

STS/EACTS Latin America Cardiovascular Surgery Conference

November 15-17, 2018

Hilton Cartagena | Cartagena, Colombia



The Arterial Switch Operation at 40: *Not As Good As It Gets?*

Gil Wernovsky, MD, FAAP, FACC

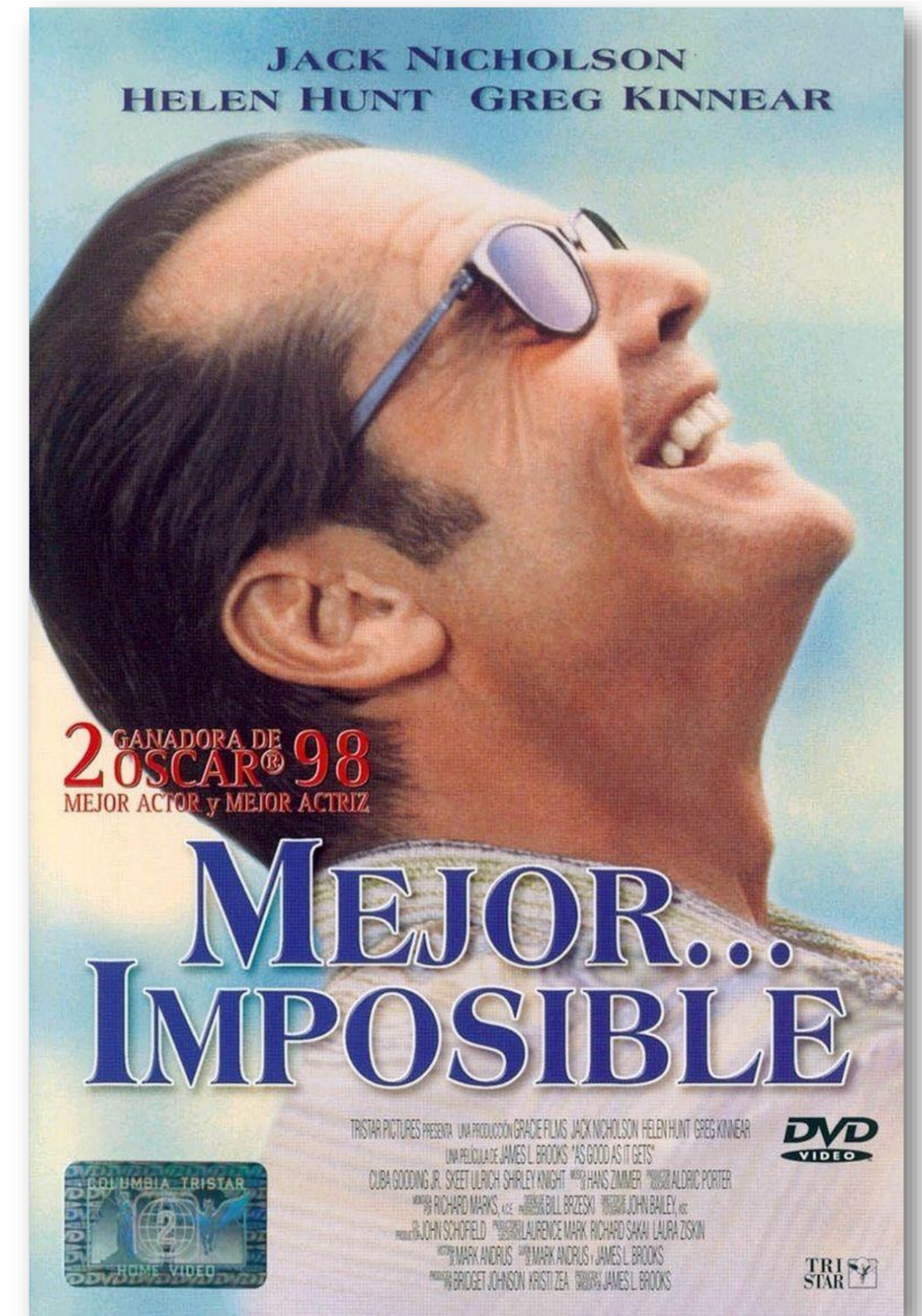
*Senior Consultant in Cardiology and Cardiac Critical Care
Professor of Pediatrics
Children's National Health System
Washington DC USA*



Disclosures

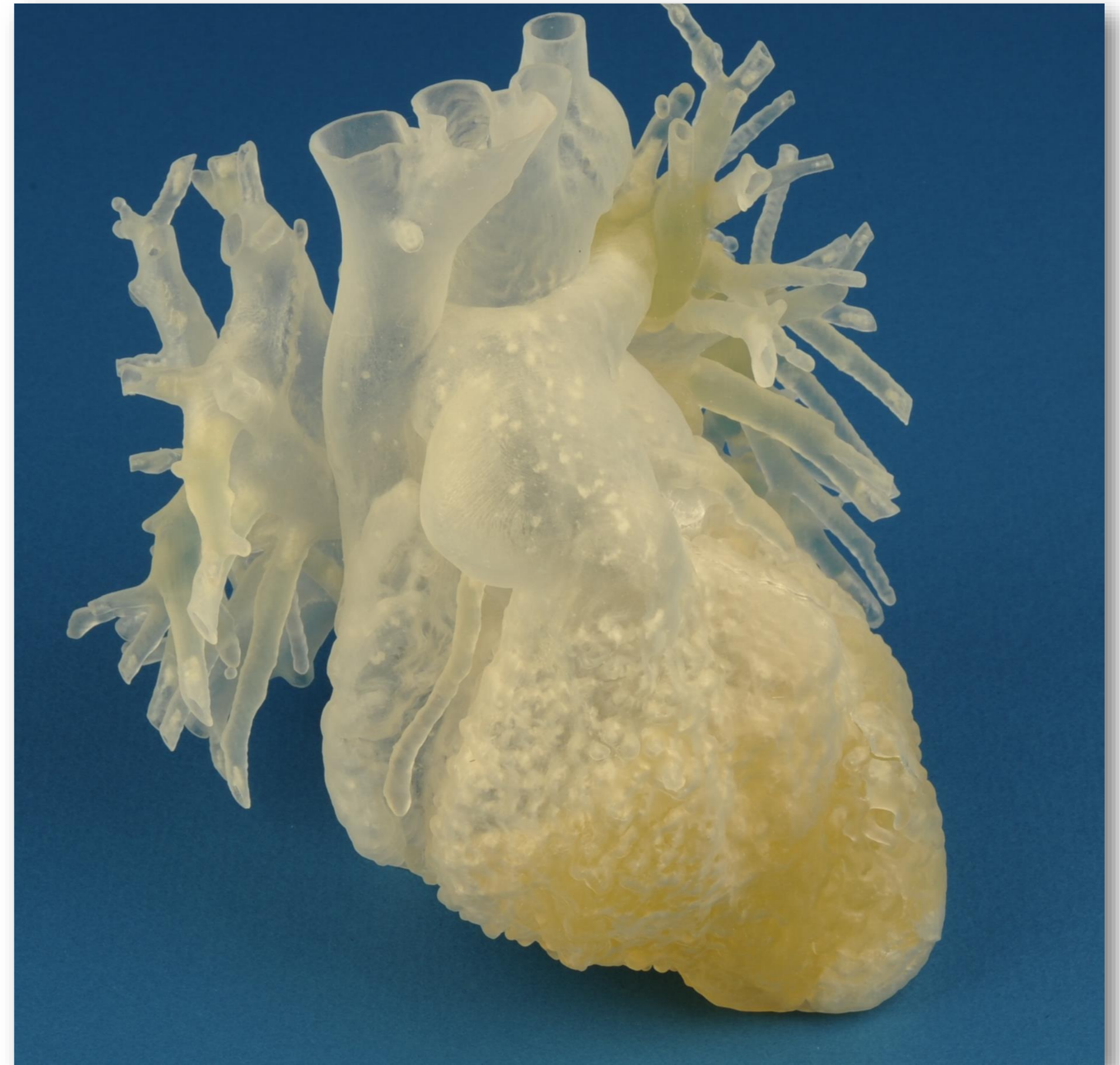
I have no real or perceived conflicts of interest related to this talk

I will not be discussing off-label use of drugs or devices



The Arterial Switch is Now Over 40 years Old!

What Have We Learned in 40 years?



The Arterial Switch is NOT an “Anatomical Correction”

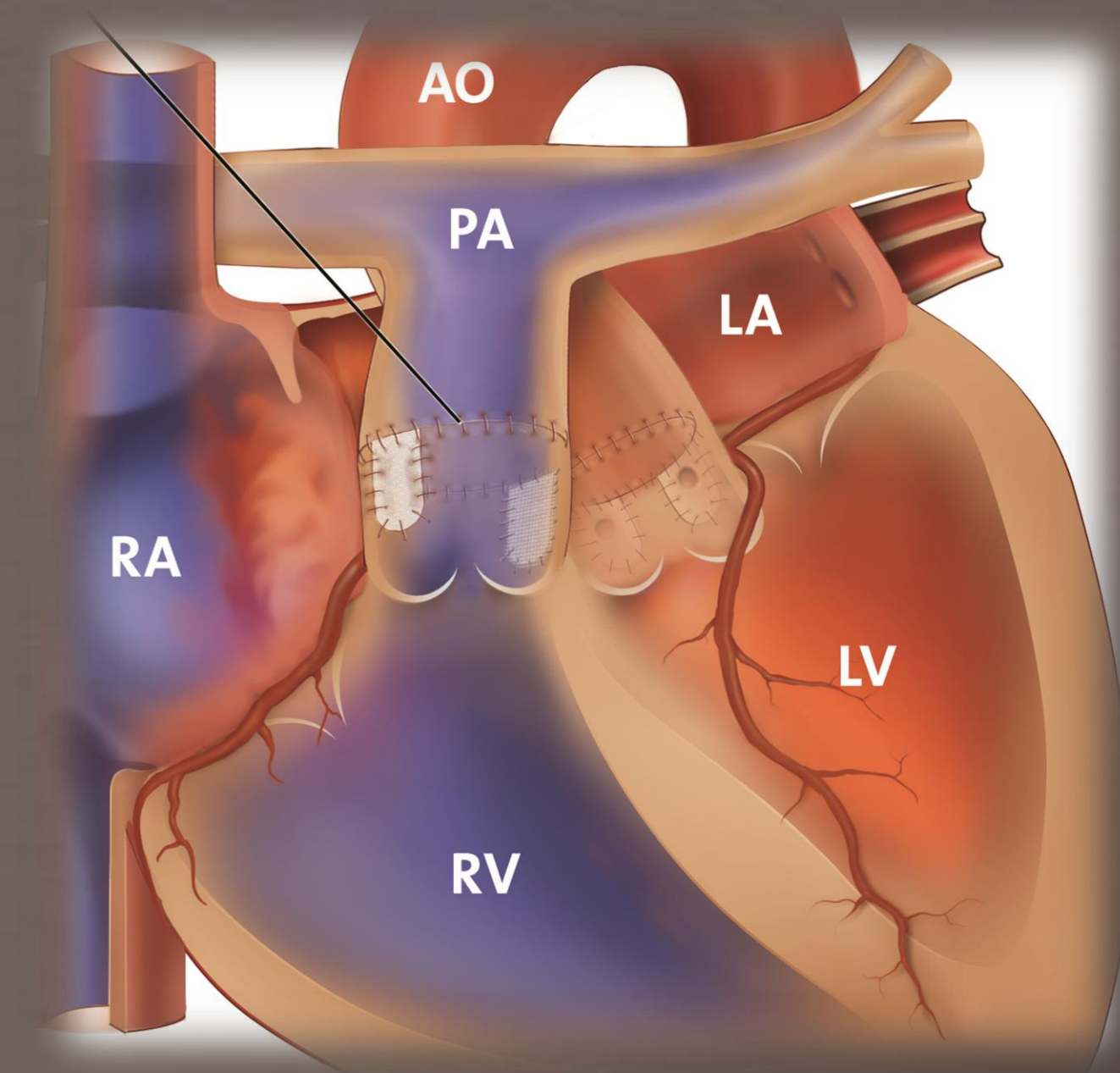
The anatomical pulmonary valve (and root) must function in the systemic circulation

- 2/3 sinuses of the neo-aortic valve have had incisions and coronary re-implantation

The neo-pulmonary root contains pericardial patches

Both pulmonary arteries are anterior to the neo-aorta (“Lecompte maneuver”)

- “Front-to-back” tension on main pulmonary artery
- Anterior compression on neo-aorta, just above root and re-implanted coronary arteries

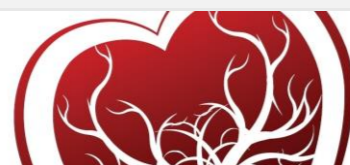
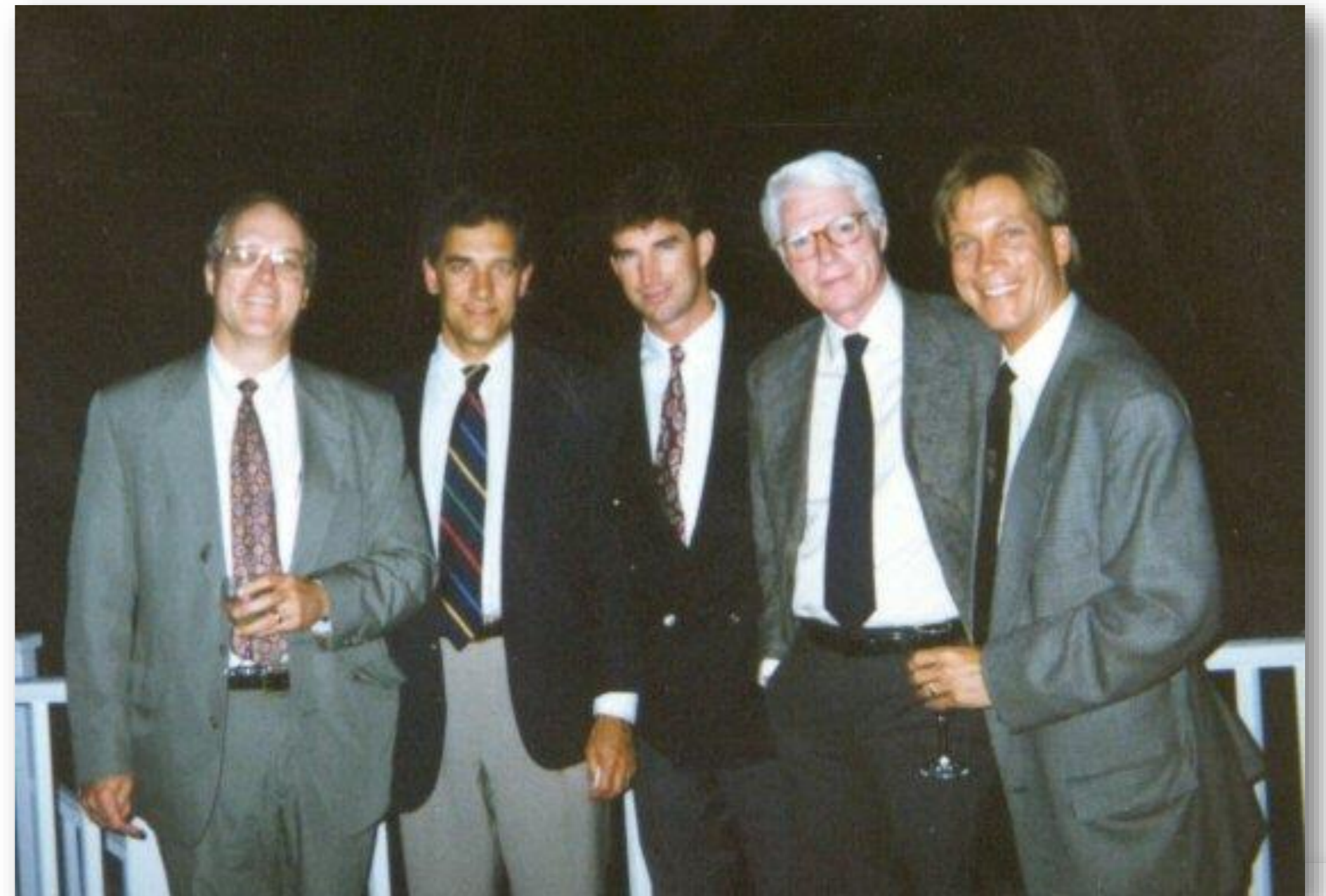


Midterm results after the arterial switch operation for transposition of the great arteries with intact ventricular septum: clinical, hemodynamic, echocardiographic, and electrophysiologic data [published erratum appears in *Circulation* 1988 Aug;78(2):A5]

G Wernovsky, TJ Hougen, EP Walsh, GF Sholler, SD Colan, SP Sanders, IA Parness, JF Keane, JE Mayer and RA Jonas
Circulation 1988;77:1333-1344

Preoperative Catheterization in Most

**Follow-up Protocol Included
Catheterization at 1y**



Current Data on Survival, Reintervention and Morbidities

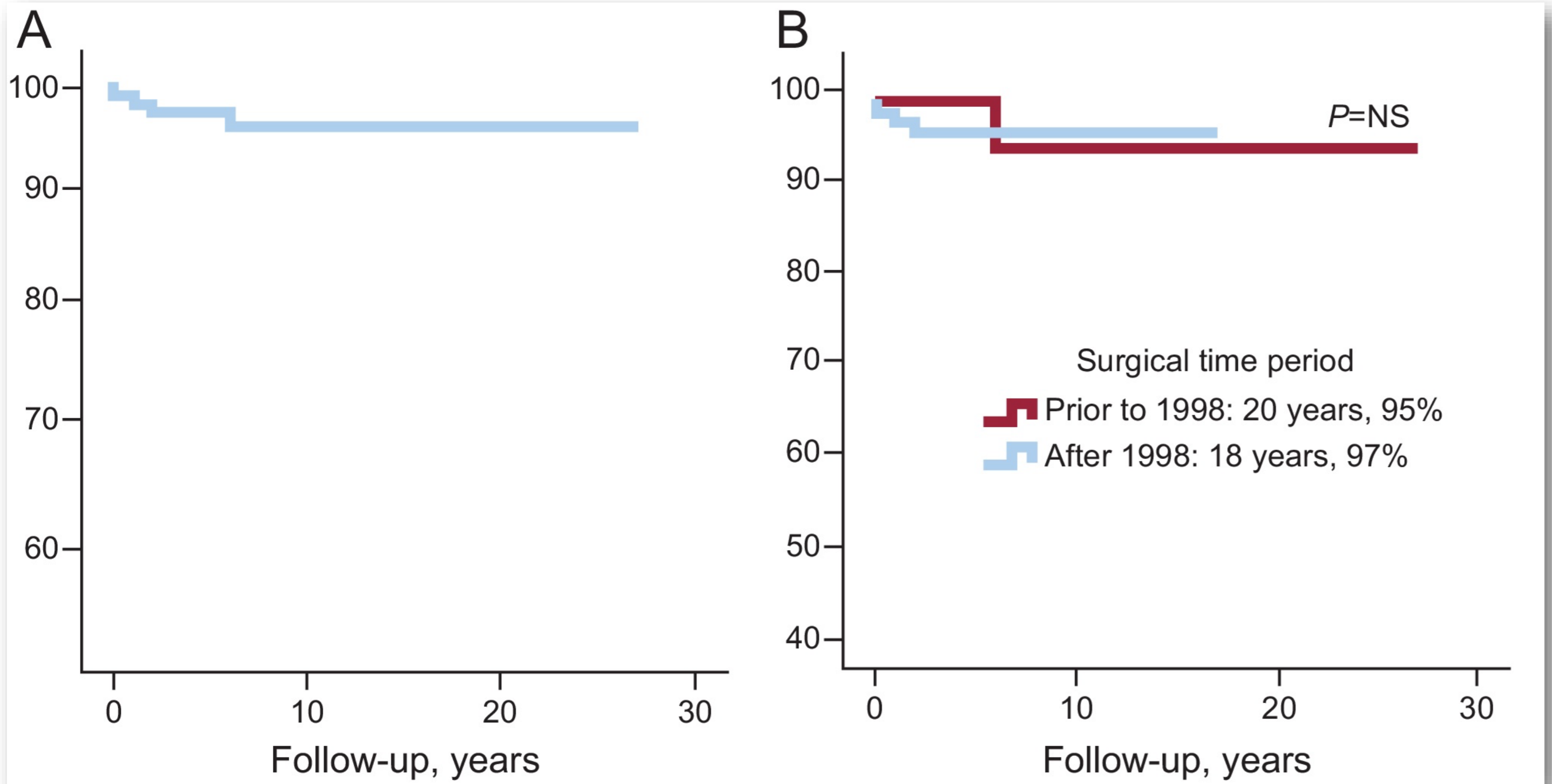
Original article

Mid-term Morbidity and Mortality of Patients After Arterial Switch Operation in Infancy for Transposition of the Great Arteries

