



Are There Indications for Atrial Switch (or Atrial Inversion Surgery) in the 21st Century?

Marcelo B. Jatene

marcelo.jatene@incor.usp.br



No disclosures

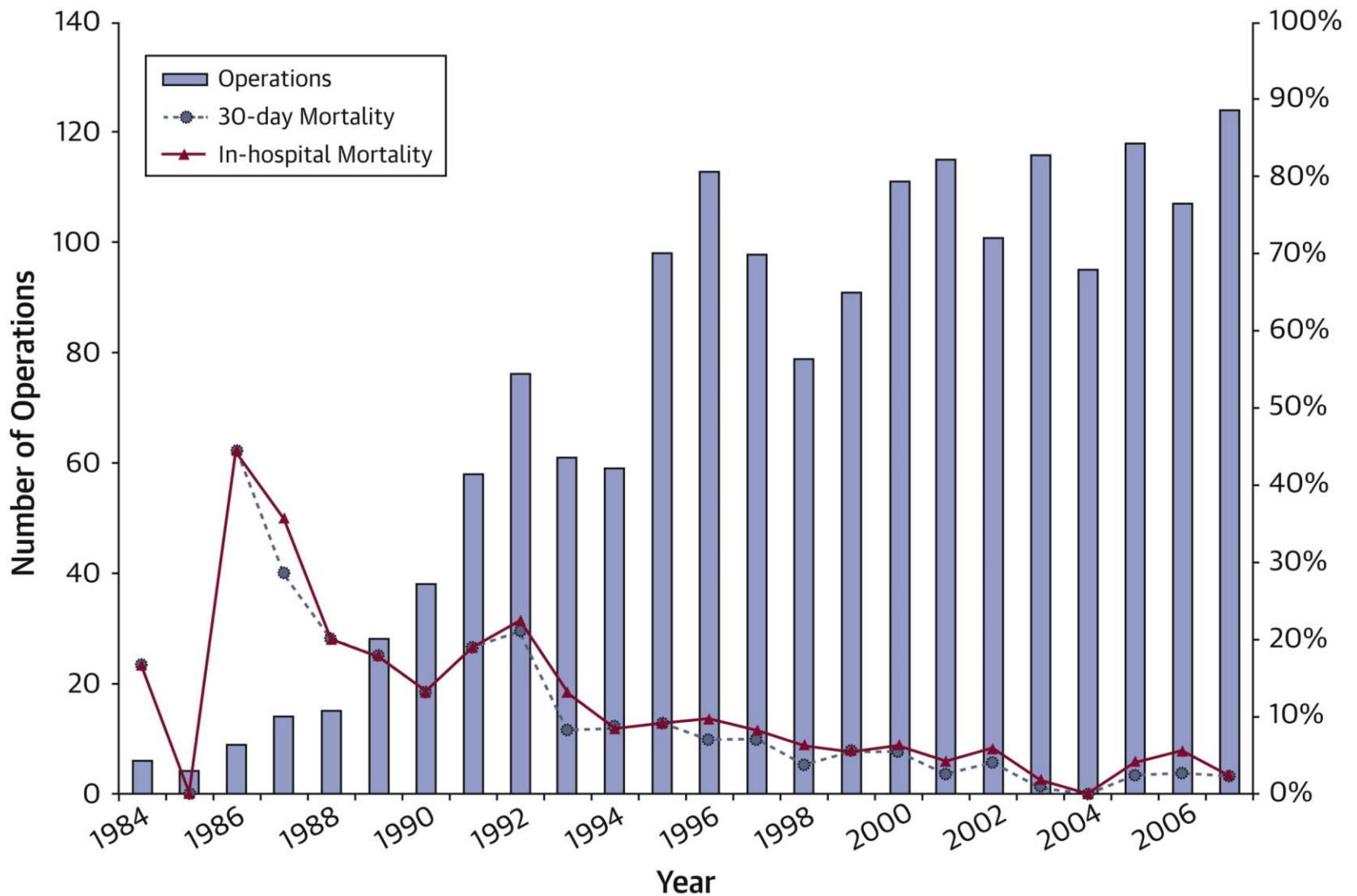
Transposition of Great Arteries in the 21st century

Few doubts about

- Total and neonatal correction is the treatment of choice !!
- Clinical and anatomic diagnosis - ECHO
- Timing of operation – first 2 weeks
- Jatene operation (ASO) – treatment of choice

