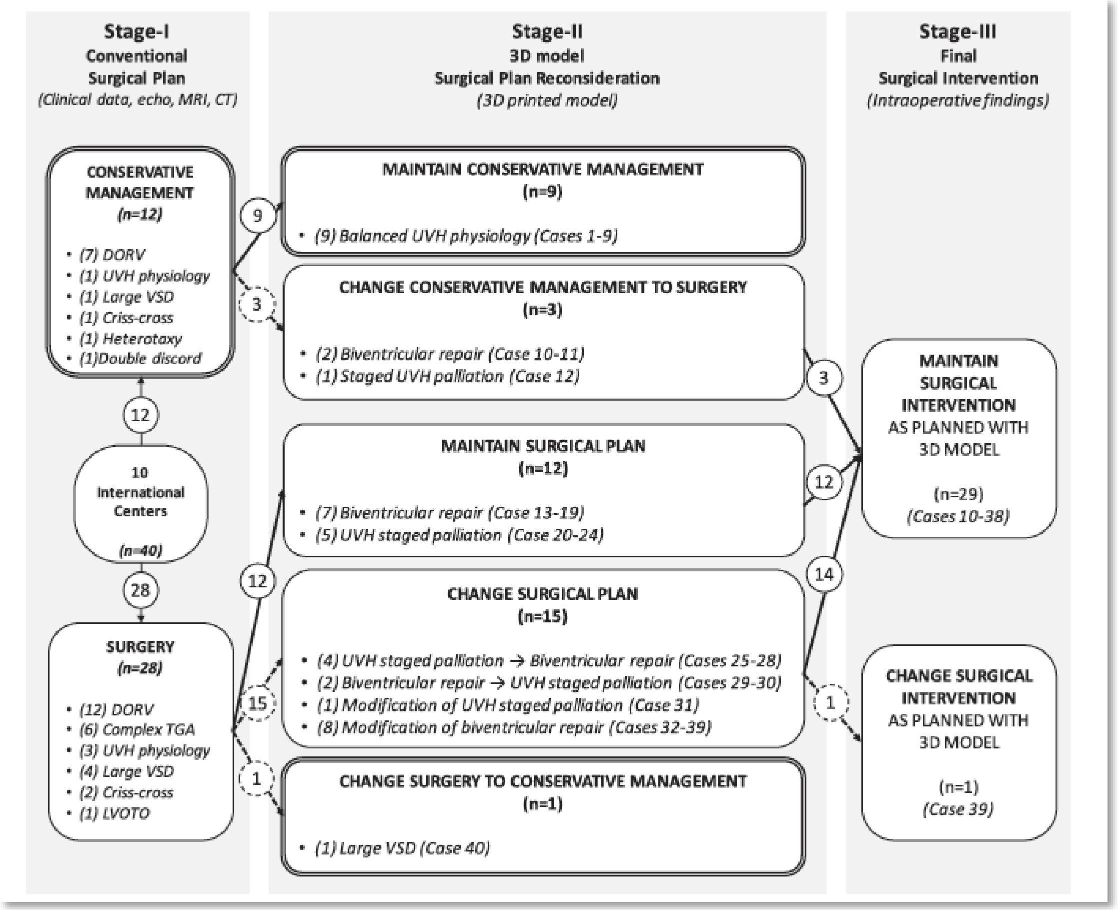




European Journal of Cardio-Thoracic Surgery 52 (2017) 1139–1148

CLINICAL EFFECTIVENESS OF 3D MODELLING IN INTERDISCIPLINARY CARE OF COMPLEX CONGENITAL CARDIAC LESIONS

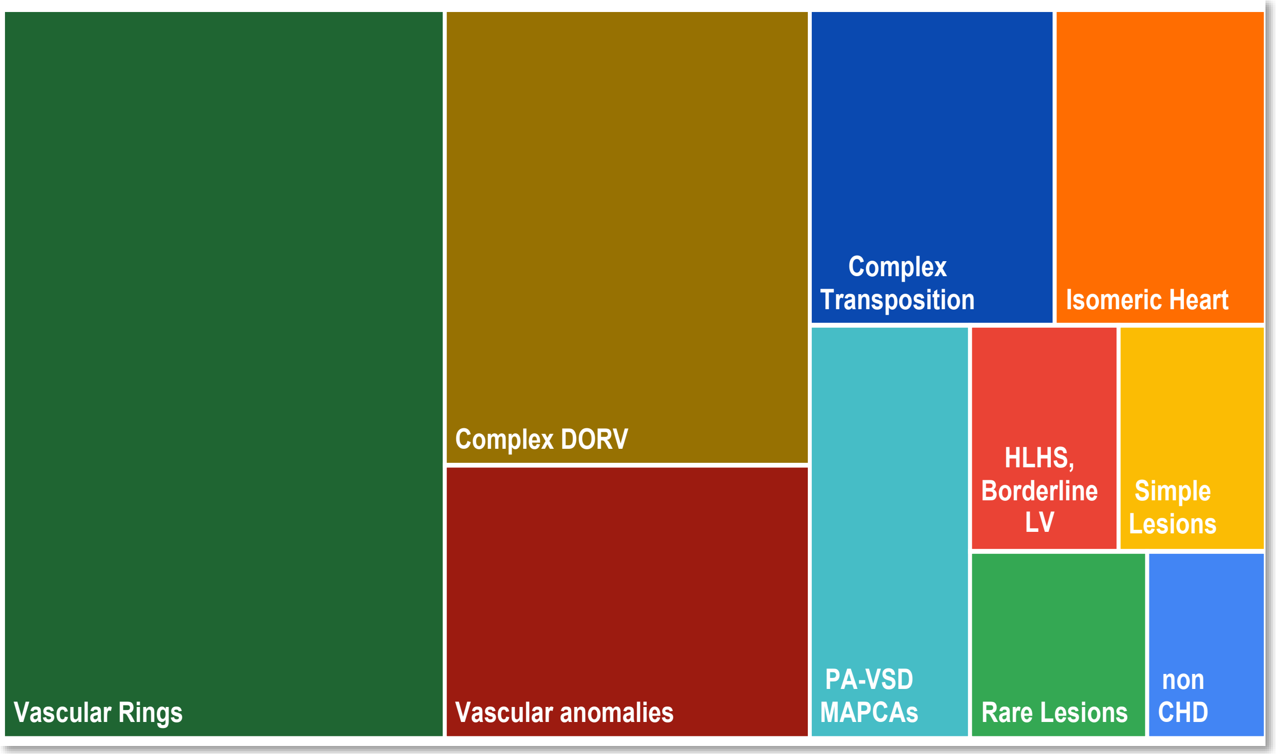
SOUTHAMPTON Children's Hospital

University Hospital Southampton NHS Foundation Trust

Viola N[1], Richens T[2], Bharucha T[2]
[1] Congenital Cardiac Surgery, University Hospital Southampton, United Kingdom
[2] Pediatric Cardiology, Southampton Children Hospital, United Kingdom

WPCPSC, Bologna 2024

PATIENT DEMOGRAPHICS	
Patients (n)	90
Models (n)	93
MORPHOLOGY	
CHD	60
DORV / Complex DORV	15
Vascular anomalies	9
Complex Transposition	7
Isomeric Heart	6
PA-VSD MAPCAs	6
HLHS, Borderline LV	3
Simple Lesions	3
Rare Lesions	3
OTHER	31
Vascular Rings	29
Acquired Lesions	2
IMAGING MODALITY	
MRI	1
CT	92
3D PRINTING	Axial 3D