María José Rodríguez Puras,^a Luisa Cabeza-Letrán,^a Manuela Romero-Vazquianez,^a José Santos de Soto,^b Reza Hosseinpour,^{a,c} Mauro Gil Fournier,^c Antonio Alvarez Madrid,^c Antonio González,^{a,c} Pilar Pérez,^a and Pastora Gallego^{a,*}

155 patients with complete follow-up

Unidad Intercentro de Cardiopatías Congénitas del Adulto Área del Corazón
Hospitales Virgen del Rocío y Virgen Macarena
Sevilla, Spain

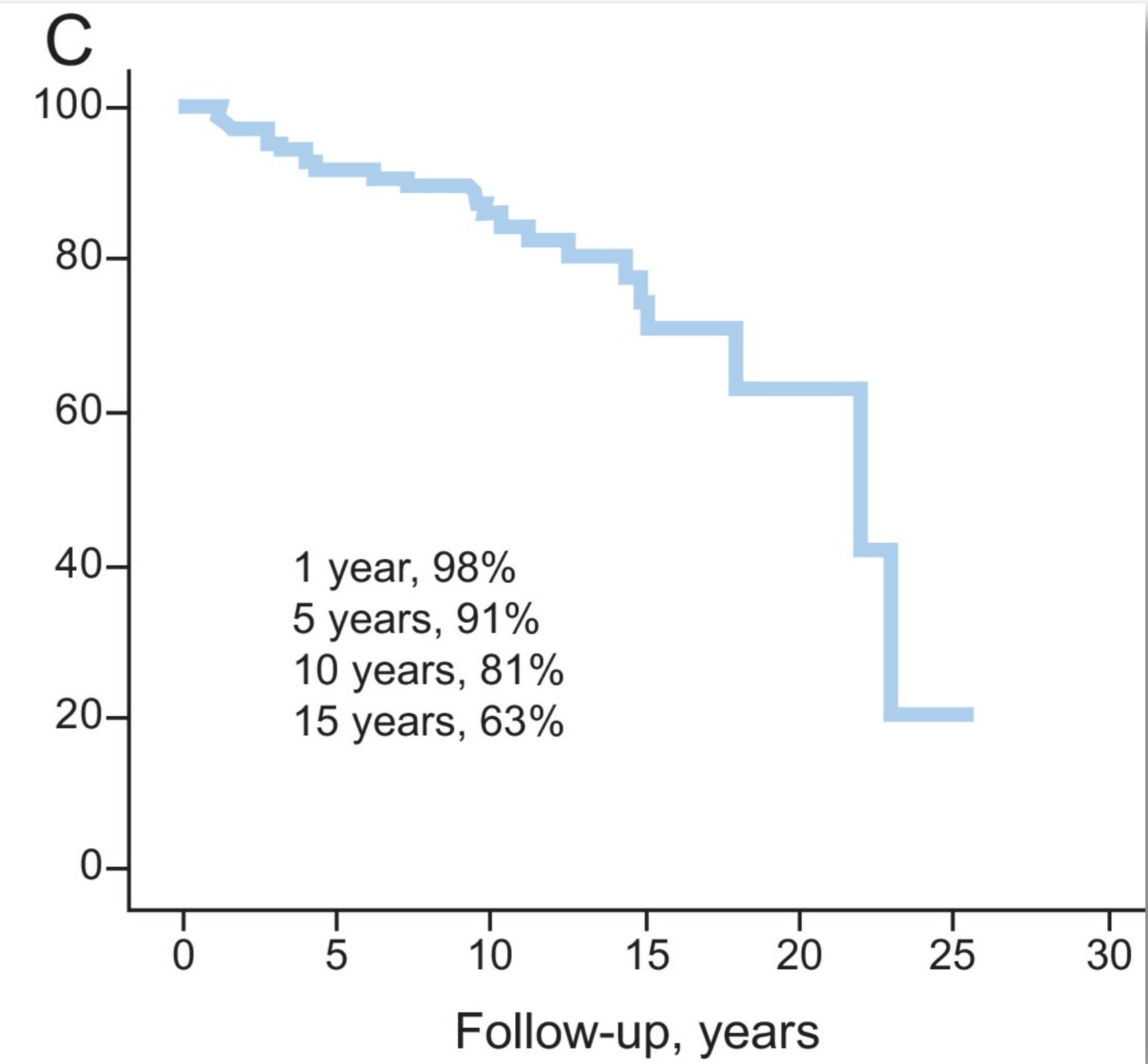
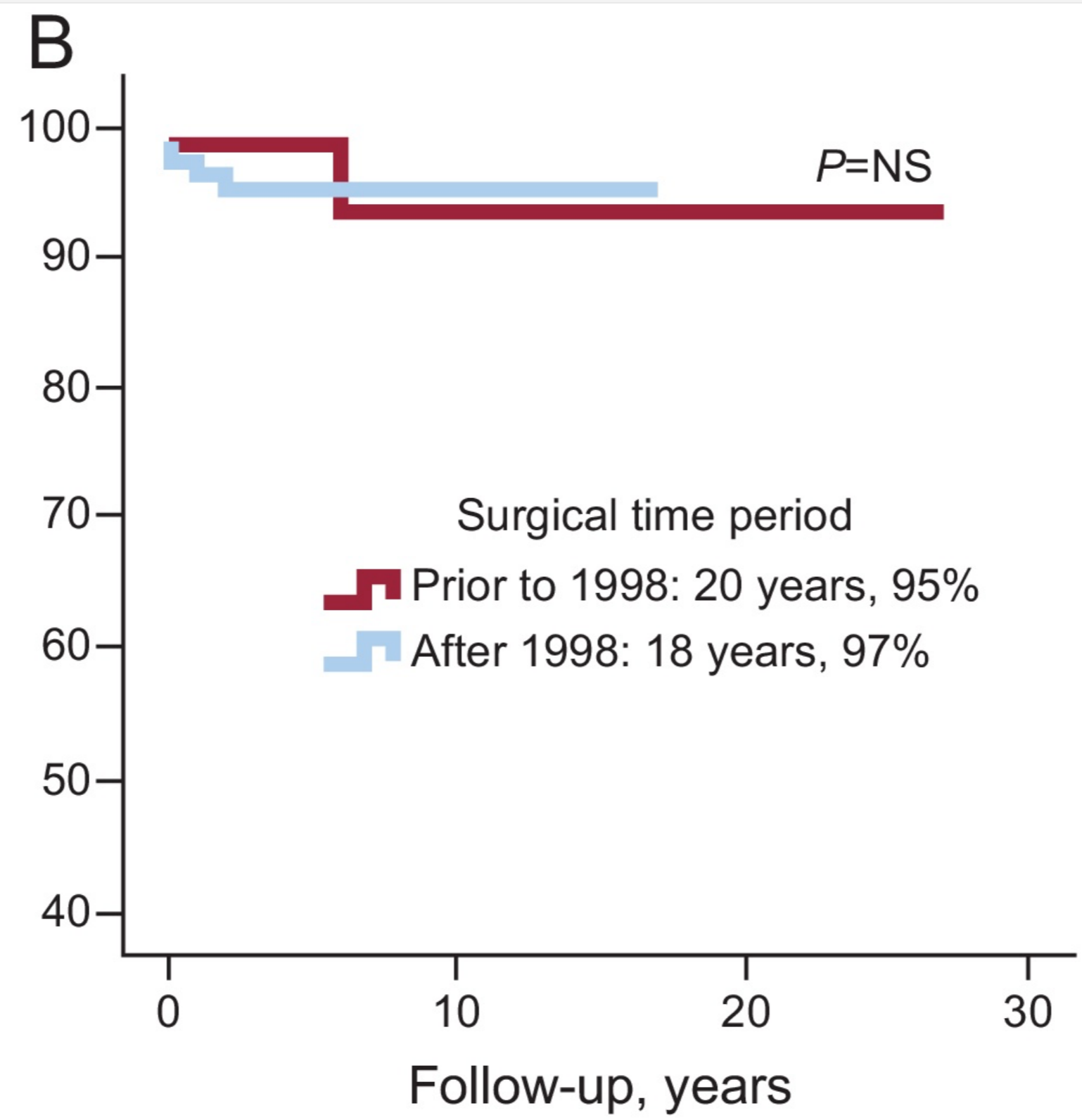
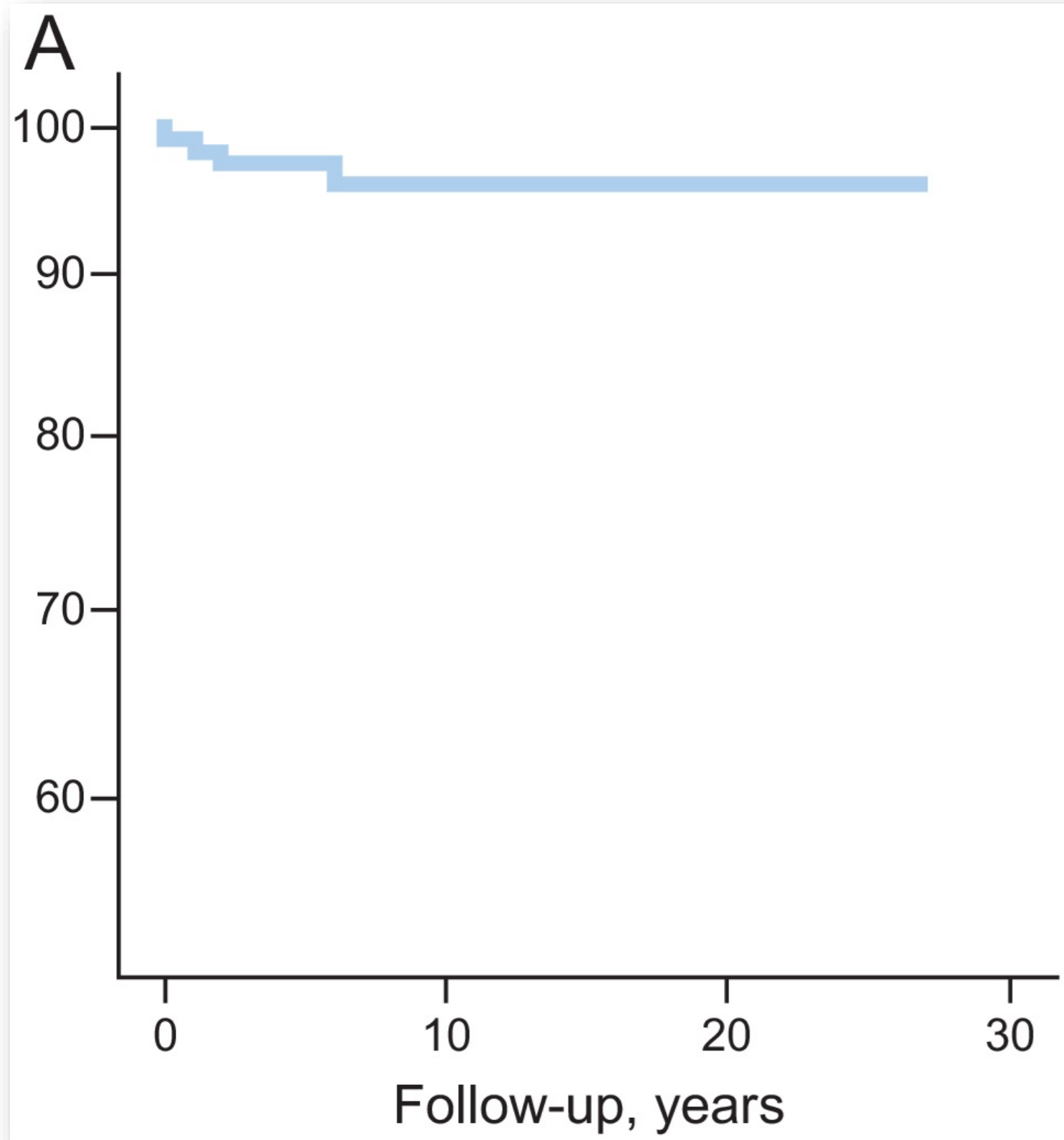


Survival

Original article

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Survival

Freedom From Reintervention

Original article

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As Good As it Gets?

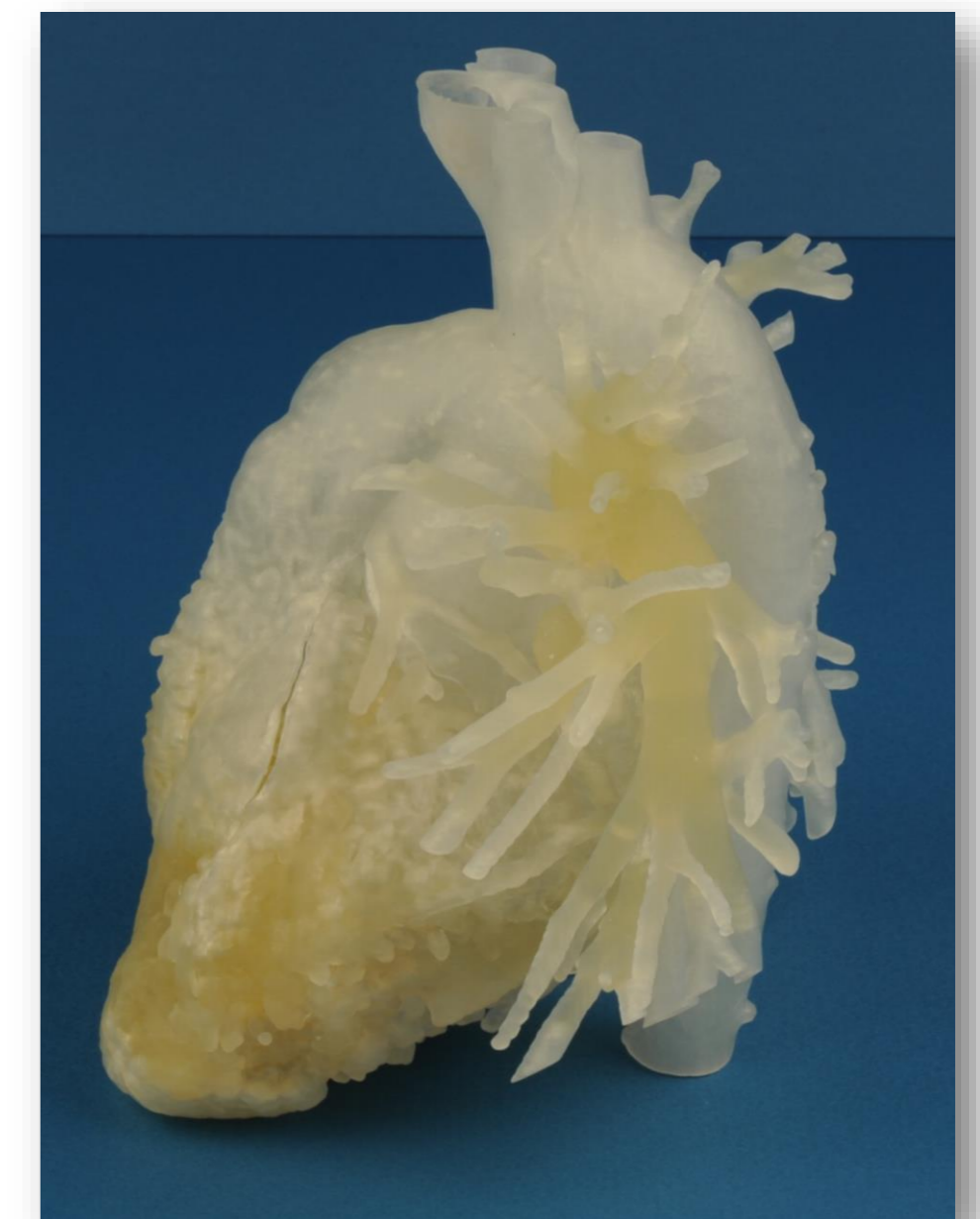
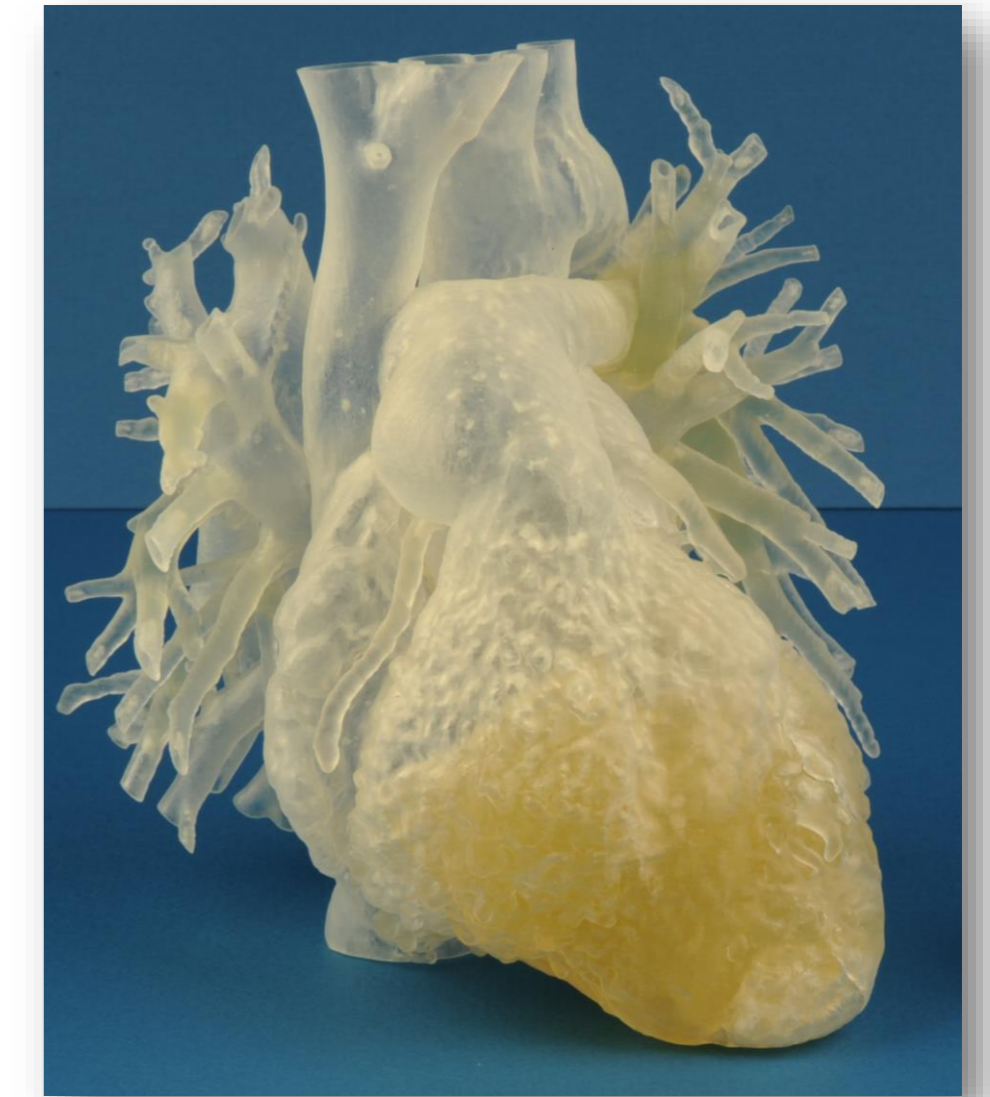
1. The Great Vessel Anastomoses