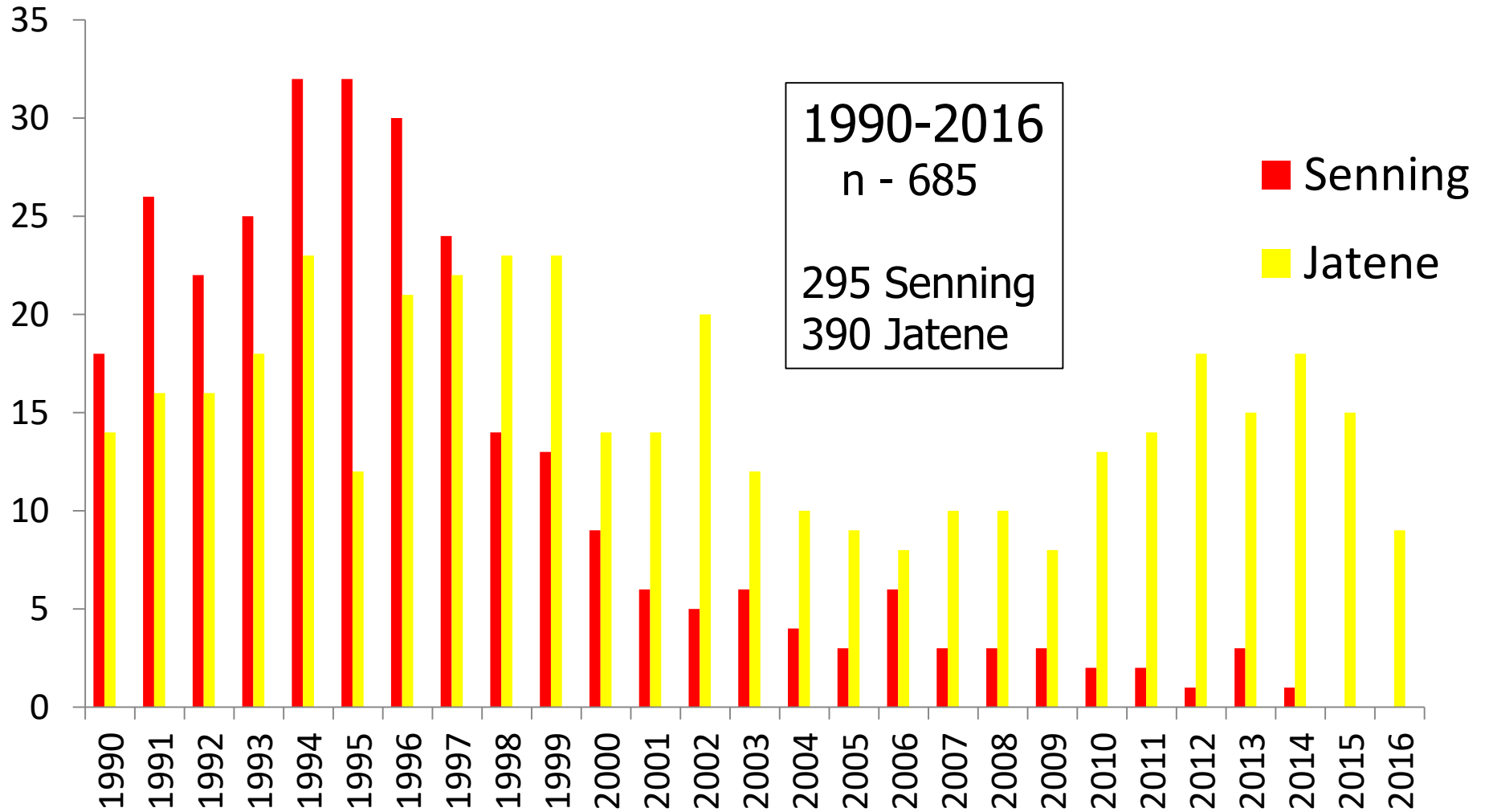
BUT

- Unfavourable anatomical, clinical, logistical and structural condition
- Other surgical option should be considered