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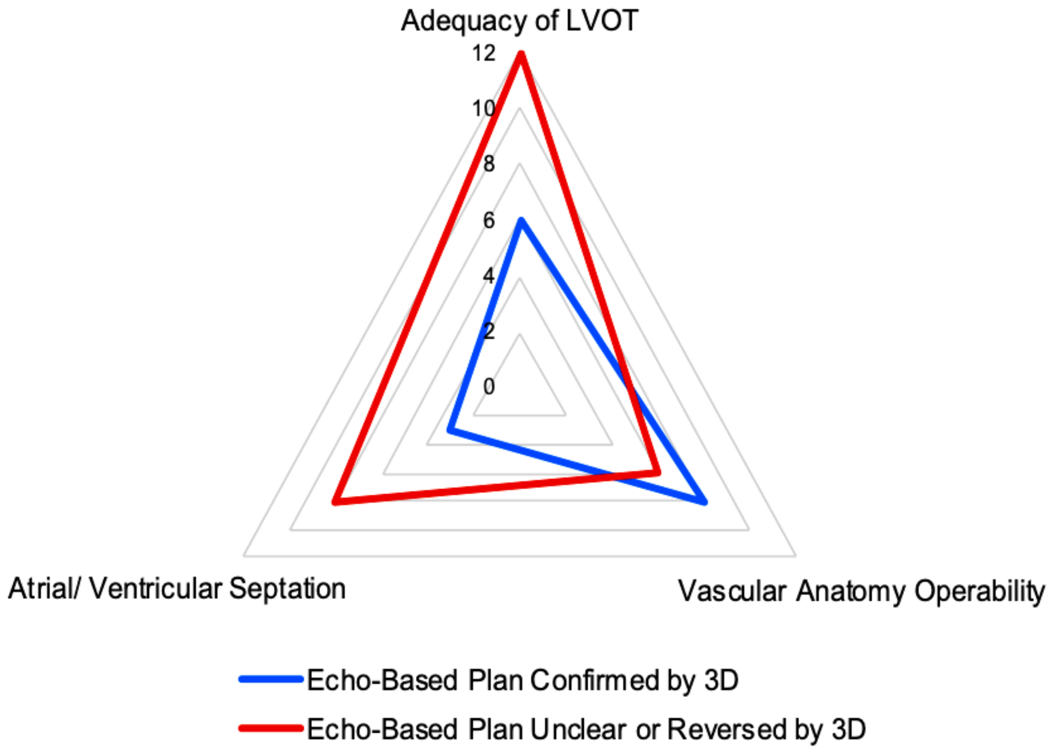

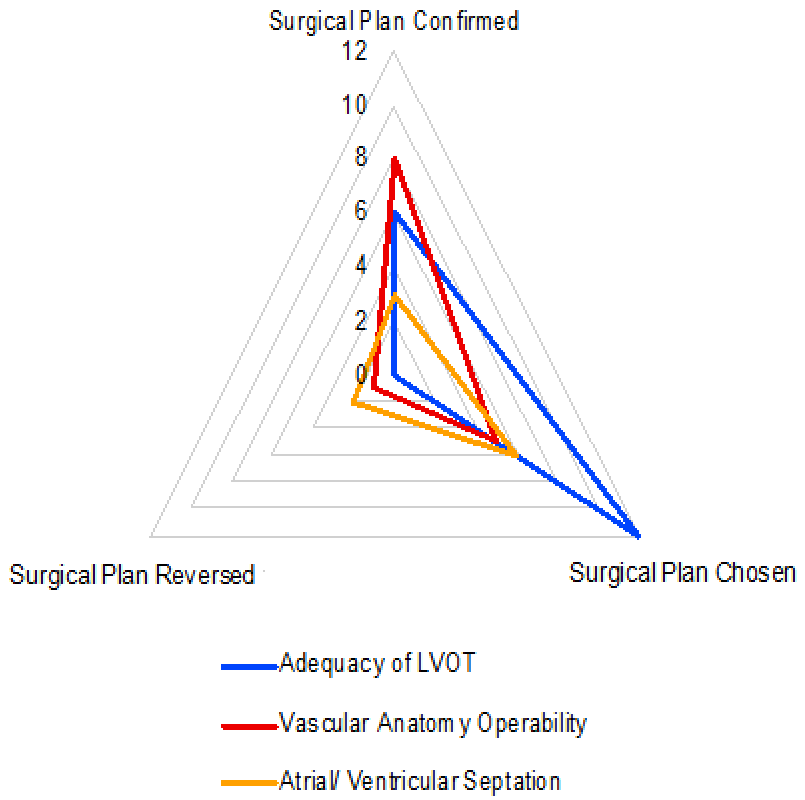

The “Library Effect”

Powering 3D pattern recognition in understanding complex lesions

THE 3D CONGENITAL HEART COLLECTION™
At University Hospital Southampton

Conclusions

- Silicone is a very good friend, not best yet, but we are working through things
- 3D printing is a reliable and powerful education and training tool. Its widespread use is set against its inherent costs
- Preliminary experience seems to point at detectable clinical benefit. Its widespread clinical use will require stronger, quantitative evidence of its benefit for patients
- Morbidity (especially long term) more than mortality will require large data and concerted multicenter efforts to power meaningful comparison with pre-3D outcomes

Thank You

Nicola Viola MD

10^{th} Utrecht Sessions
Utrecht 2025