2. The Neo-Aortic Root

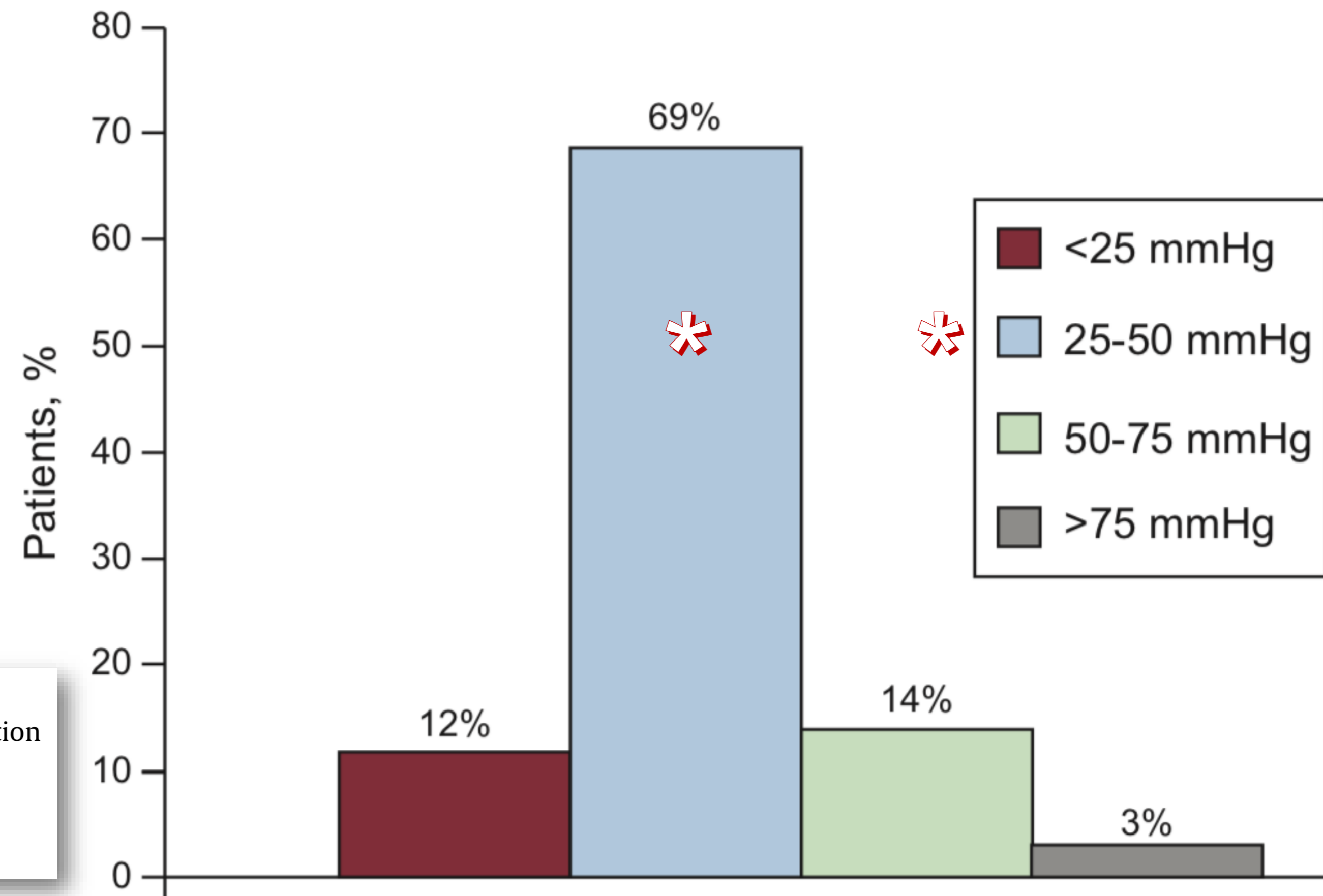
3. The Coronary Arteries

4. The Lungs

- Accessory Blood Flow
- Elevated Pulmonary Vascular Resistance
- Restrictive Lung Disease



Right Ventricular Outflow Obstruction is Typically Mild-Moderate



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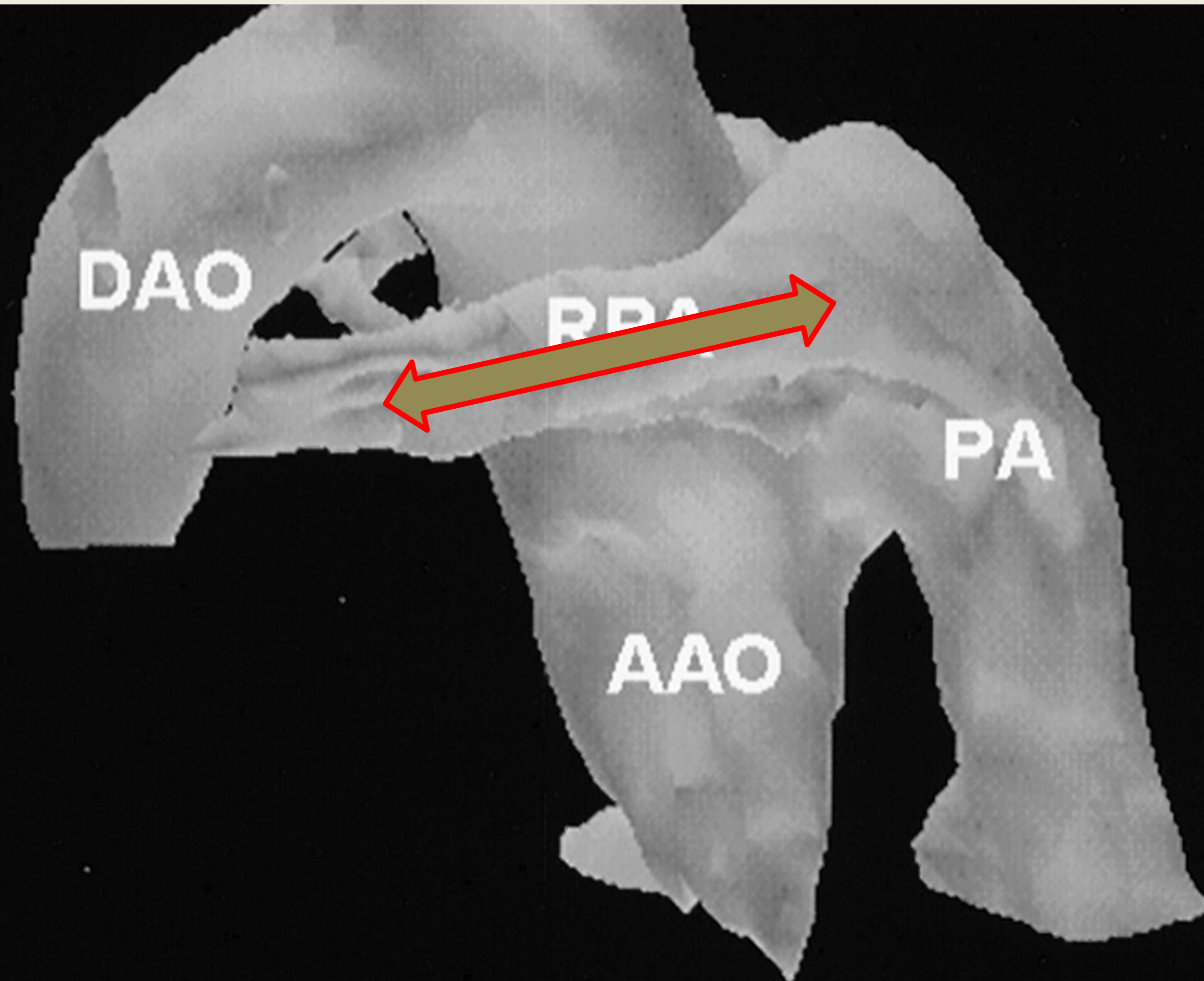
Figure 4. Percent distribution of patients with residual stenosis of right ventricular outflow tract according to the severity of the obstruction measured by Doppler echocardiography.



“Straddling” of Aorta by Pulmonary Arteries After the LeCompte Maneuver - Anterior View



”Straddling” of Aorta by Pulmonary Arteries After the LeCompte Maneuver - Lateral View



As Good As it Gets?

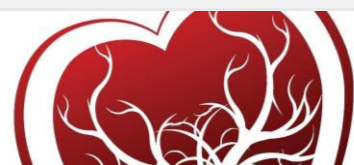
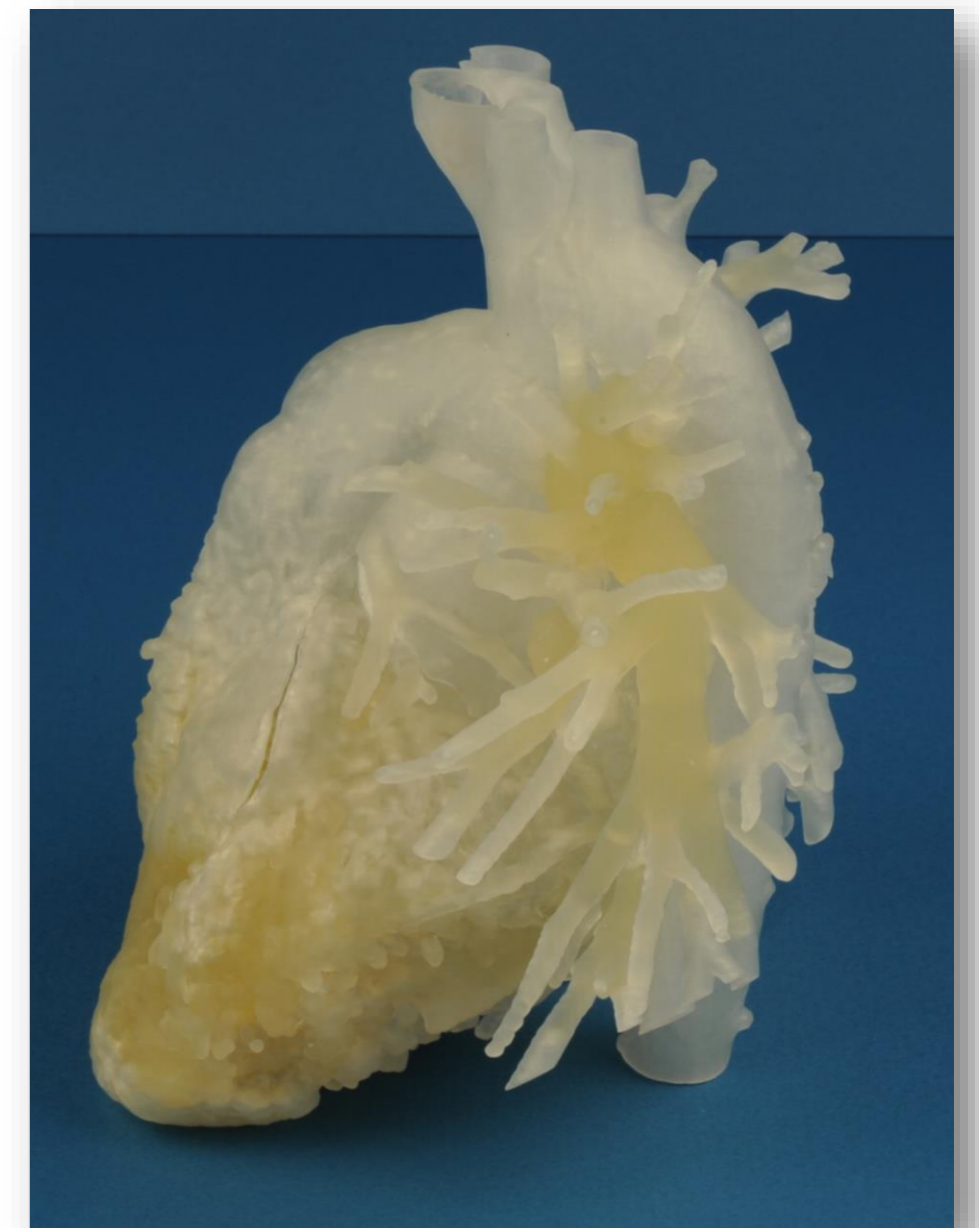
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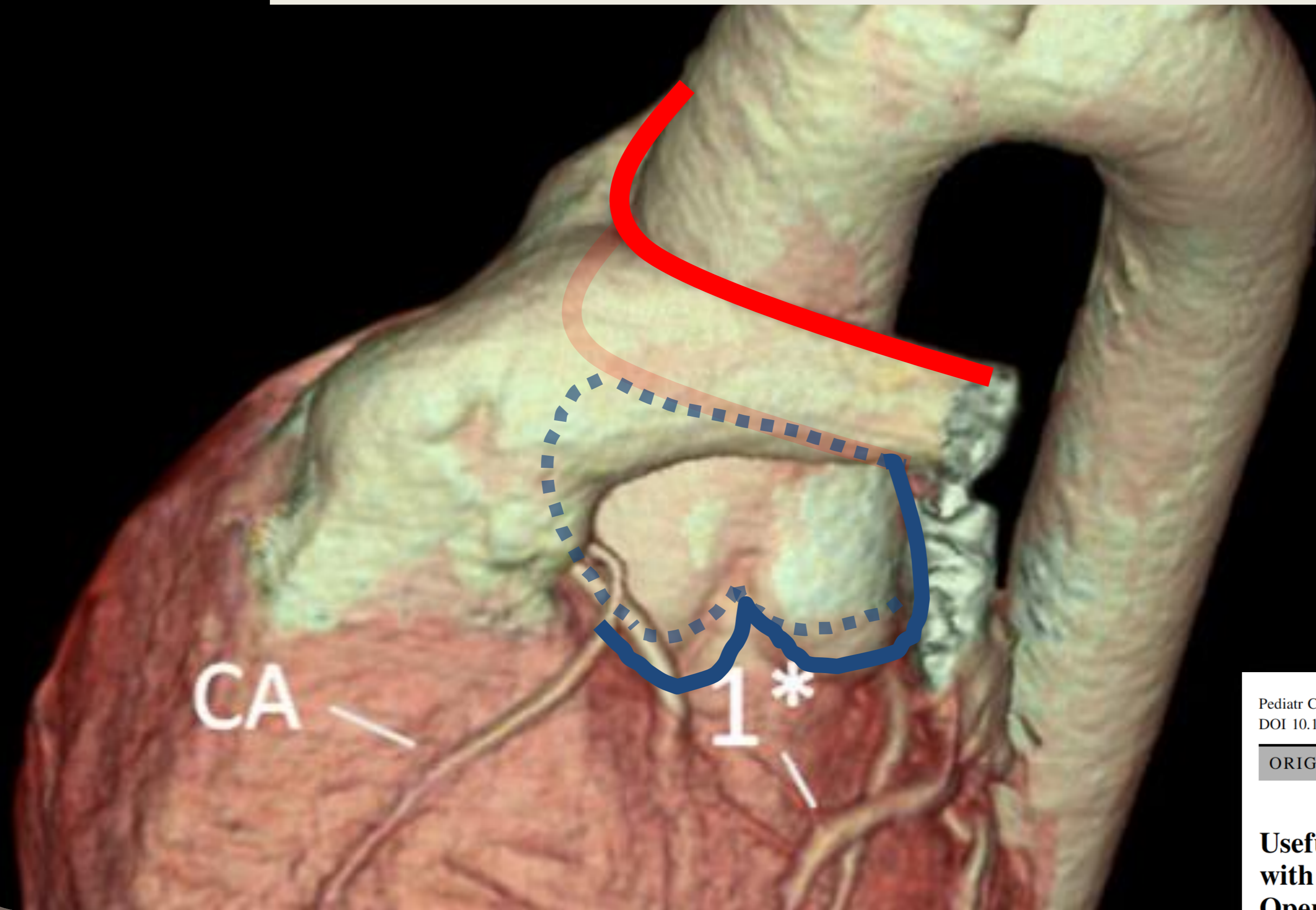
3. The Coronary Arteries

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- Accessory Blood Flow
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Do the Pulmonary Arteries “Jail” the Neo-Aortic Root?



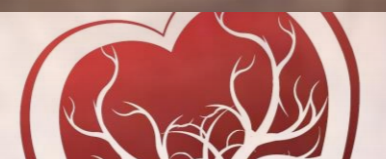
Pediatr Cardiol
DOI 10.1007/s00246-017-1761-z

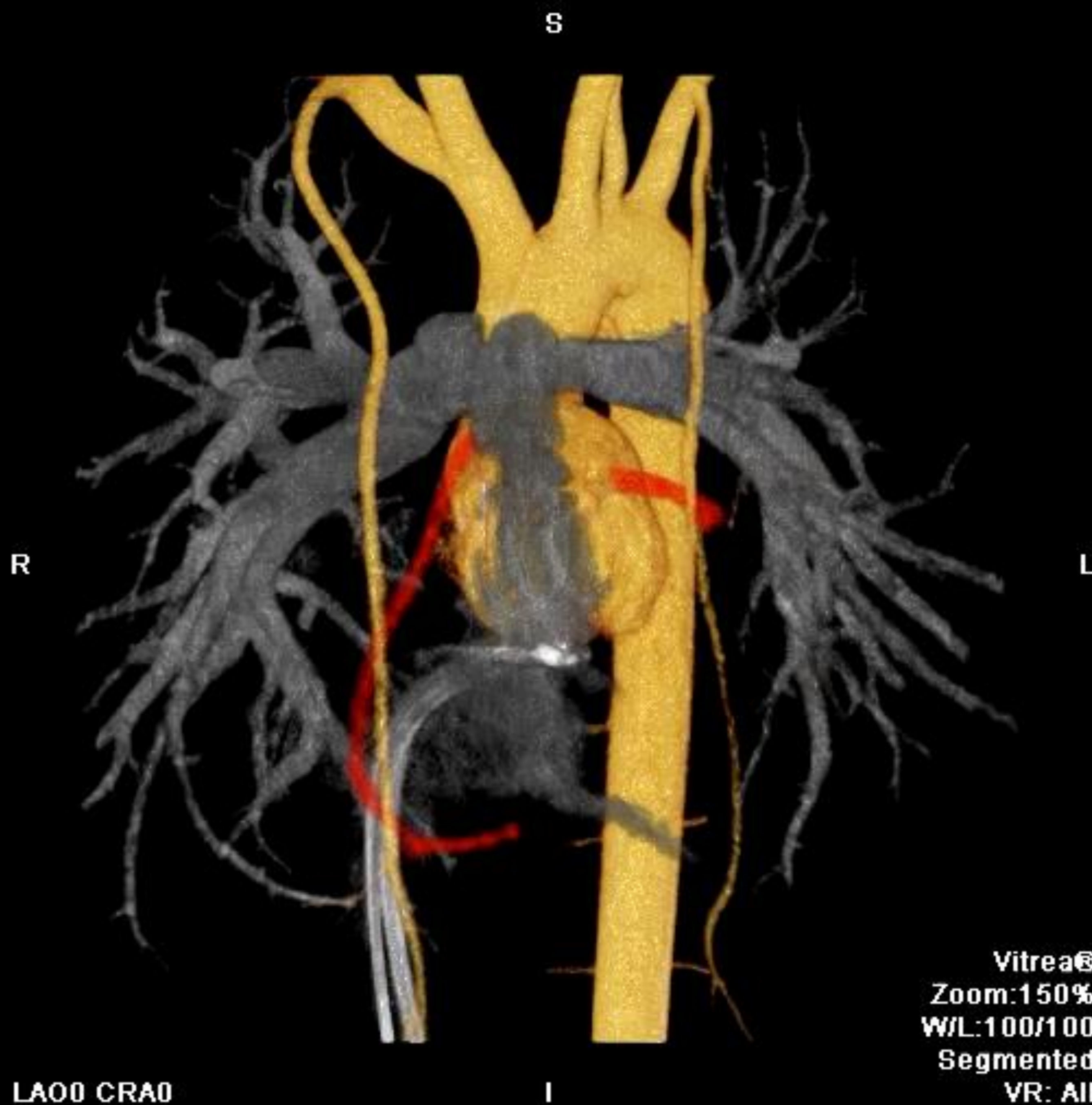


ORIGINAL ARTICLE

Usefulness of Routine Coronary CT Angiography in Patients with Transposition of the Great Arteries After an Arterial Switch Operation

Konrad Szymczyk¹ · Maciej Moll² · Katarzyna Sobczak-Budlewska³ ·
Jadwiga A. Moll³ · Ludomir Stefańczyk¹ · Piotr Grzelak⁴ · Jacek J. Moll² ·
Krzysztof W. Michalak³





Vitreax®
Zoom: 150%
W/L: 100/100
Segmented
VR: All

LAO CRAO



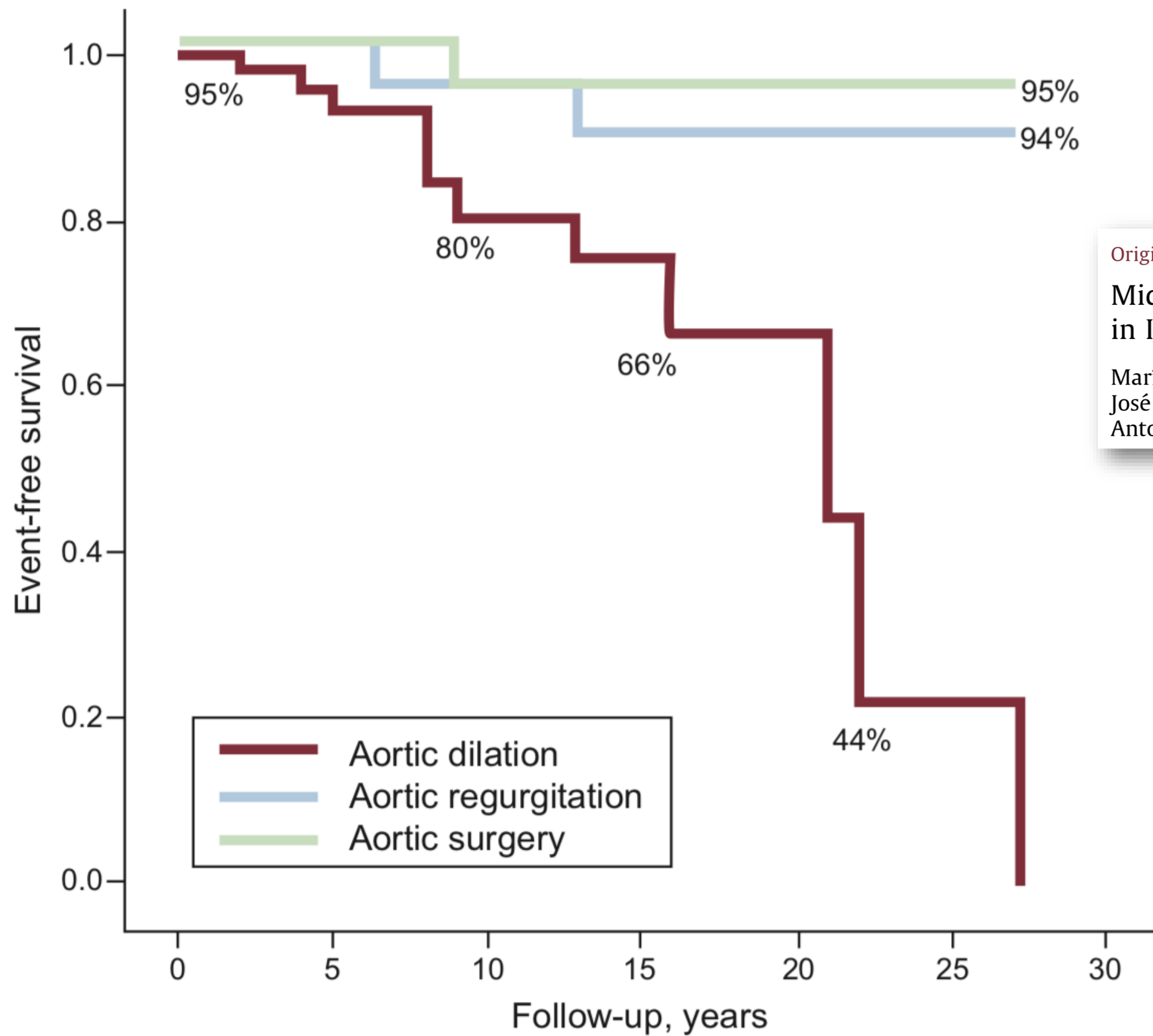
The Neo-Aorta: Root Growth and Dilation/Valve Function

Neo-aortic insufficiency increasingly prevalent with increasing duration of follow-up

Every published report has shown dilation of the neo-aortic root out of proportion to somatic growth

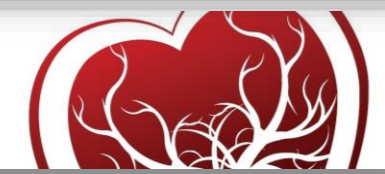
- ?Etiology: Is the pulmonary valve “different”?
- Does coronary reimplantation play a role?
- Does the Lecompte maneuver play a role?