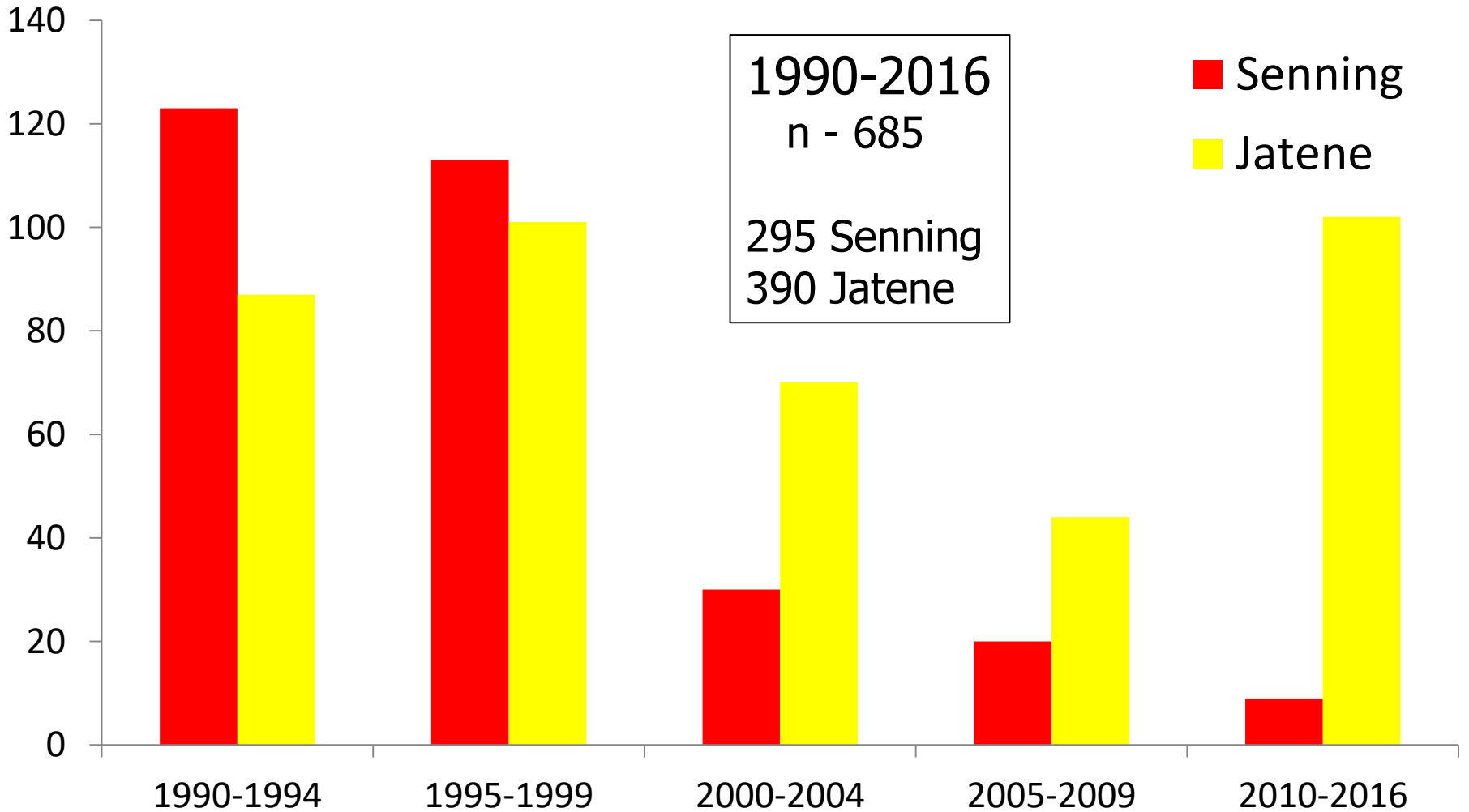


Neonatal ASO for D-TGA by Year in the PCCC Registry (1984 to 2007)

Surgical Treatment of TGA - InCor



Surgical Treatment of TGA - InCor



Dextro-Transposition of the Great Arteries

Long-term Sequelae of Atrial and Arterial Switch



Christiane Haeffele, MD, MPH^{a,*}, George K. Lui, MD^{a,b}

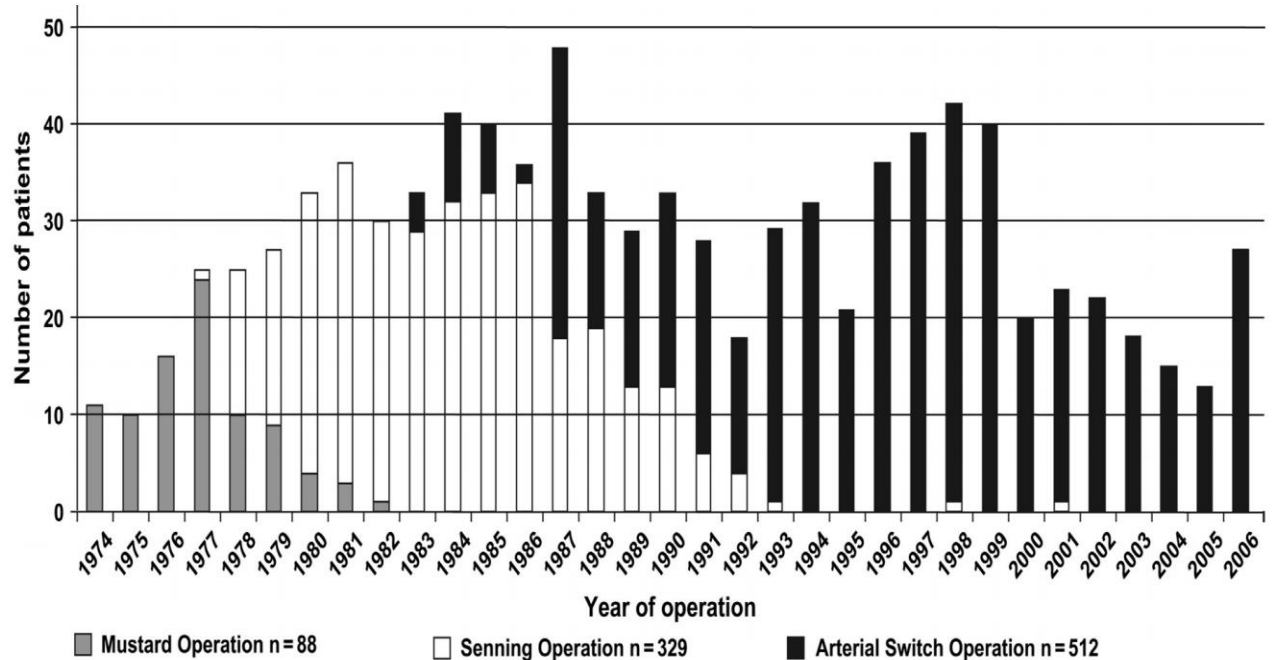
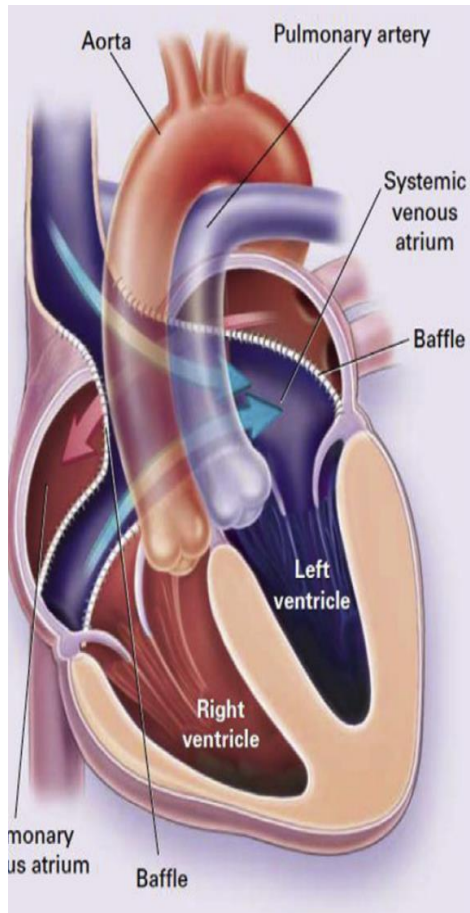


Fig. 2. Overall surgical trend from 1974 to 2006 for repair of TGA. The Mustard operation was the primary repair early on but was gradually replaced by the Senning procedure as surgical technique improved. The arterial switch had high mortality rates early on as the technique was introduced but, with experience, replaced the Senning as the operation of choice for D-TGA. (From Horer J, Schrieber C, Cleuziou J, et al. Improvement in long-term survival after hospital discharge but not in freedom from reoperation after the change from atrial to arterial switch for transposition of the great arteries. *J Thorac Cardiovasc Surg* 2009;137(2):349; with permission.)