Isolated case reports of neo-aortic valve replacement

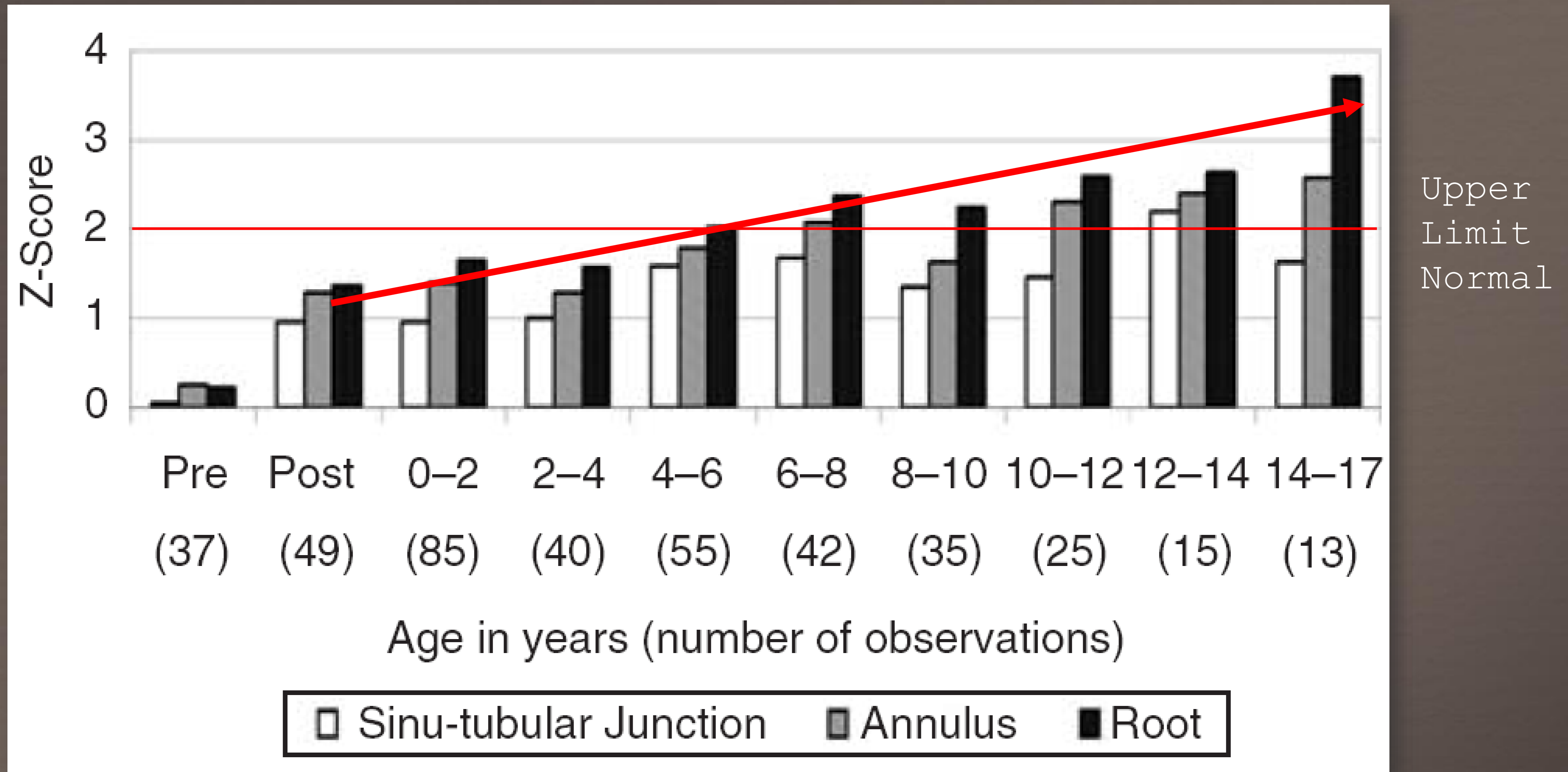


Original article
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Figure 5. Kaplan-Meier curves corresponding to survival free of aortic dilation, aortic regurgitation, and surgery to treat aortic dilation and/or aortic regurgitation.



Growth of the Neo-Aorta



Marino BS et al
 Neo-aortic valvar function after the arterial switch
 Cardiol Young 2006;16:481-489



Freedom from Neo-Aortic Insufficiency \geq Moderate

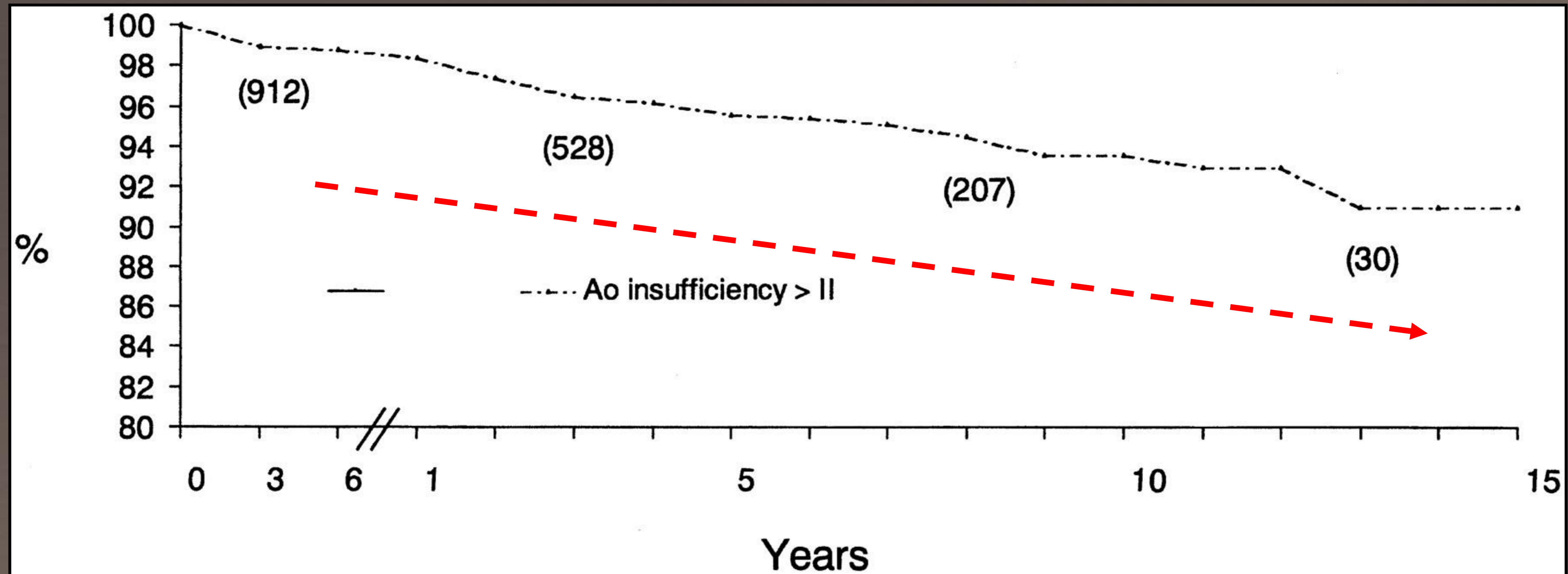


Planche et al, Paris, 1095 Patients

As Good As it Gets?

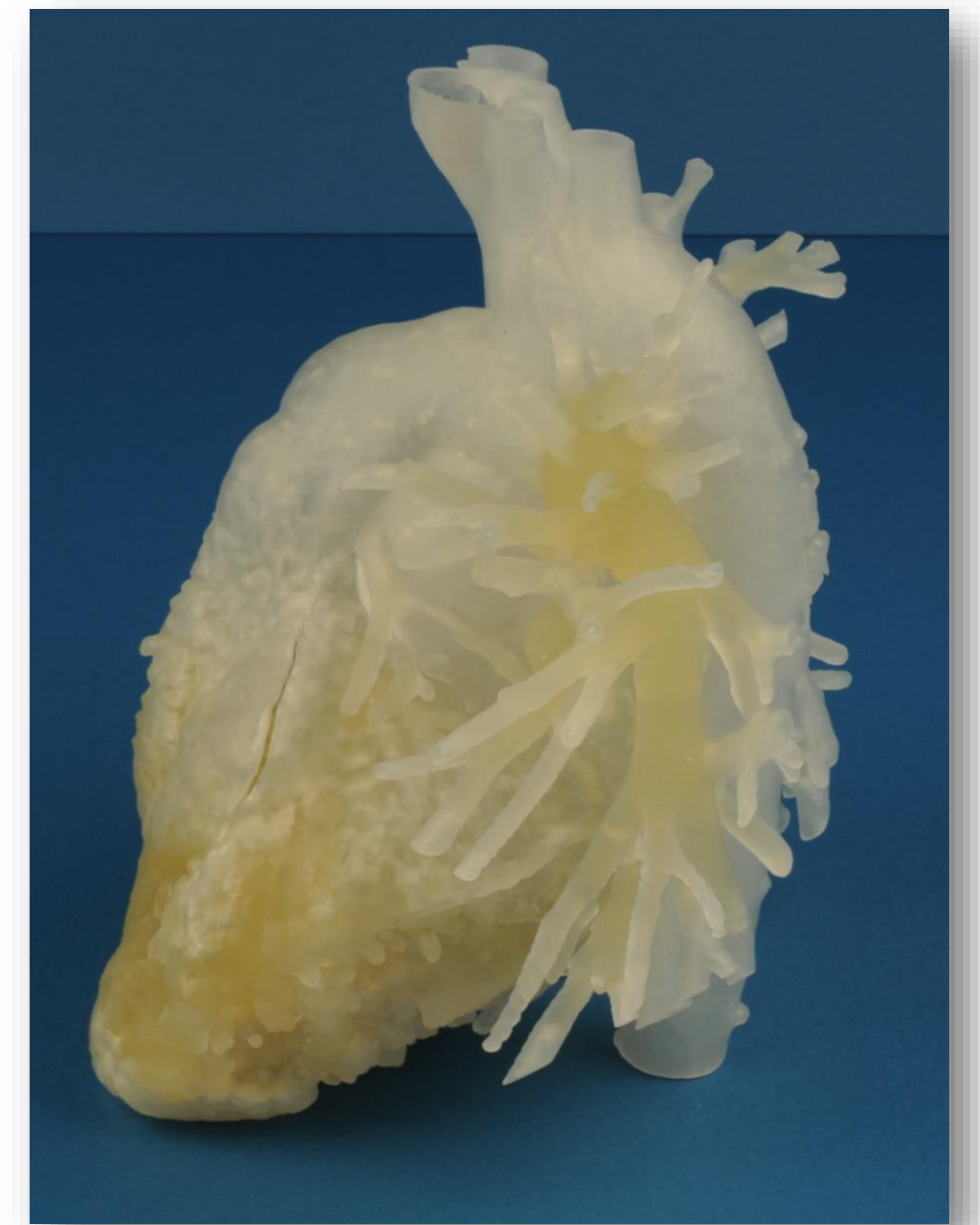
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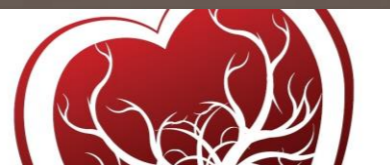
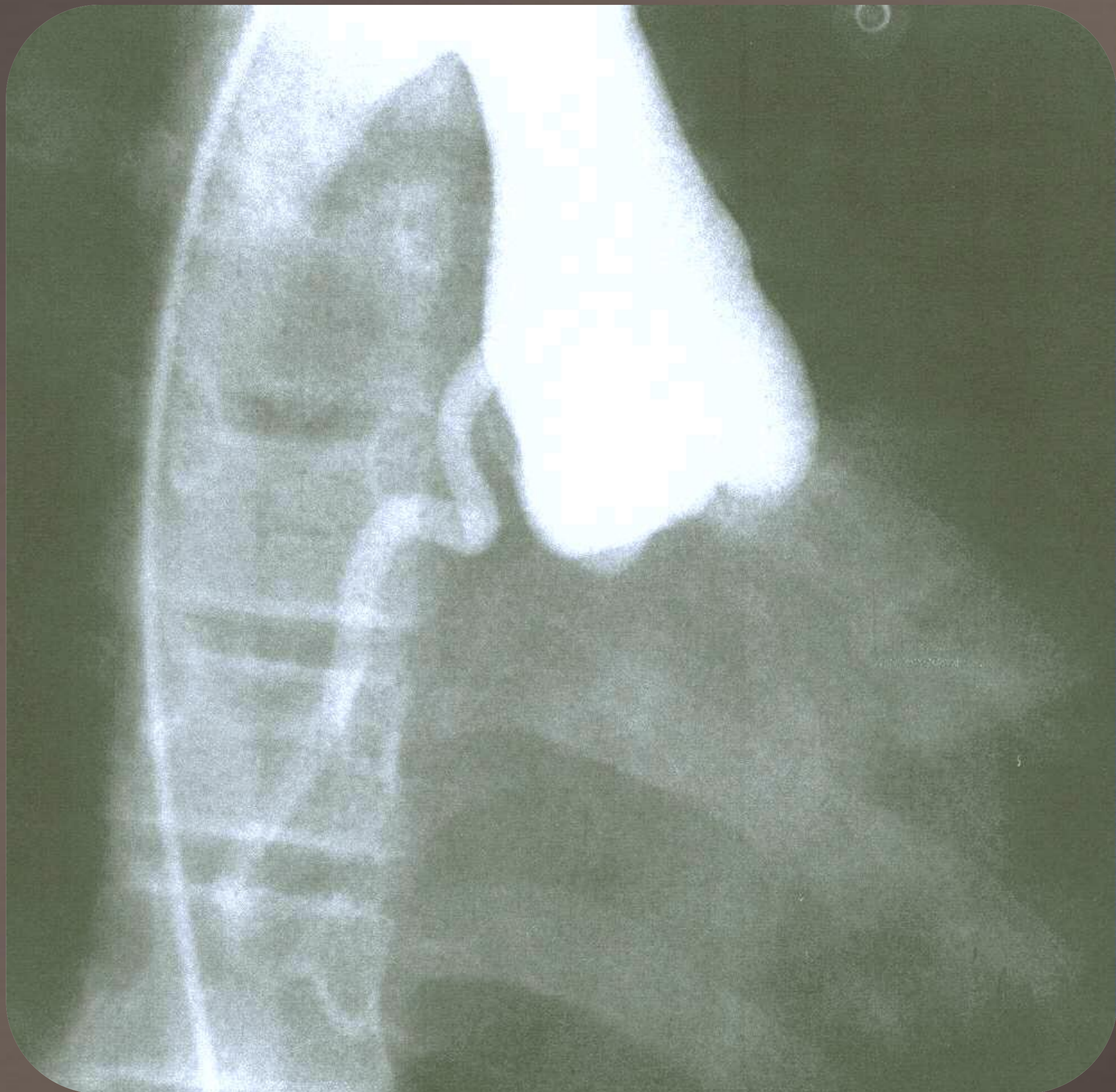
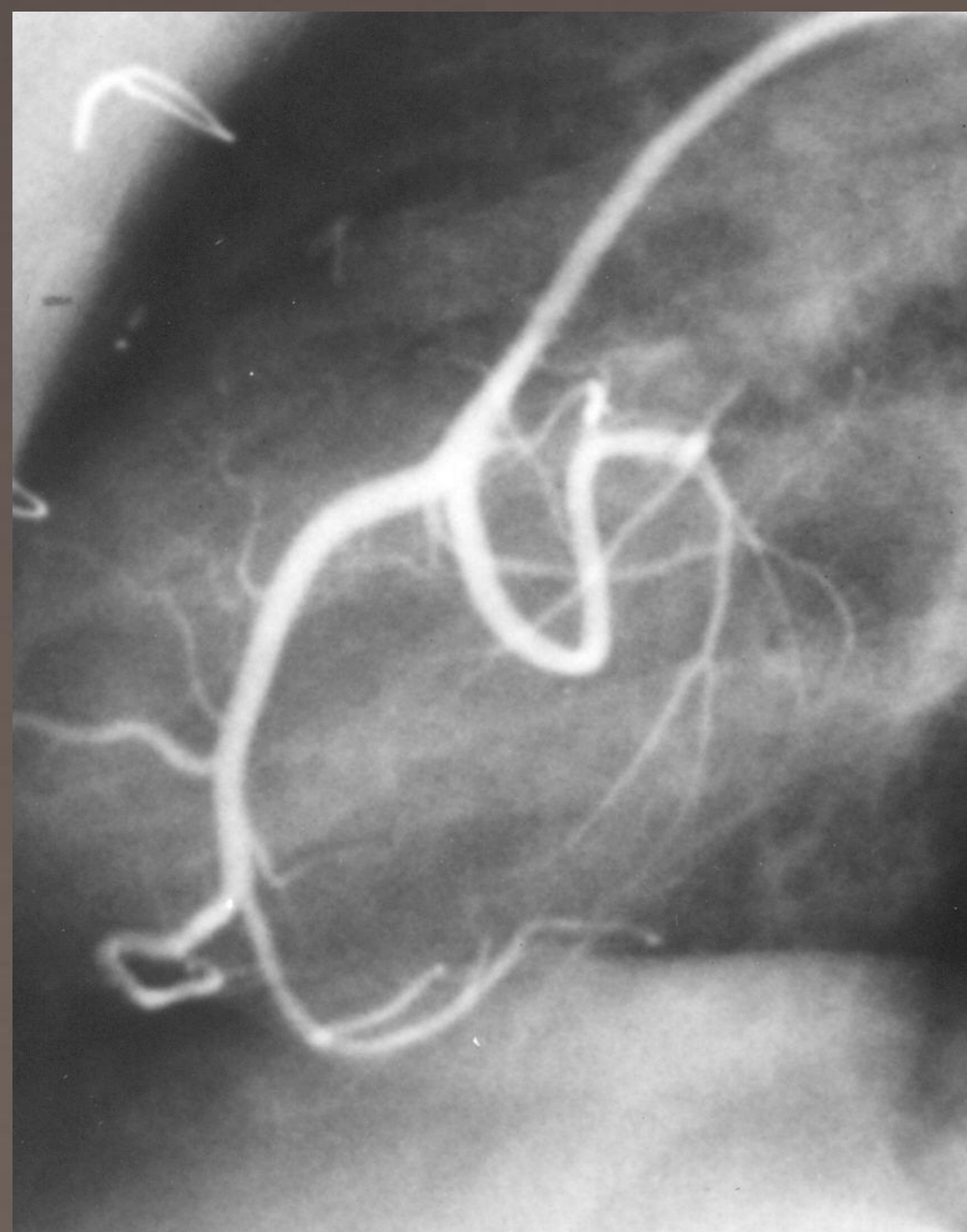
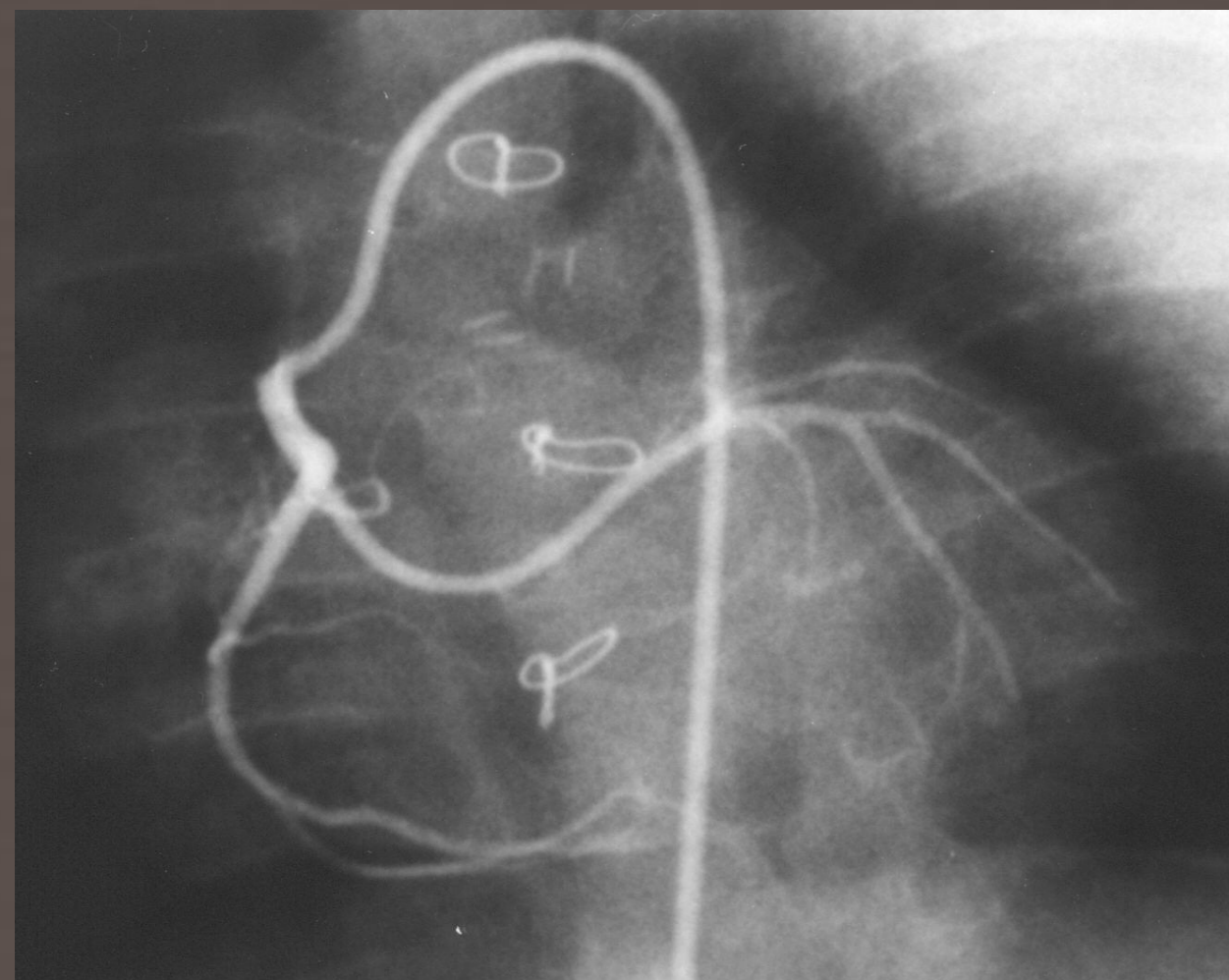
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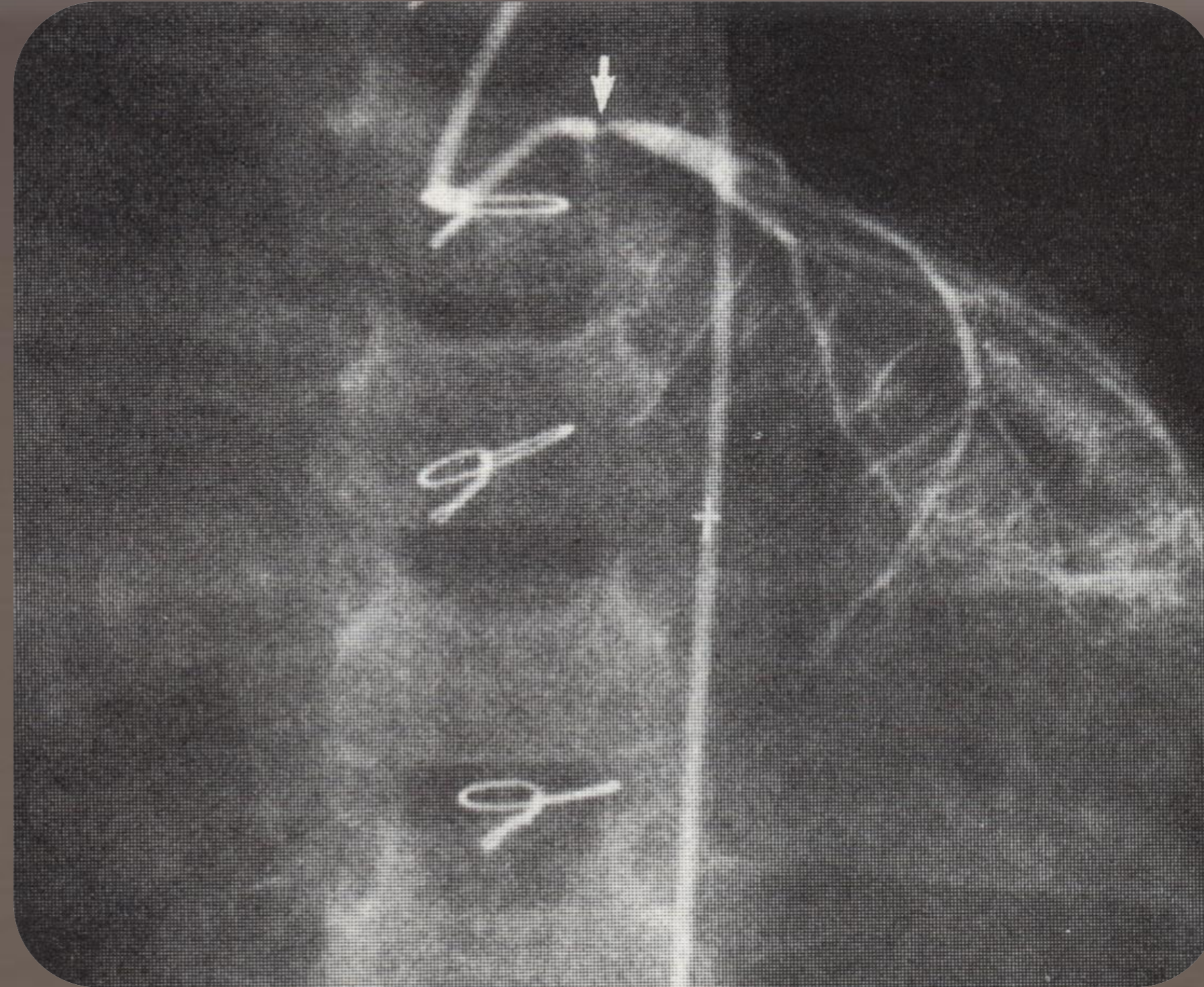
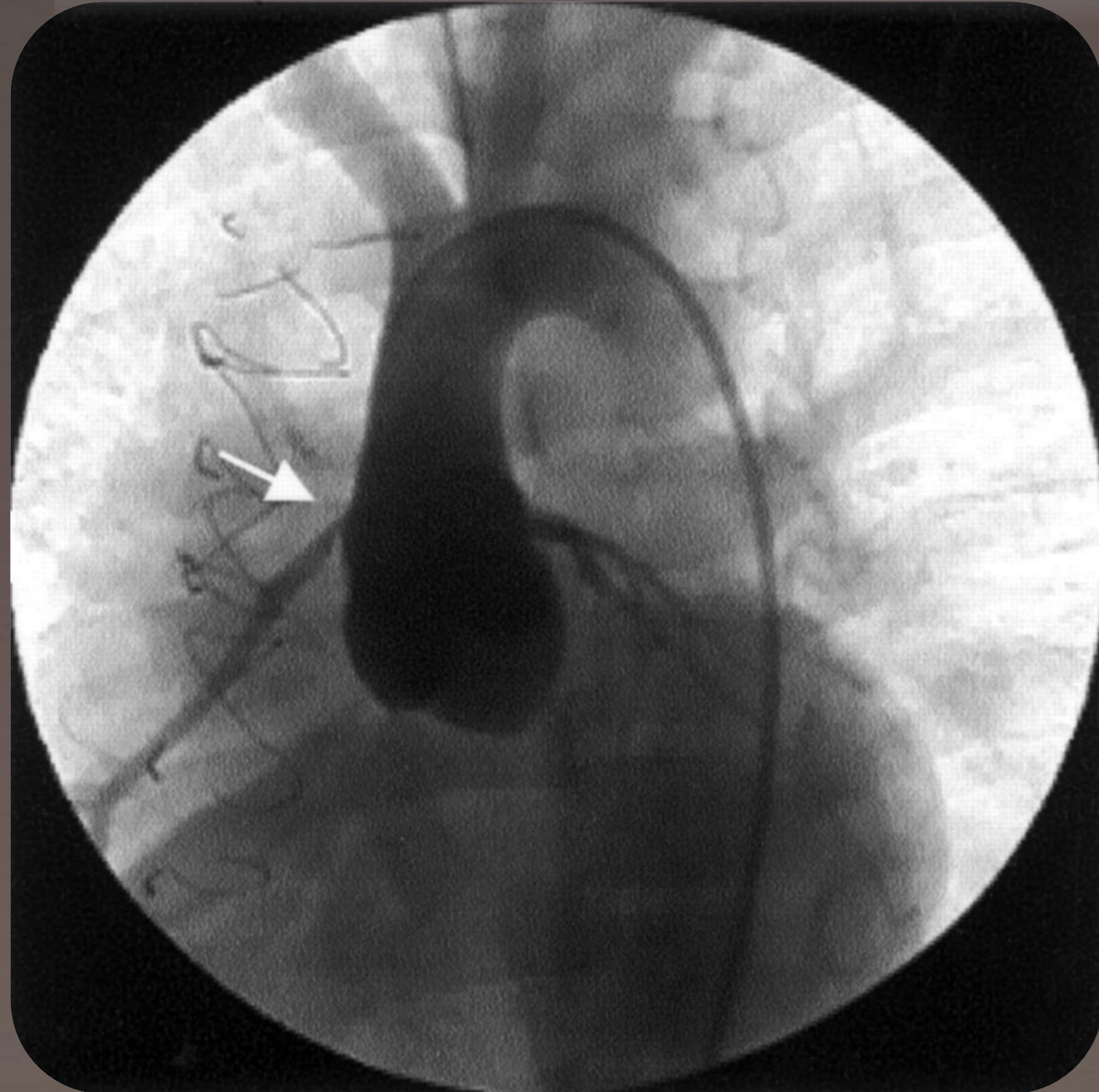


Am J Cardiol. 1995 Jul 15;76(3):153-7.

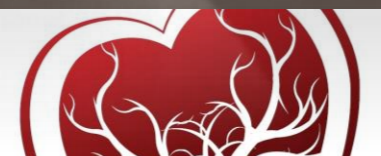
Coronary artery abnormalities detected at cardiac catheterization following the arterial switch operation for transposition of the great arteries.

Tanel RE¹, Wernovsky G, Landzberg MJ, Perry SB, Burke RP.

Tanel RE, Wernovsky G, Landzberg MJ, Perry SB, Burke RP.



n=363; ALL asymptomatic
3% with occlusion or stenosis



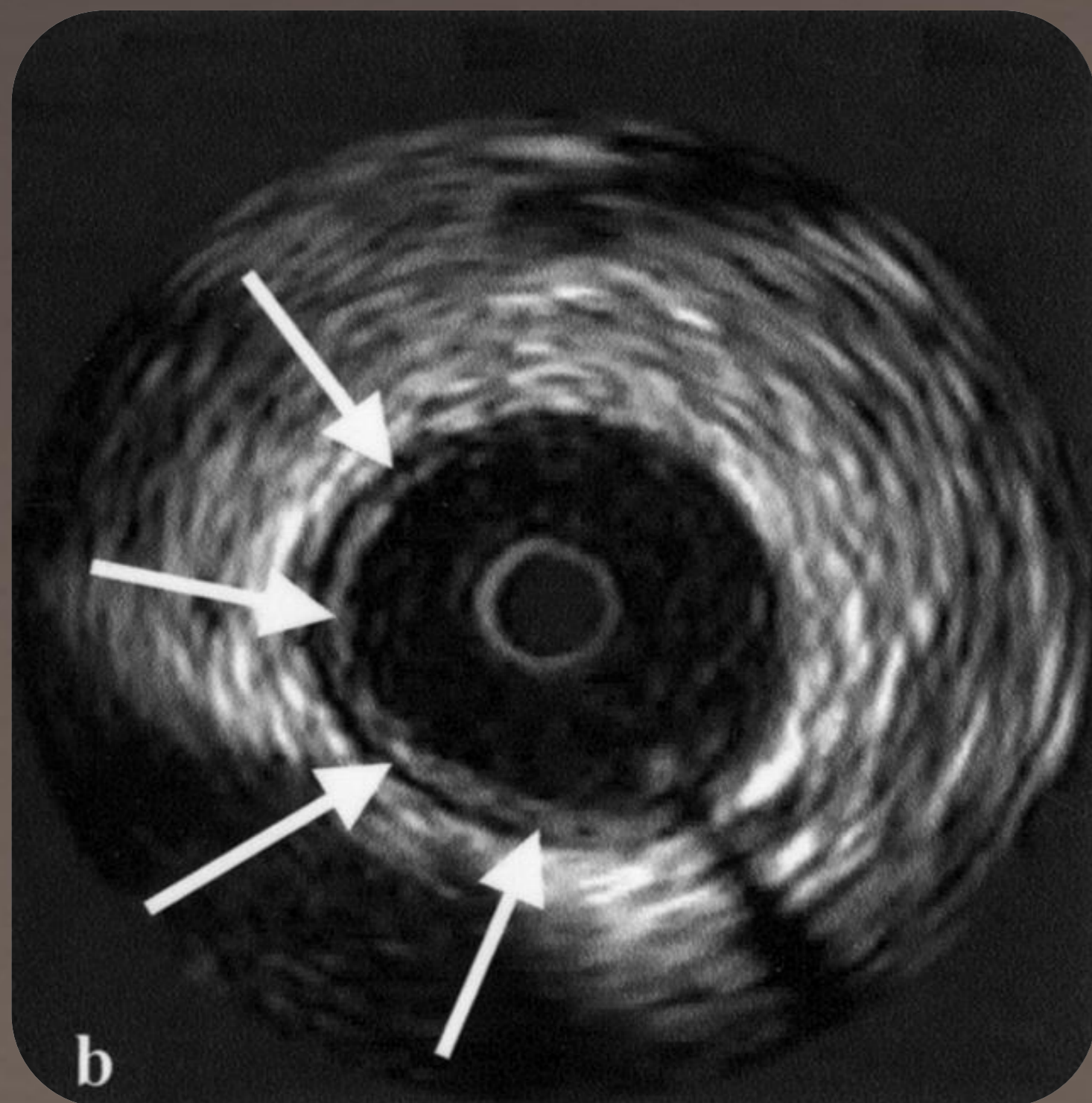
Congenital Heart Disease

Intracoronary Ultrasound Assessment Late After the Arterial Switch Operation for Transposition of the Great Arteries

Simone R. F. F. Pedra, MD, Carlos A. C. Pedra, MD, Alexandre A. Abizaid, MD, Sérgio L. N. Braga, MD, Rodolfo Staico, MD, Raul Arrieta, MD, J. Ribamar Costa, JR, MD, Vinicius D. Vaz, MD, Valmir F. Fontes, MD, J. Eduardo R. Sousa, MD

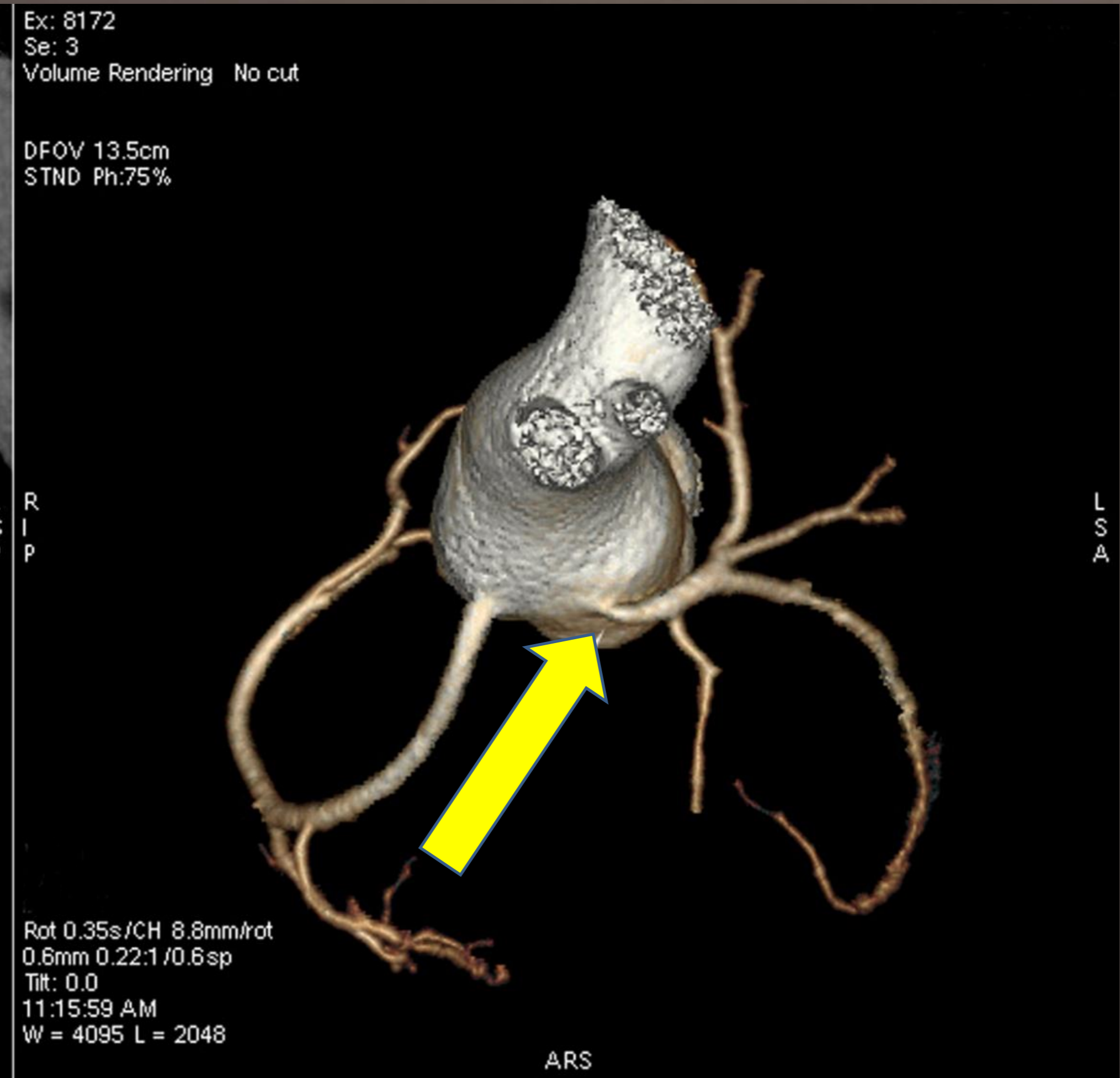
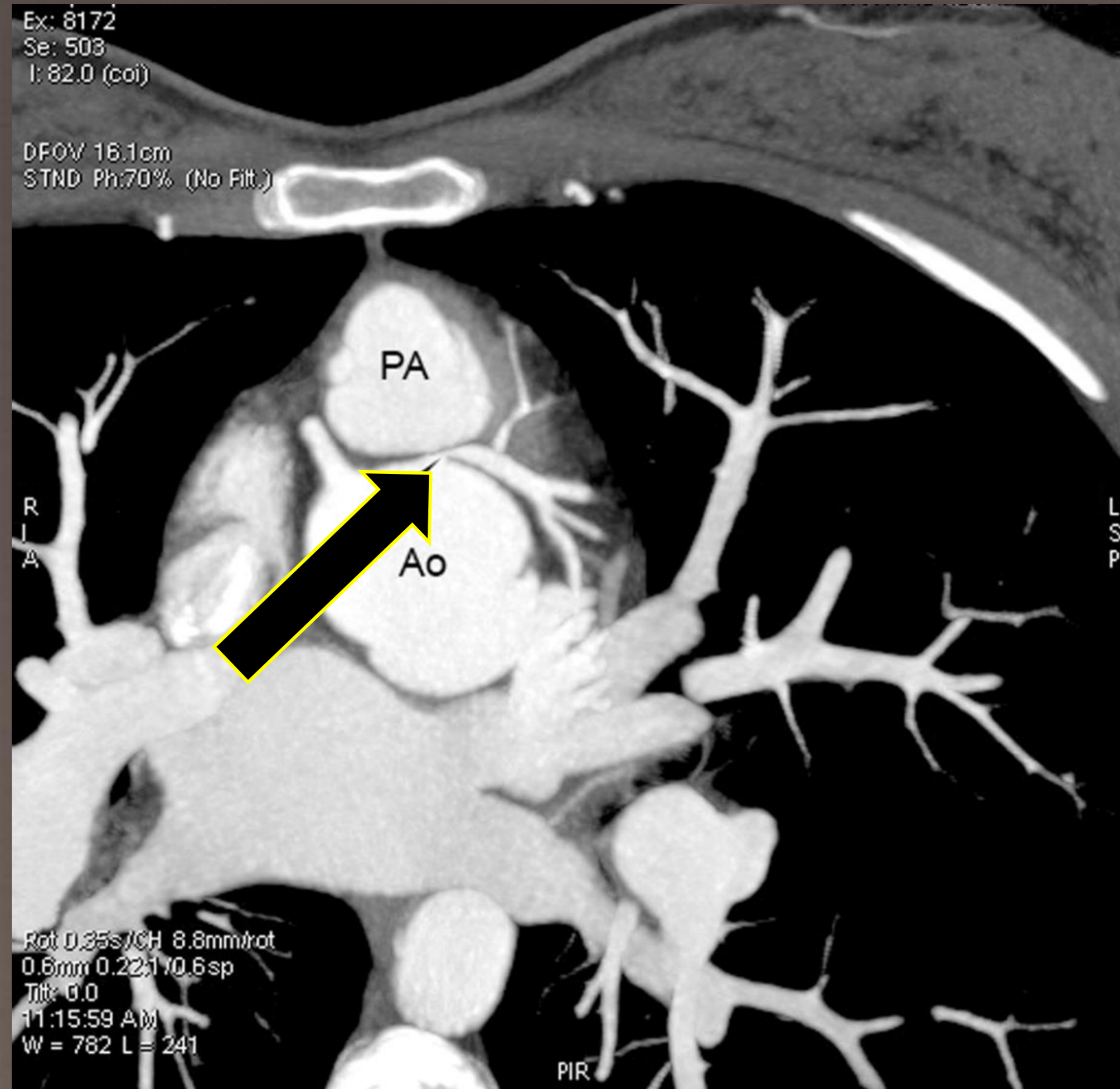
São Paulo, Brazil