Dextro-Transposition of the Great Arteries

Long-term Sequelae of Atrial and Arterial Switch



Christiane Haefele, MD, MPH^{a,*}, George K. Lui, MD^{a,b}

Indications for intervention on complications

Complications of Atrial Switch

Indication for Intervention

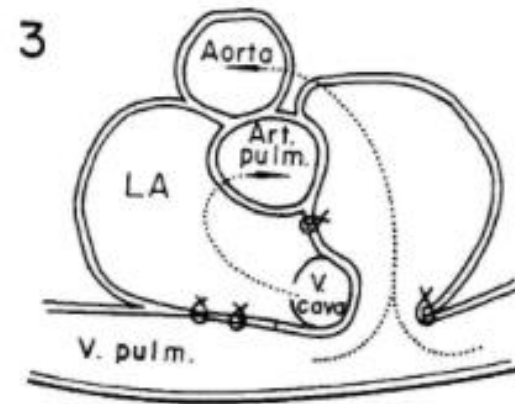
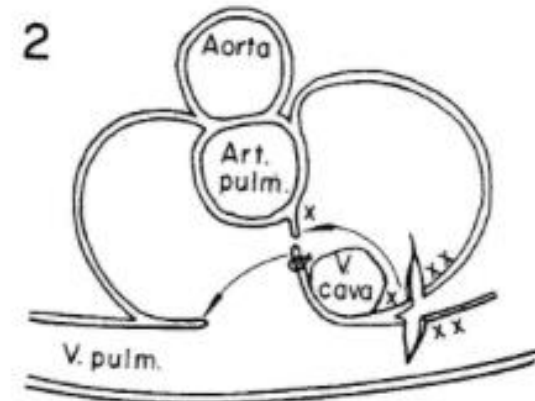
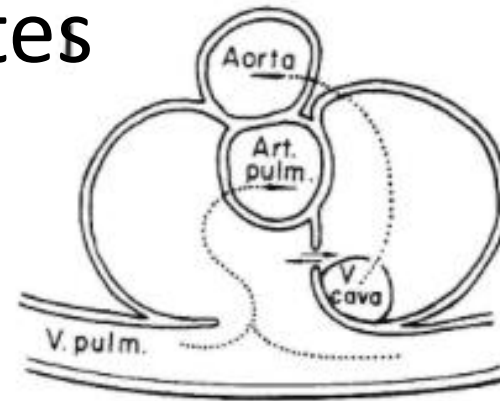
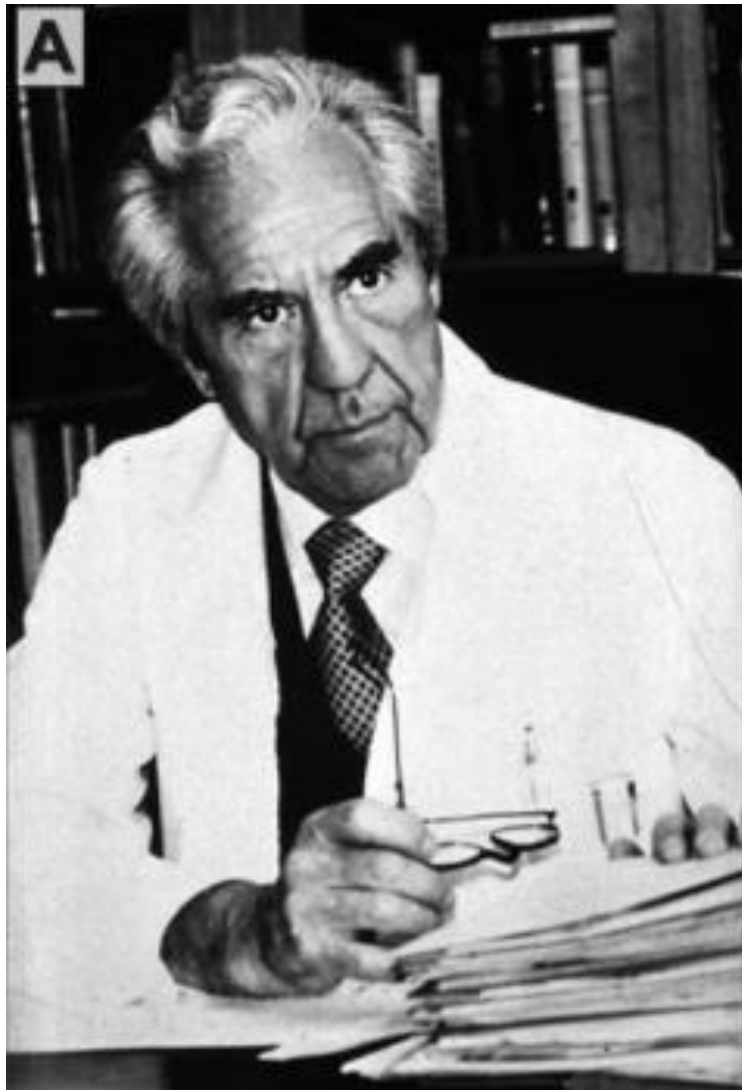
Baffle leak	<ul style="list-style-type: none"> • Left to right shunt with Qp:Qs >1.5 • Dilation of the LV (subpulmonic ventricle) • Paradoxical embolus • Pacemaker/ICD (increased risk of paradoxical embolus)
Baffle stenosis	<ul style="list-style-type: none"> • Symptoms • Pacemaker/ICD implantation and stenosis prevents placement of pacemaker leads
Atrial flutter	<ul style="list-style-type: none"> • Catheter ablation if recurrent symptomatic or drug refractory
Severe tricuspid regurgitation	<ul style="list-style-type: none"> • Primary tricuspid valve disease • PA band can be considered as bridge to transplantation
Failing RV	<ul style="list-style-type: none"> • Heart transplant • PA band • Atrial switch takedown and ASO