Intimal Proliferation



Elliptical Orifice

Ostial Compression/Kinking





R
6
5

L
6
5

No VOl
kv 100
mA Mod.
Rot 0.35s/CH 8.0mm/rot
0.6mm 0.2:1 /0.6sp
Tilt: 0.0
08:45:42 AM
W = 4095 L = 2048

1111





ORIGINAL ARTICLE

Usefulness of Routine Coronary CT Angiography in Patients with Transposition of the Great Arteries After an Arterial Switch Operation

Konrad Szymczyk¹ · Maciej Moll² · Katarzyna Sobczak-Budlewska³ ·
Jadwiga A. Moll³ · Ludomir Stefańczyk¹ · Piotr Grzelak⁴ · Jacek J. Moll² ·
Krzysztof W. Michalak³

Łódź, Poland

Кrzysztof W. Michalak³

Jadwiga A. Moll³ · Ludomir Stefańczyk¹ · Piotr Grzelak⁴ · Jacek J. Moll² ·

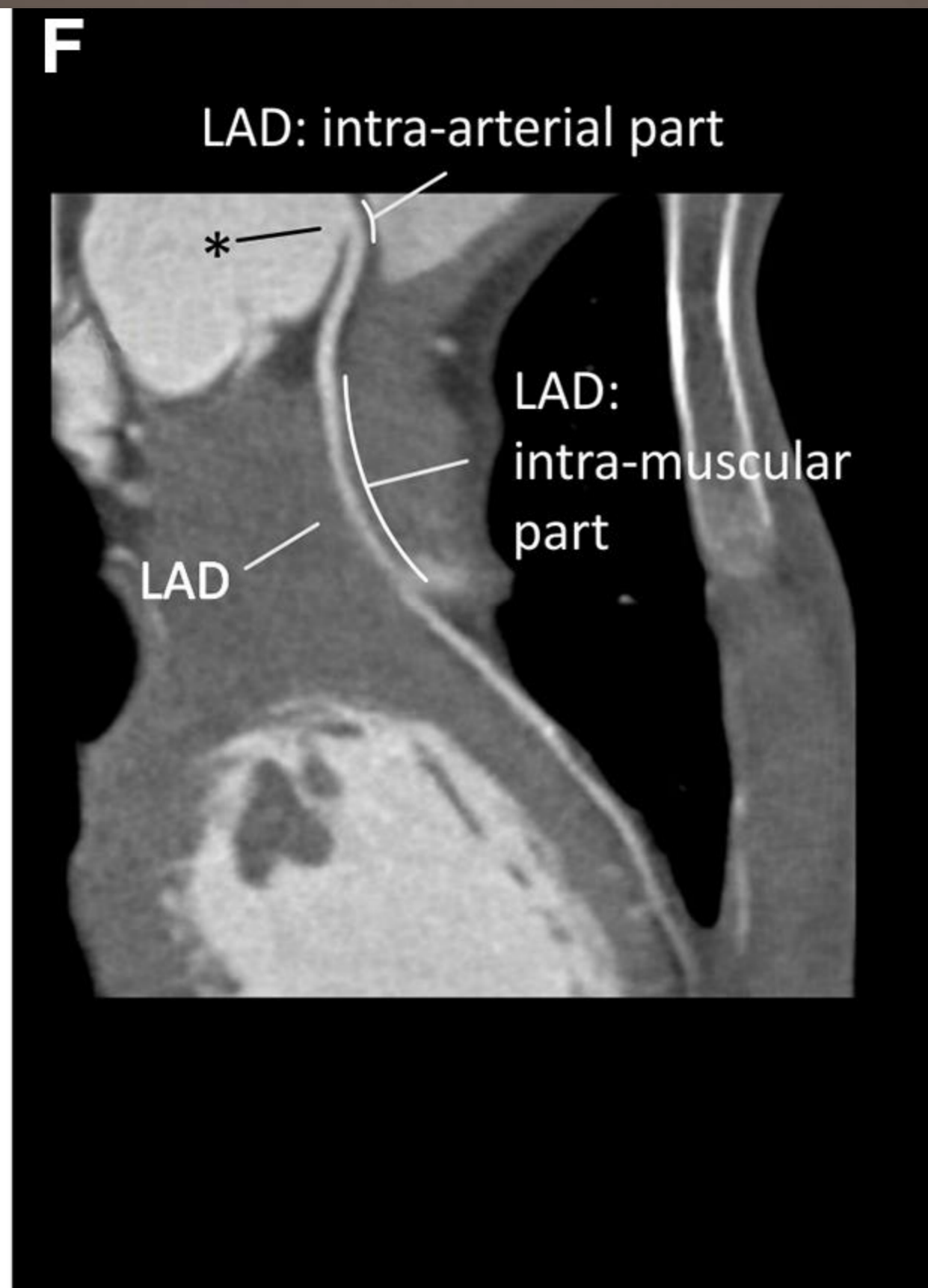
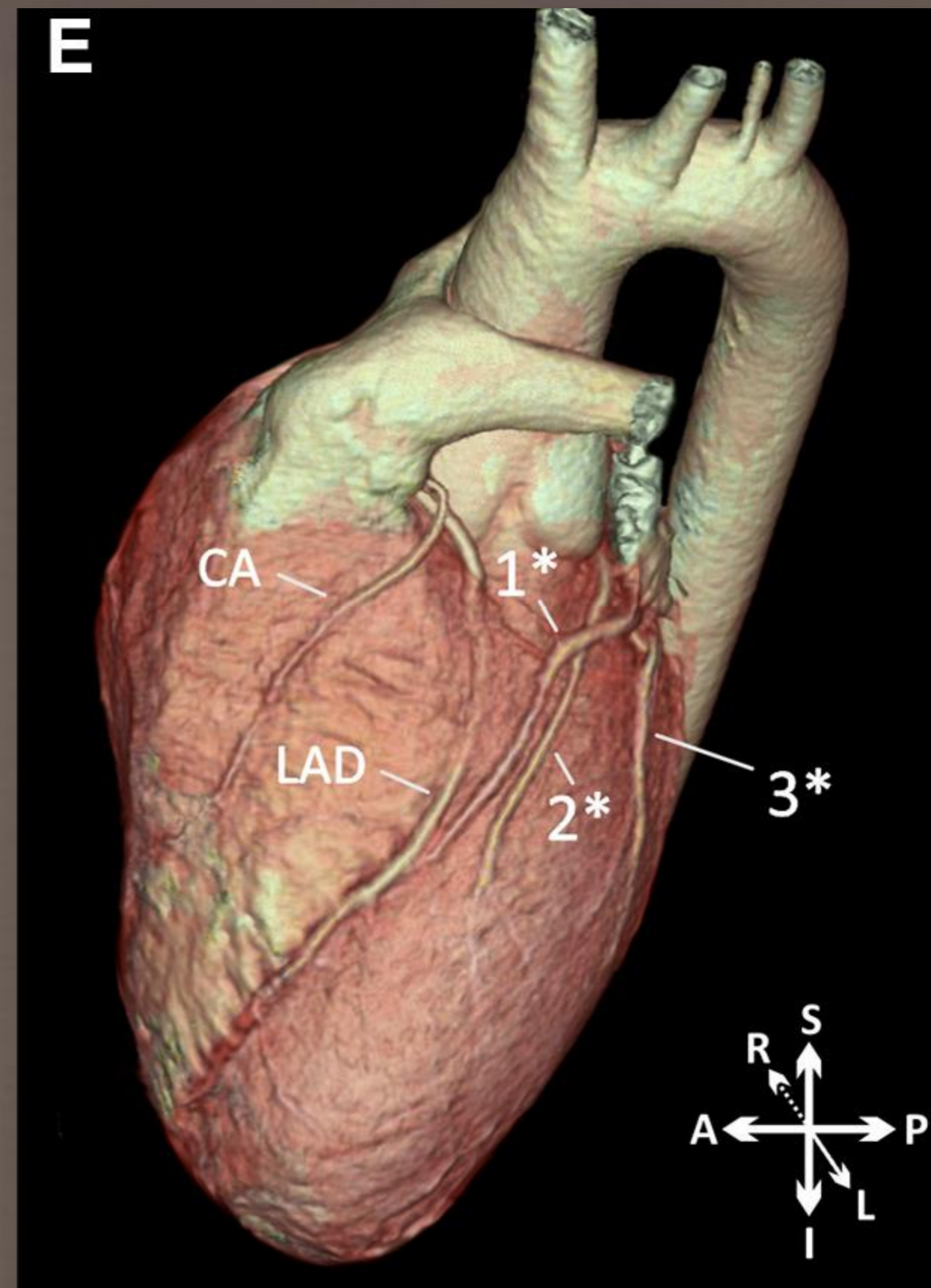
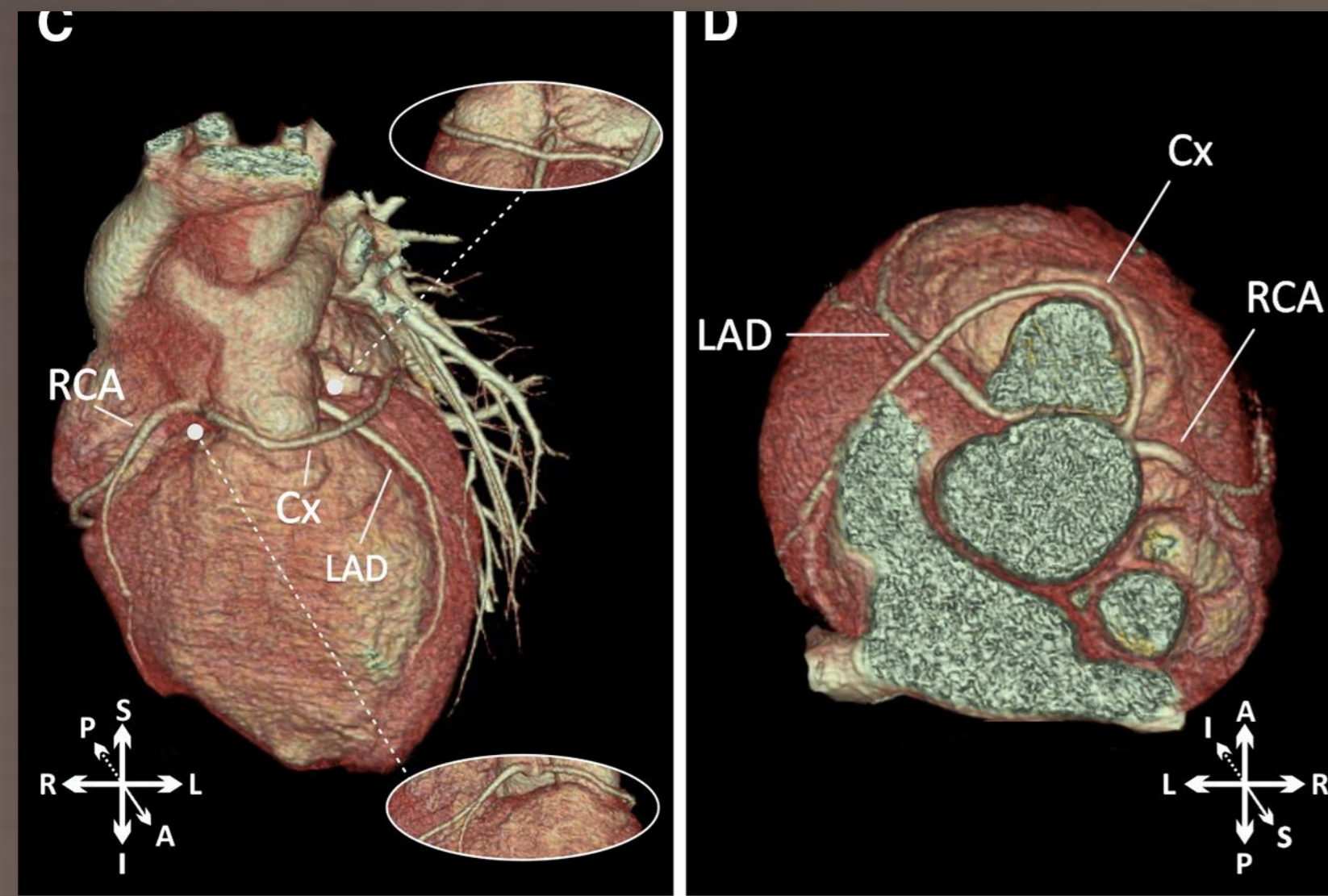
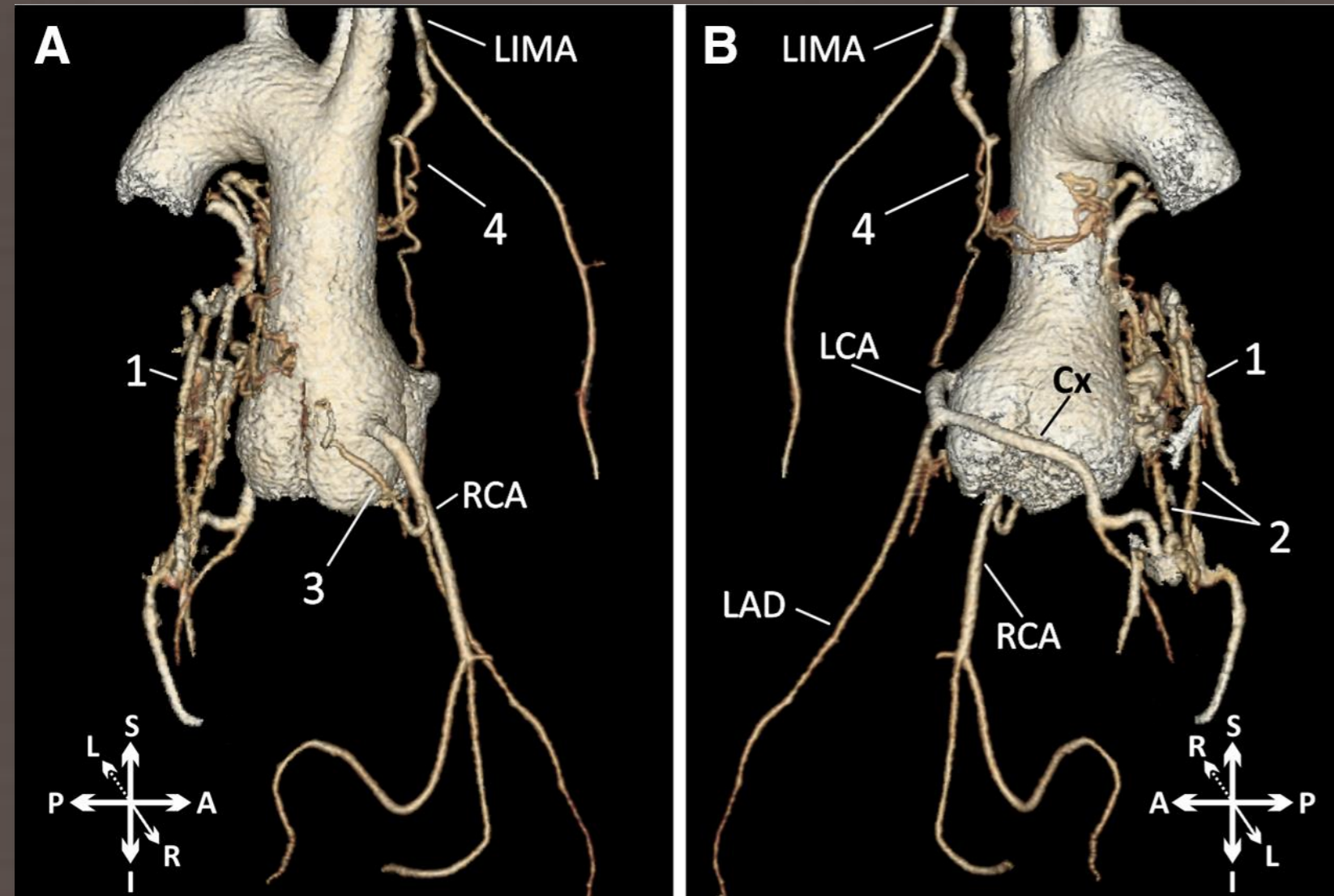
Konrad Szymczyk¹ · Maciej Moll² · Katarzyna Sobczak-Budlewska³ ·