Complications of Arterial Switch

Indication for Intervention

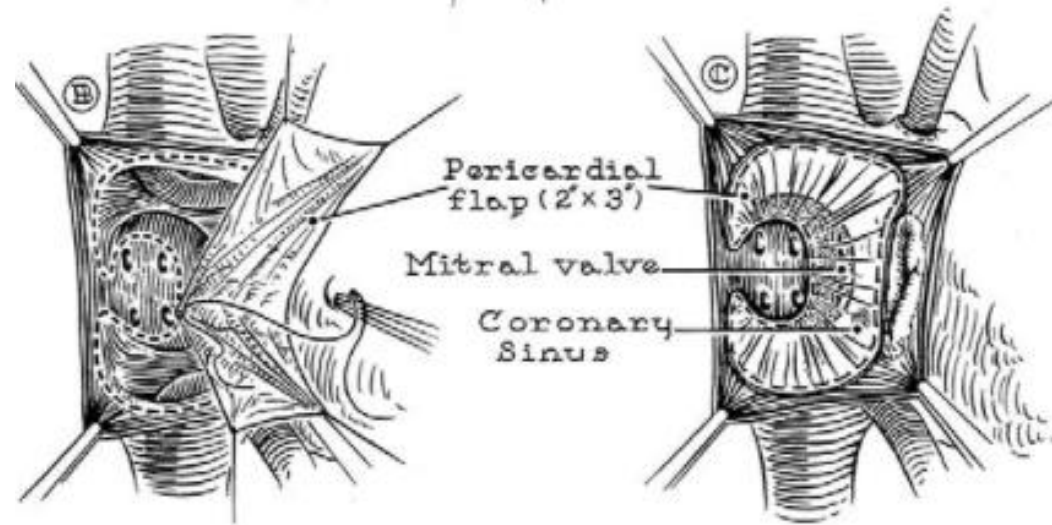
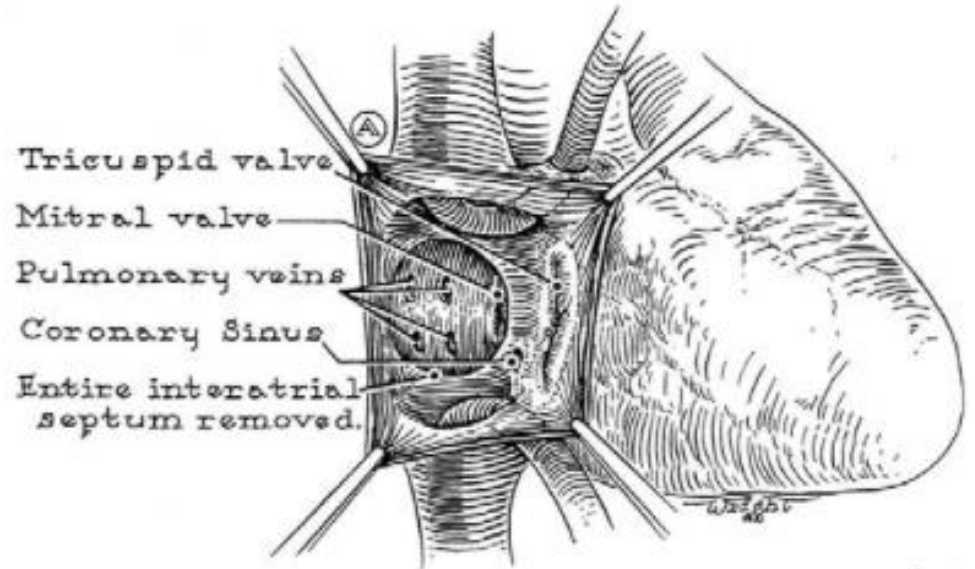
Coronary artery stenosis	<ul style="list-style-type: none"> • Symptoms • Evidence of ischemia by exercise testing or cardiac markers
PA stenosis	<ul style="list-style-type: none"> • Symptoms • Greater than 50% stenosis of branch PA • RV systolic pressure >50 mm Hg
Neo-aortic regurgitation	<ul style="list-style-type: none"> • Symptoms • Evidence of LV dysfunction or progressive LV dilation

Historical Notes



Senning A, Surgery; 1959;45:966-80

Historical Notes



Mustard WT, Surgery; 1964;55:469-72

Atrial switch operation

- Advantages
 - First effective surgical treatments for TGA
 - Application in complex cases of TGA
 - Favourable immediate results
 - Shorter learning curve
- Disadvantages
 - Must be familiar with the technique (lot of details!!)
 - Non anatomical correction
 - Different long term complications with difficult resolution
 - Morbidity during “waiting time” for correction

TGA study CHSS (85/89)