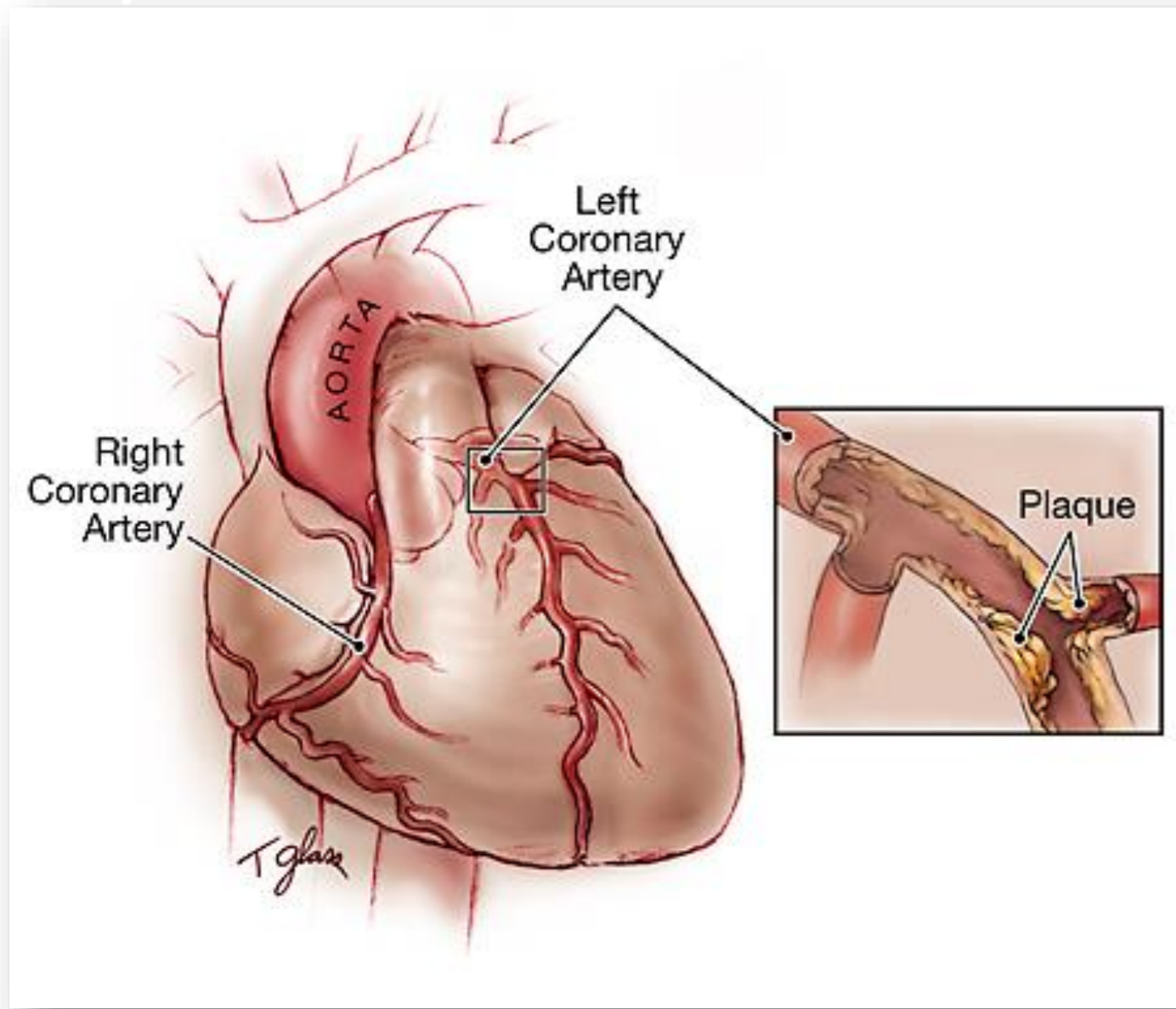
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Krzysztof W. Michalak³

Łódź, Poland

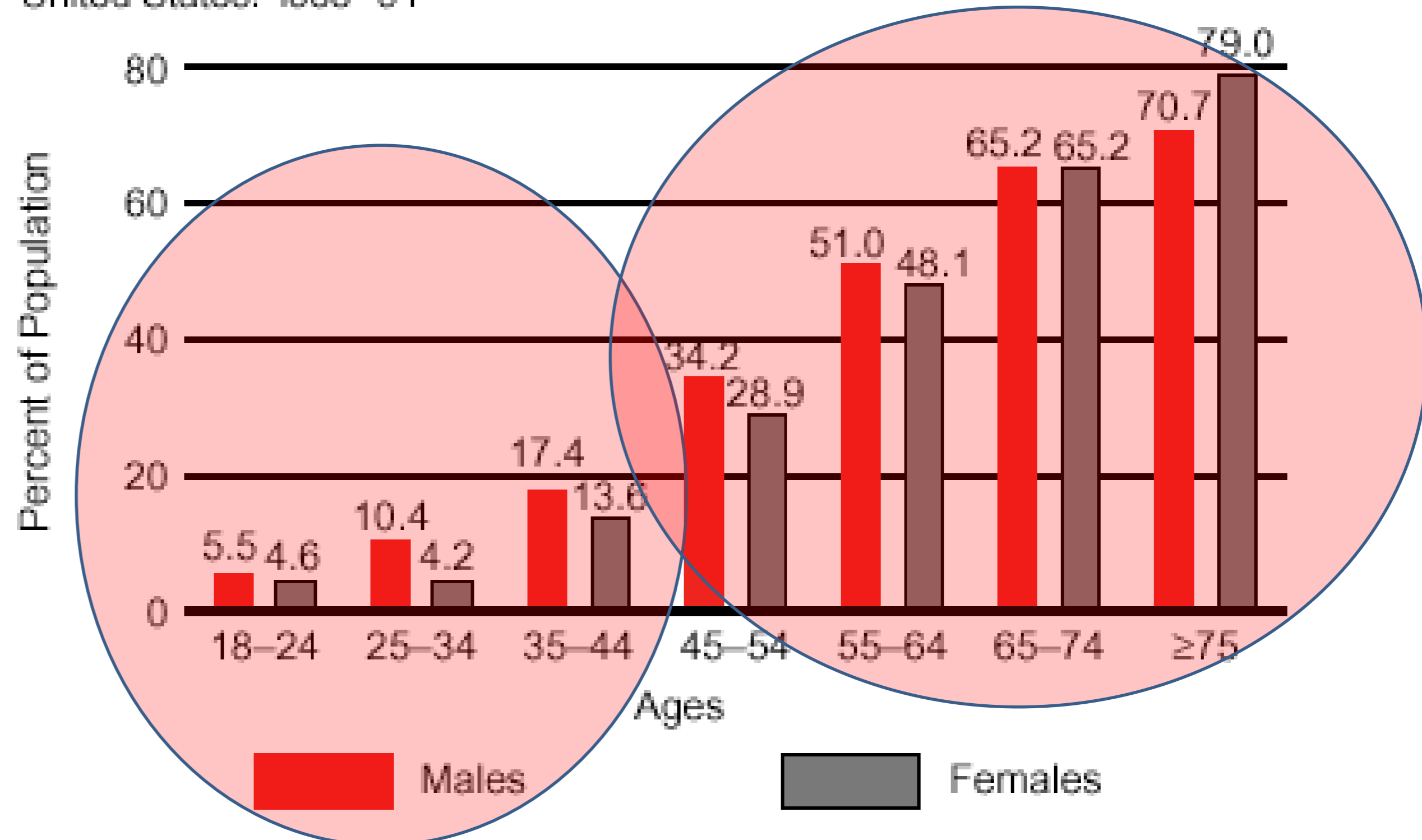


Coronary Artery Disease in Adults

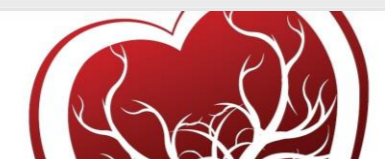
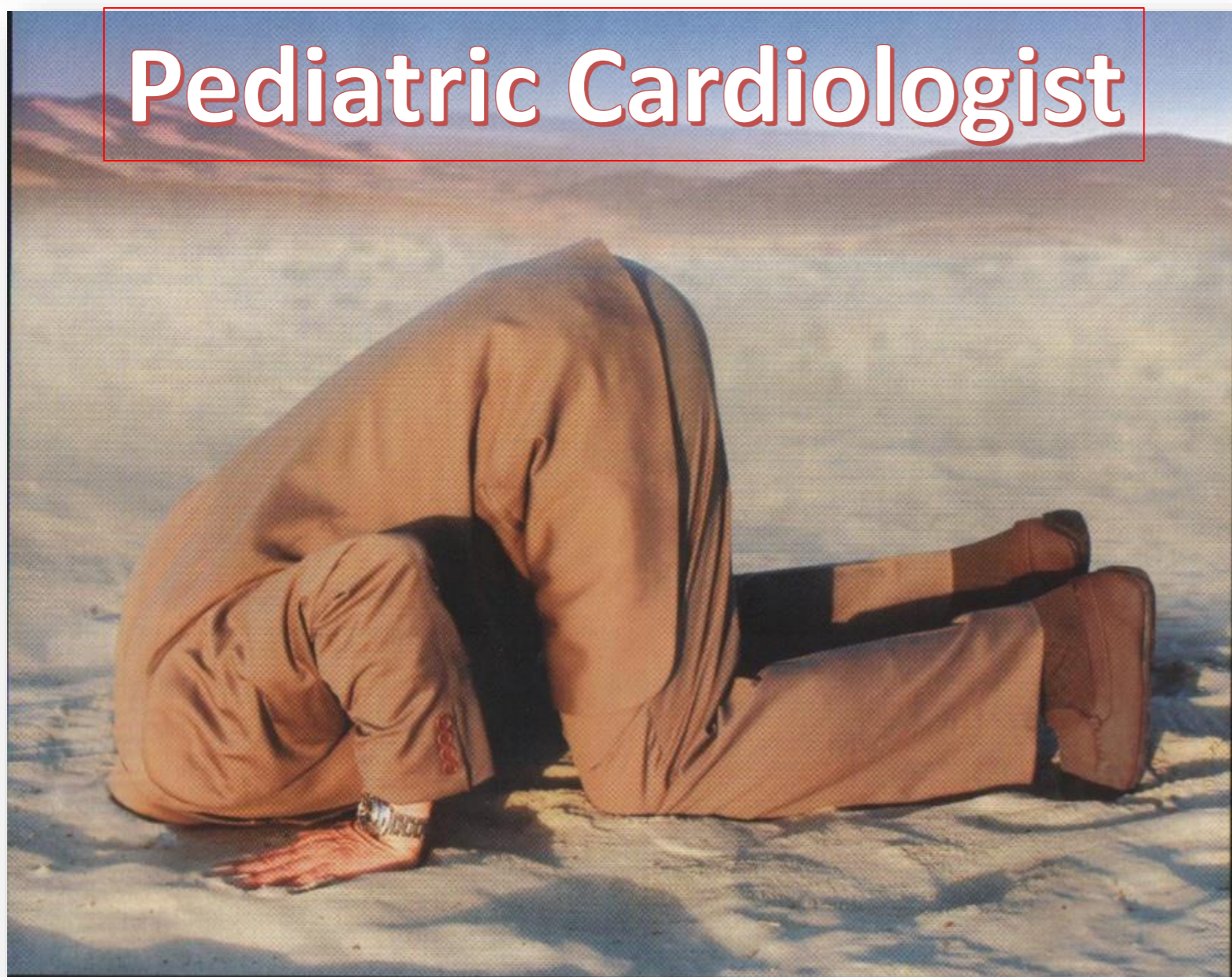


Estimated Prevalence of Cardiovascular Diseases by Age and Sex

United States: 1988–94



Source: National Health and Nutrition Examination Survey III (NHANES III), 1988–94, CDC/NCHS and the American Heart Association.



As Good As it Gets?

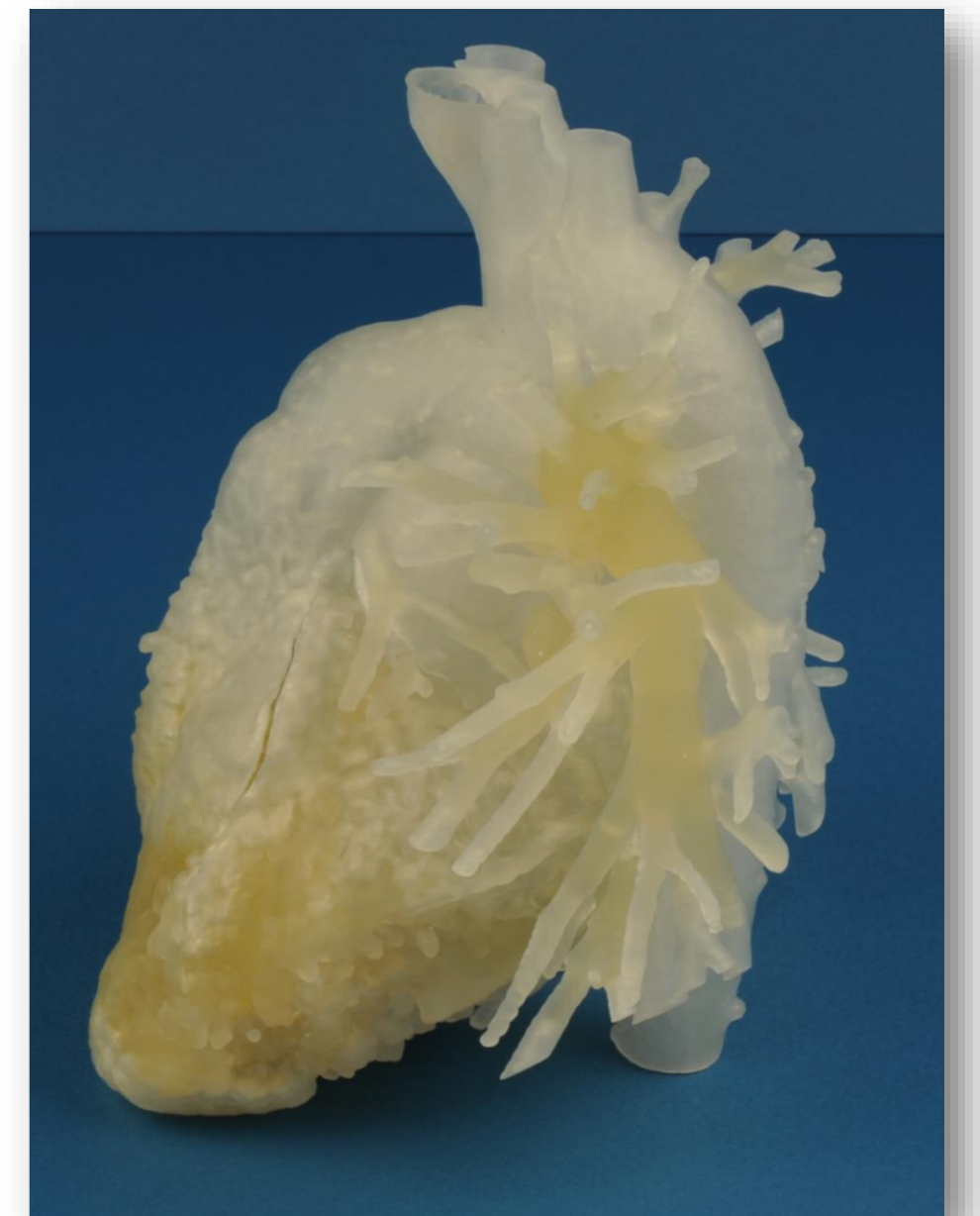
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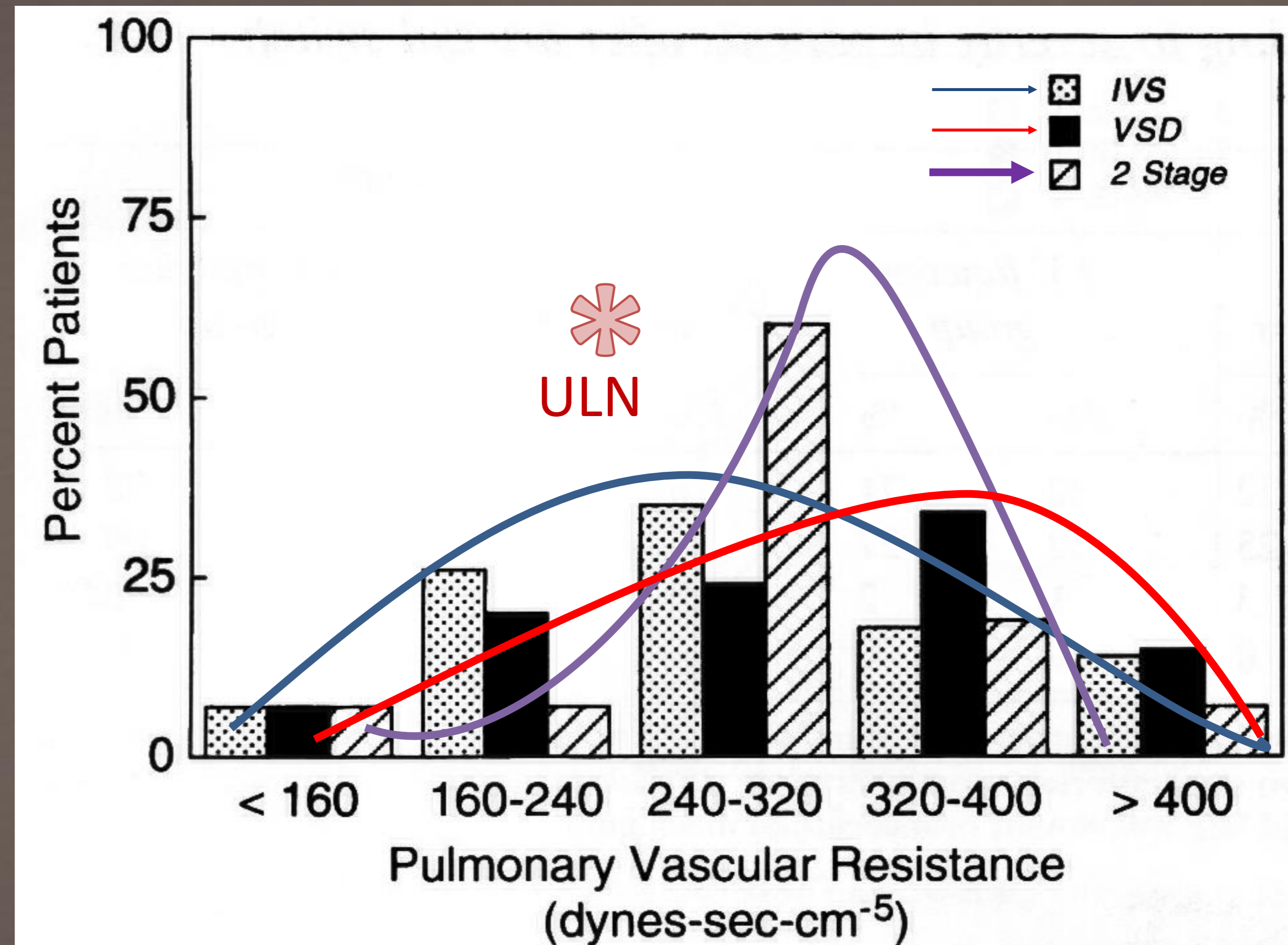
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- Elevated Pulmonary Vascular Resistance
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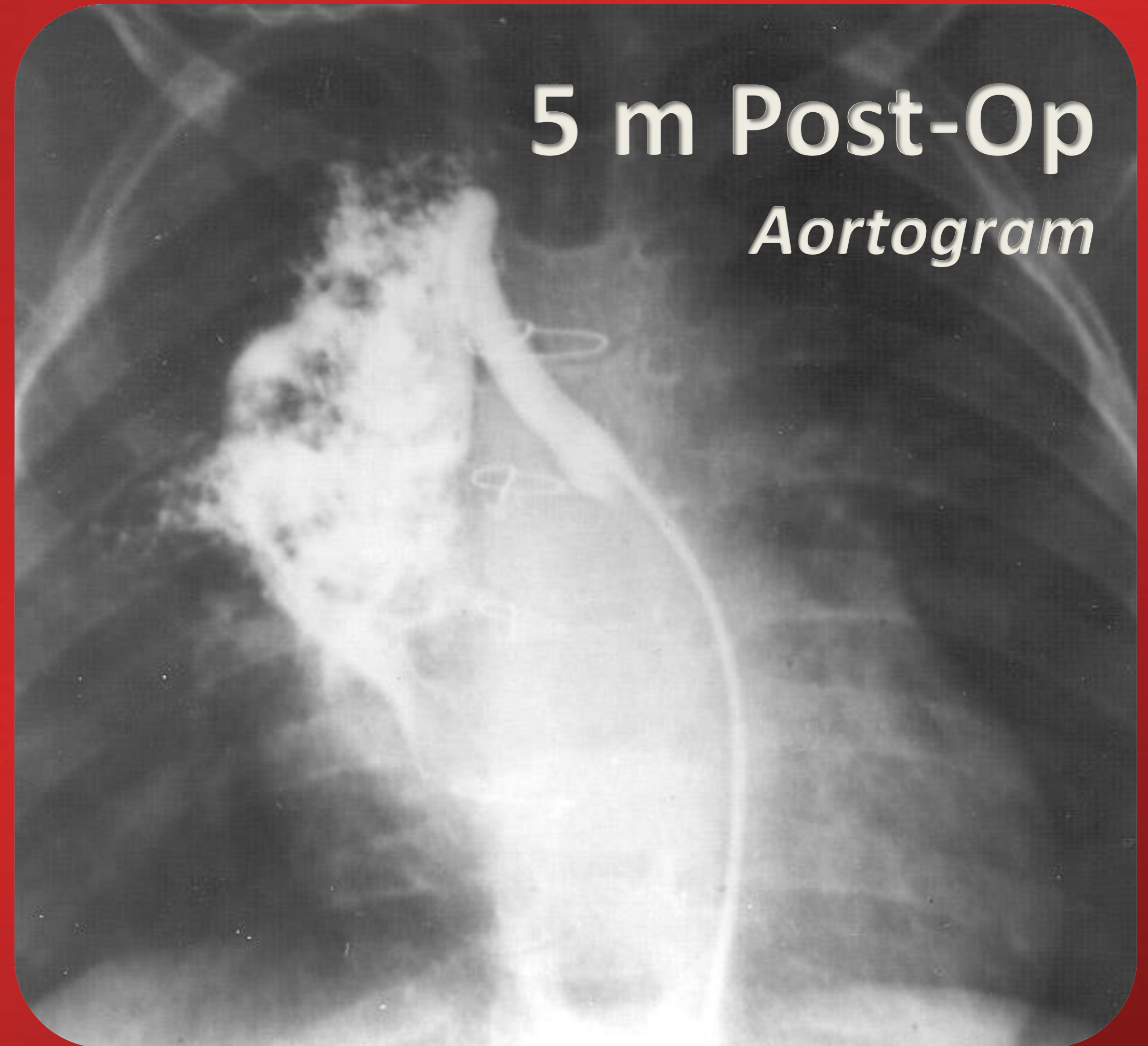
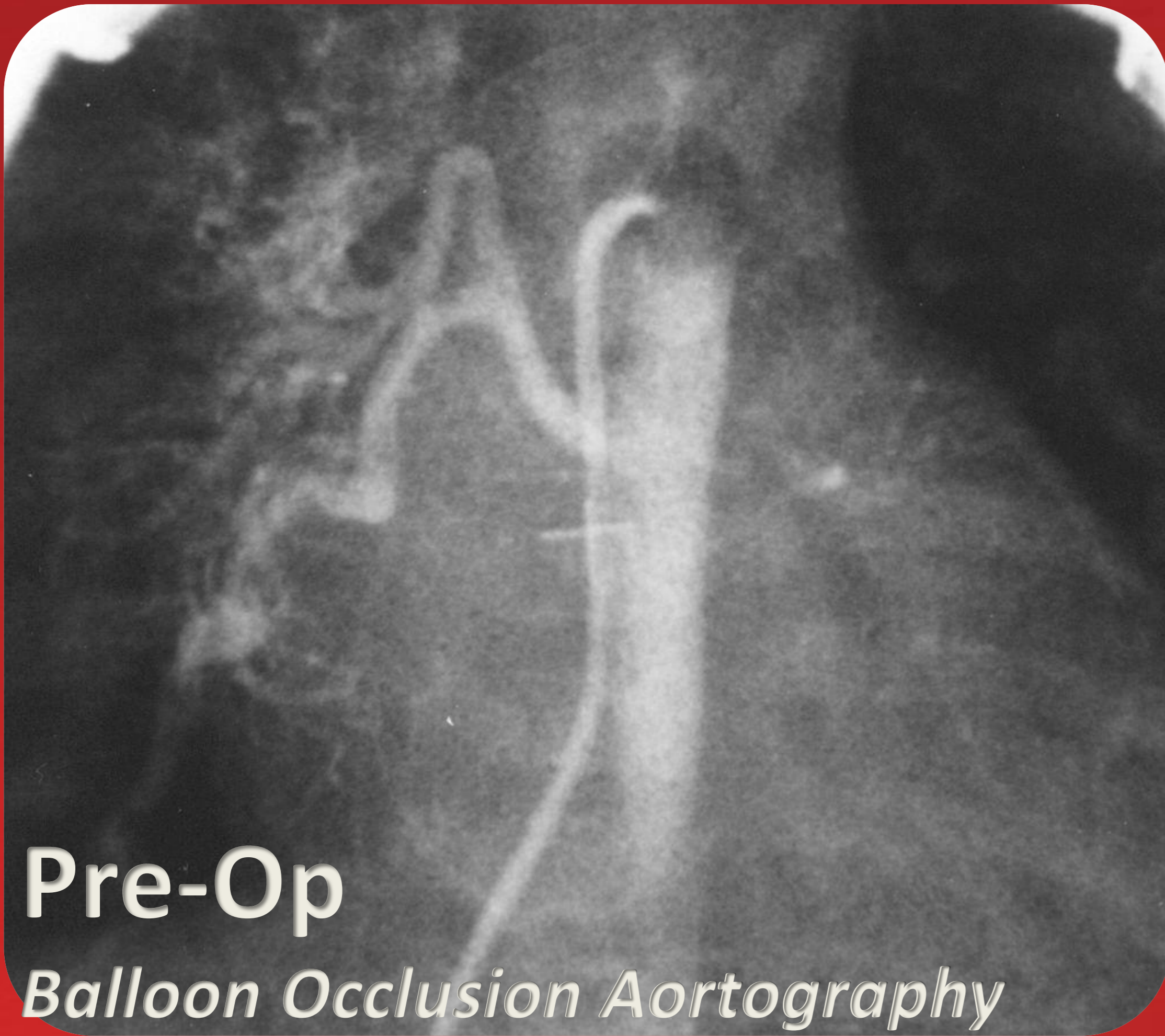