845 pts TGA – 286 op. Atrial level

Mortality 4,9% while waiting

n = 286

Mortality 8% while waiting

Senning
162

Mustard
124

Simple TGA
(TGA / IVS)
139

Complex TGA
(TGA / VSD)
23

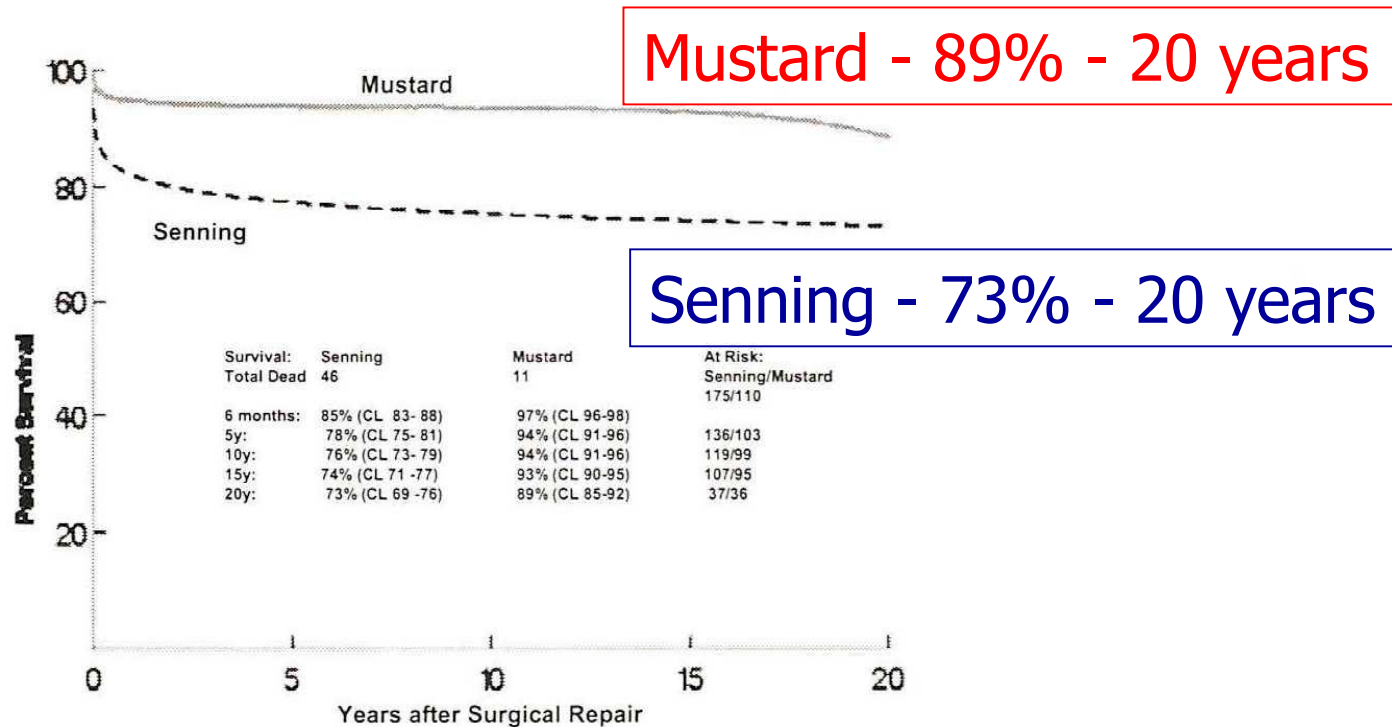
Simple TGA
(TGA / IVS)
112

Complex TGA
(TGA / VSD)
23

Figure 2. Patients assigned to the atrial switch protocol. TGA, transposition of the great arteries; IVS, intact ventricular septum; VSD, ventricular septal defect.

TGA study CHSS (85/89)

TGA – atrial switch



Actuarial survival – Mustard X Senning

TGA study - CHSS (85/89)

281 Operations atrial level

Reoperation after Mustard and Senning

Indication	N of patients	Mortality (%)
RV failure	2	2/2 (100)
Systemic venous pathway obstruction	7	3/7 (43)
SVC only	3	
IVC only	1	
SVC + IVC	3	
Pulmonary venous pathway obstruction	5	2/5 (40)
Baffle leak	5	0/5 (0)
Total	19	7/19 (37)

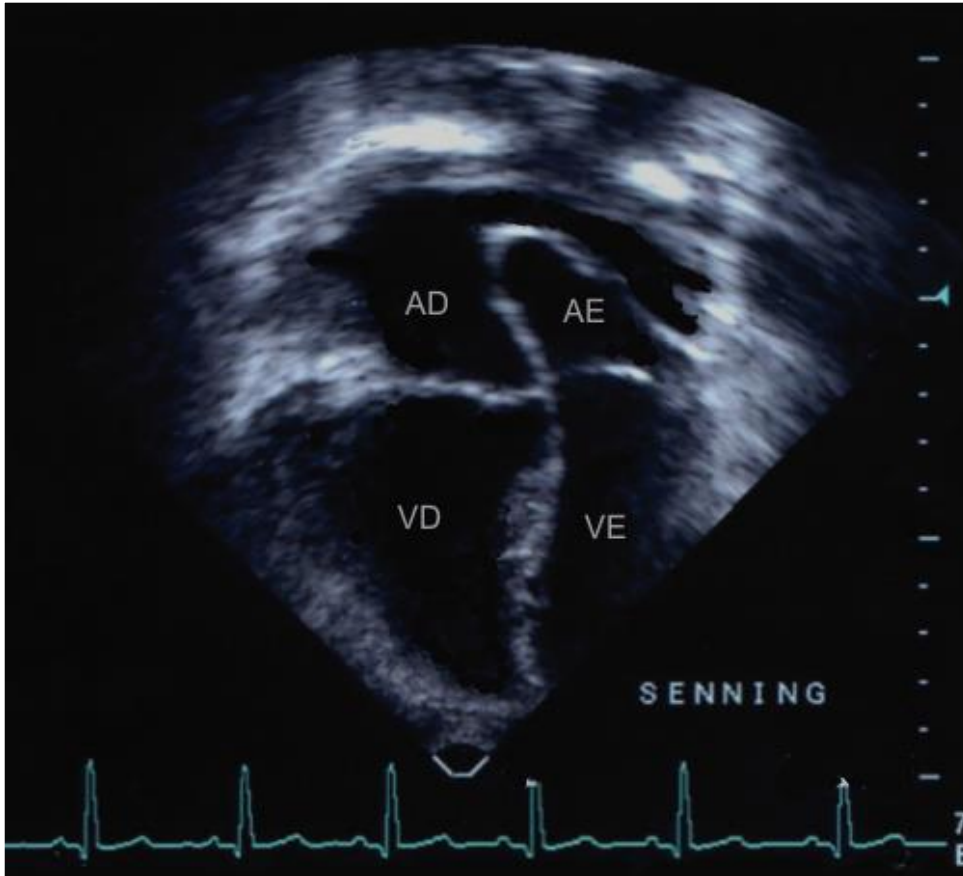
Senning – 44 patients

Follow-up > 20 years

Age (20 to 33 y)

median = 23 y

- NYHA - FC I = 42
FC II = 2
- Regular sports practice = 9
- Graduated/working = 20



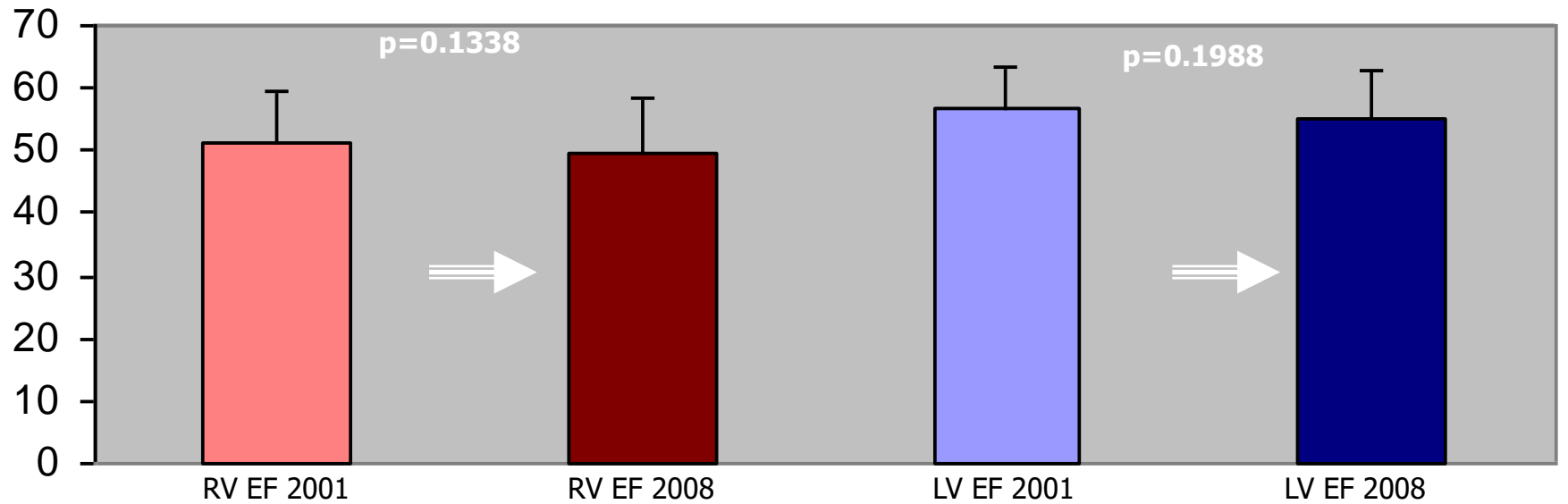
Senning – 44 patients

Arrhythmias

- Arrhythmias detected in Holter – 100%
- Symptomatic – 20 - 44,5%
 - Tachiarhythmias with CHF : 5 (2 Flutter)
 - ER procurement : 11
 - Hospitalization : 7
 - Pace maker implant : 3
- Use of medications = 30 - 68%
Antiarrhythmics, Ieca, diuretics

Gated RV and LV

2001 x 2008



Senning – 44 pacientes

Morbidity

- Stroke sequelae / cerebral disrhythmia 5
- Morbid obesity 4
- Pulmonary enphisema 1
- Tuberculosis 2
- Arterial hypertension 5

Maternity = 4 (CHF grade III – post pregnancy = 2)

Long-Term Outcome of Mustard/Senning Correction for Transposition of the Great Arteries in Sweden and Denmark

Niels Vejstrup, MD, PhD; Keld Sørensen, MD, DMSc; Eva Mattsson, MD, PhD;
Ulf Thilén, MD, PhD; Per Kvidal, MD; Bengt Johansson, MD, PhD; Kasper Iversen, MD, DMSc;
Lars Søndergaard, MD, DMSc; Mikael Dellborg, MD; Peter Eriksson, MD

- n=468 (operated TGA)
- Mustard or Senning between 1967-2003
- mean age at the time of surgery: 1.9y
- 319 males
- perioperative mortality: 93 (20%)