Status of the left ventricle after arterial switch operation for transposition of the great arteries. Hemodynamic and echocardiographic evaluation.

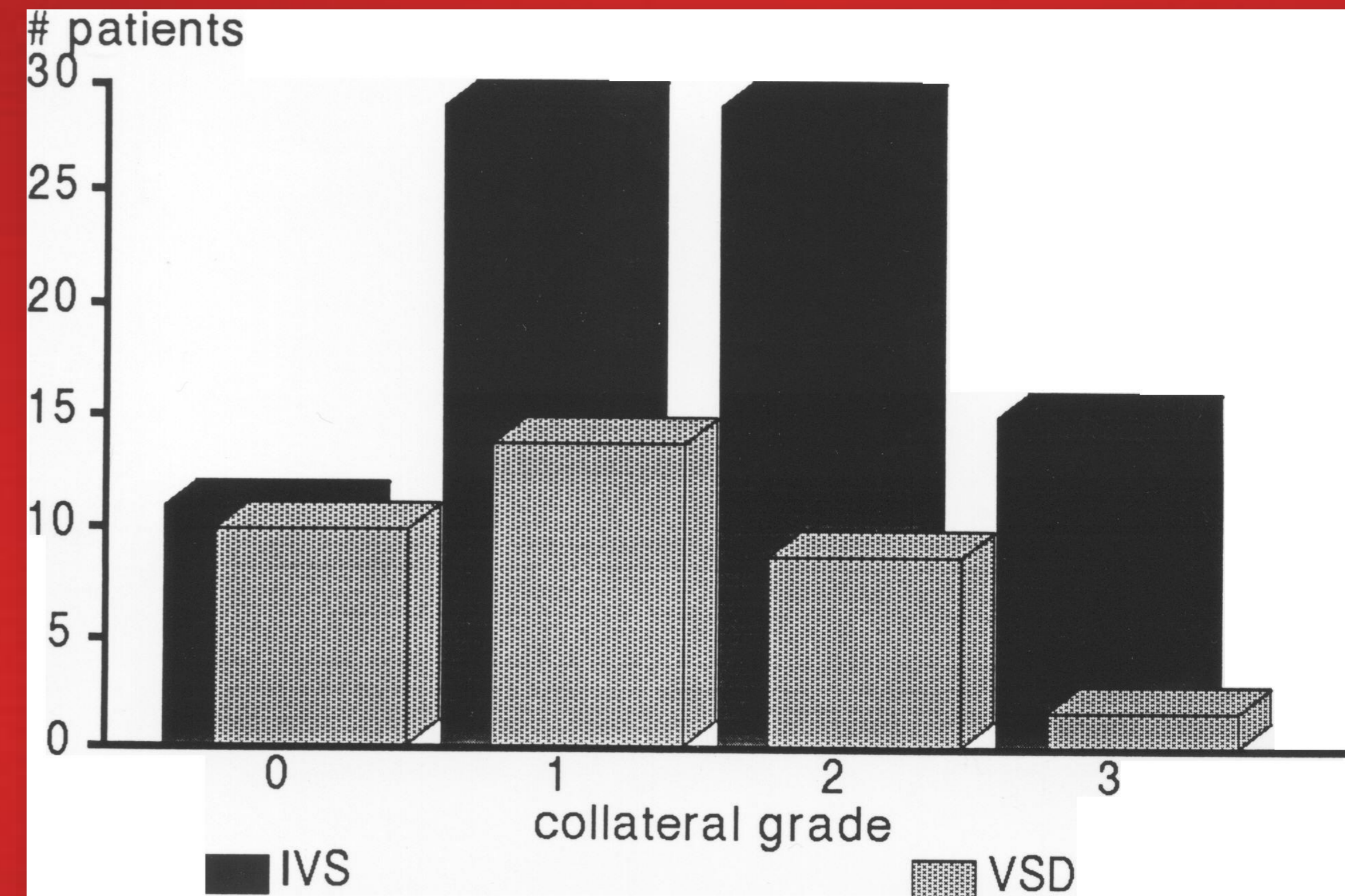
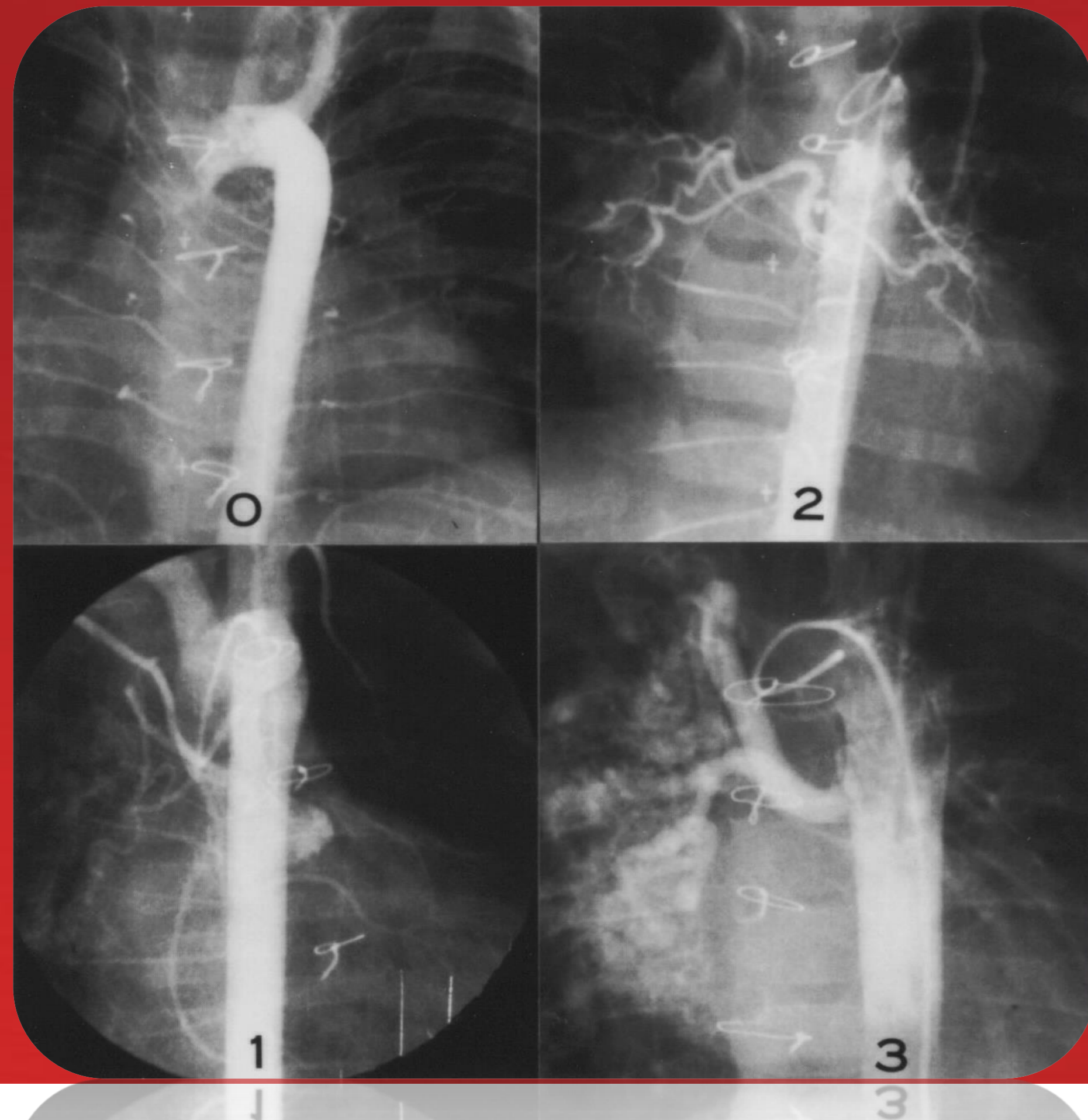
Colan SD¹, Boutin C, Castañeda AR, Wernovsky G.

Cath n = 330; 1.6 years postop
↑ Pulmonary Vascular Resistance in Many





Accessory Pulmonary Blood Flow: Bronchial Collaterals



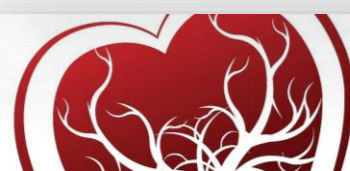
JACC Vol. 21, No. 2
February 1993:465-70

465

Enlarged Bronchial Arteries After Early Repair of Transposition of the Great Arteries

GIL WERNOVSKY, MD, FACC, NANCY D. BRIDGES, MD, VALERIE S. MANDELL, MD,
ALDO R. CASTAÑEDA, MD, FACC, STANTON B. PERRY, MD

Boston, Massachusetts



Accessory Pulmonary Blood Flow: Bronchial Collaterals

Int J Cardiol. 2018 May 1;258:237-242. doi: 10.1016/j.ijcard.2018.01.132. Epub 2018 Feb 2.

Aortopulmonary collaterals in neonates with d-transposition of the great arteries - Clinical significance early after arterial switch operation.

Wipf A¹, Christmann M², Navarini-Meury S¹, Dave H³, Quandt D¹, Knirsch W¹, Kretschmar O¹.

Zurich, Switzerland

- 15/98 patients underwent coil embolization
- Associated with longer LOS at index surgery
- Associated with lower preoperative saturation



Exercise Capacity is Reduced Secondary to Pulmonary Function Abnormalities And (mild) Chronotropic Impairment

Table 5. Exercise capacity of patients compared with references

	References	TGA all	P*	TGA/IVS	TGA/VSD	P**
Max. exercise capacity (watts)	120 ± 30 (70-180)	102 ± 33 (60-160)	0.02	97 ± 32 (60-160)	113 ± 35 (75-160)	0.2
Max. oxygen uptake (ml/min/kg)	48 ± 8 (29-60)	41 ± 8.3 (25-57)	< 0.01	42 ± 7.8 (28-57)	39 ± 9.6 (25-53)	0.3
Respiratory quotient	1.18 ± 0.08 (1.02-1.36)	1.20 ± 0.08 (1.05-1.43)	0.5	1.20 ± 0.09 (1.05-1.43)	1.18 ± 0.08 (1.05-1.32)	0.5
Peak heart rate (bpm)	186 ± 9 (165-209)	177 ± 12 (153-200)	<0.01	177 ± 11 (153-197)	176 ± 14 (153-200)	0.9

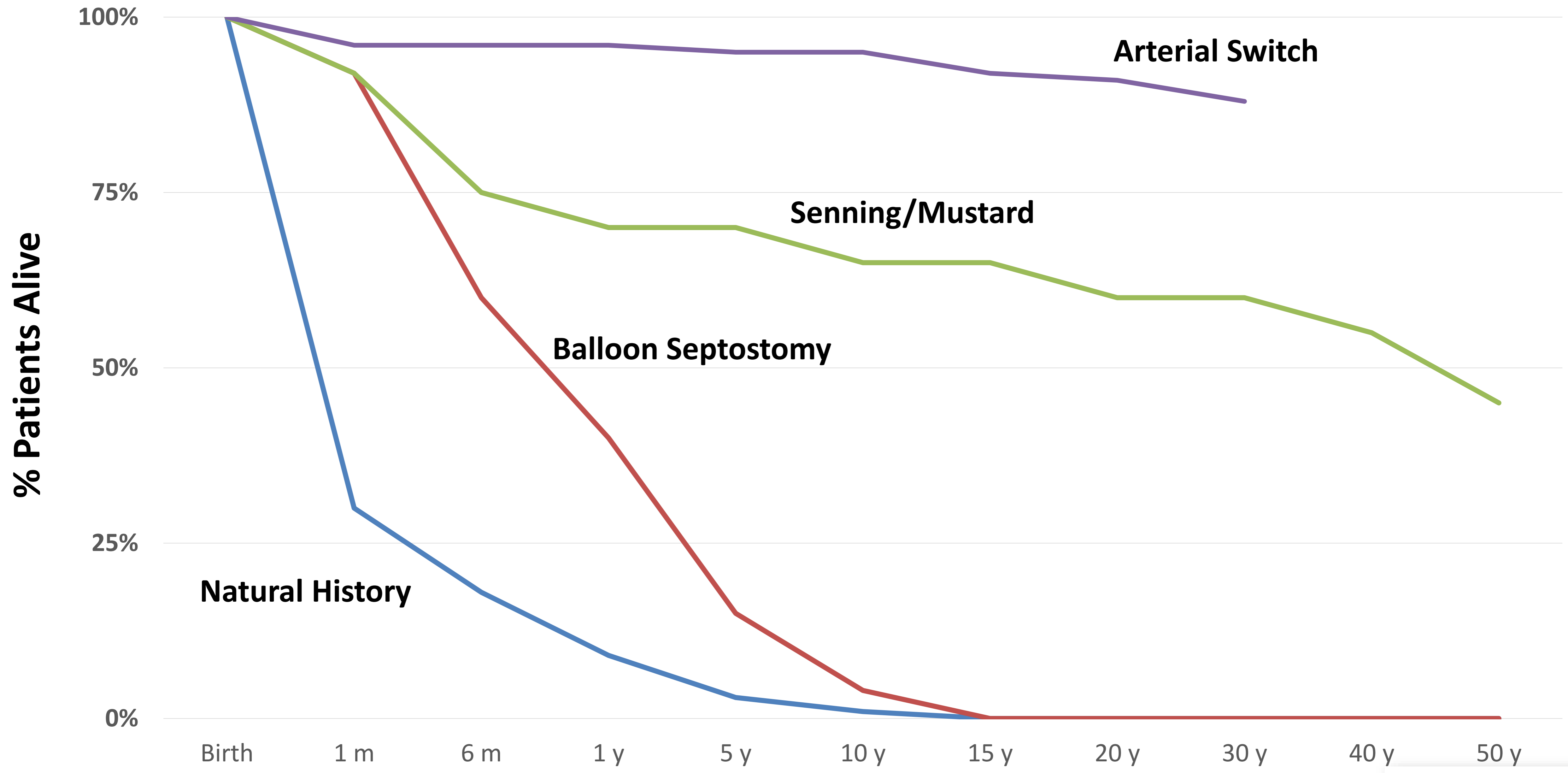
* TGA all vs. References

** TGA/IVS vs. TGA/VSD

Eur J Pediatr. 2008 Sep;167(9):995-1004. Epub 2007 Nov 7.

Follow-up outcomes 10 years after arterial switch operation for transposition of the great arteries: comparison of cardiological health status and health-related quality of life to those of the a normal reference population.

de Koning WB¹, van Osch-Gevers M, Ten Harkel AD, van Domburg RT, Spijkerboer AW, Utens EM, Bogers AJ, Helbing WA.



The Arterial Switch IS "As Good As It Gets"

- But -

It is NOT a Cure

Great Vessels

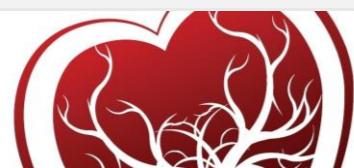
Coronary Arteries

Neo-Aortic Root

Pulmonary Abnormalities (Function, Vascular Bed)

NeuroDevelopmental Abnormalities

"Only" 40 Years Old



The Arterial Switch IS "As Good As It Gets"
- But -
It is NOT a Cure

"The incidence of long term sequelae of the treatment of congenital heart disease is directly related to how thoroughly they are sought.

The challenge is to determine which of the laboratory abnormalities are of clinical relevance."

Howard Gutgesell MD

Pulmonary valve insufficiency: malignant or benign?

J Am Coll Cardiol 1992;20:174-175.



Children's National™

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*8th World Congress of
Pediatric Cardiology
and Cardiac Surgery*

SEPTEMBER 19-24, 2021

WASHINGTON D.C.



*Se celebrará
por primera vez
en los Estados Unidos*



15
PISTAS DE SUBESPECIALIDAD

WCPCCS2021.org

STS/EACTS Latin America Cardiovascular Surgery Conference

November 15-17, 2018

Hilton Cartagena | Cartagena, Colombia



gwernovsky@childrensnational.org