- Median follow-up: 26.1y
 - pacemaker implantation - 63 patients (15%)
 - reoperation – 27 (7%)
 - death – 176 (38%)
 - heart transplant – 8 (2%)
- Patients with pacemakers increased mortality
- Special focus on the function of the right ventricle and TV

Brasil X Brazil



Case 1

- FRD, 18m, female
- From Amazon region
- Cyanosis since birth (1st clinical exam at 17m)
- TGA + Large ASD + small PDA
- Surgical options – Senning operation

Case 2

- HW, 1 day, male
- From Southeast region
- Prenatal ECHO – L TGA
- Jatene operation in 3 rd day of life
- Discharged in 10th PO day
- Normal LV function, no symptoms after 4 years

Current indications

- Late presentation for TGA intact septum
- Anatomical concerns (coronary anatomy)
- Clinical condition (infection, low weight, etc.)
- Surgical team option (experience and structure)
- Part of other complex surgeries (Double switch)
- Complex clinical condition (PH)

Atrial switch in TGA

Late presentation

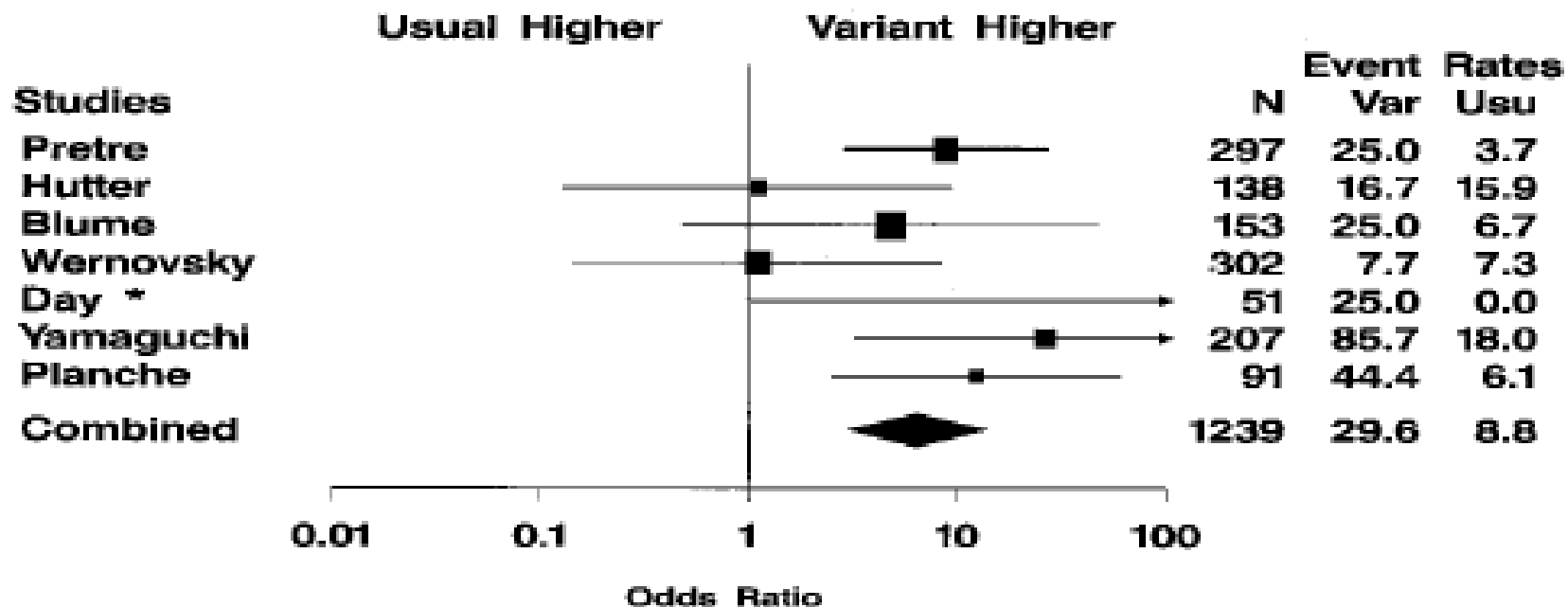
- **Structure of Health System**
 - Lack of diagnosis (pre and post birth)
 - Lack of beds for neonatal operations
 - Lack of adequate transportation from center to center
- **Human (Professional) Possible Causes**
 - Adequate medical formation and information
 - Adequate numbers of professionals
 - Adequate distribuiton for all areas

Coronary Artery Pattern and Outcome of Arterial Switch Operation for Transposition of Great Arteries

A Meta-Analysis

Sara K. Pasquali, et al

Intramural Coronary Artery





Palliative Senning in the Treatment of Congenital Heart Disease with Severe Pulmonary Hypertension

Juliano Gomes Penha, Leina Zorzanelli, Antonio Augusto Barbosa-Lopes, Edimar Atik, Leonardo Augusto Miana, Carla Tanamati, Luiz Fernando Caneo, Nana Miura, Vera Demarchi Aiello, Marcelo Biscegli Jatene

Instituto do Coração do Hospital das Clínicas da Faculdade de Medicina da USP, São Paulo, SP – Brazil

- 21 patients with TGA + VSD and Taussig-Bing DORV
- retrospective study based on medical records between 1991 to 2014
- Included patients with no indication of definitive repair due to suprasystemic pulmonary pressure
- all patients underwent median sternotomy, opening of the pericardium and cardiopulmonary bypass
- VSD is maintained open

45% Mortality

Transposition of the Great Arteries in the Developing World: Surgery and Outcomes

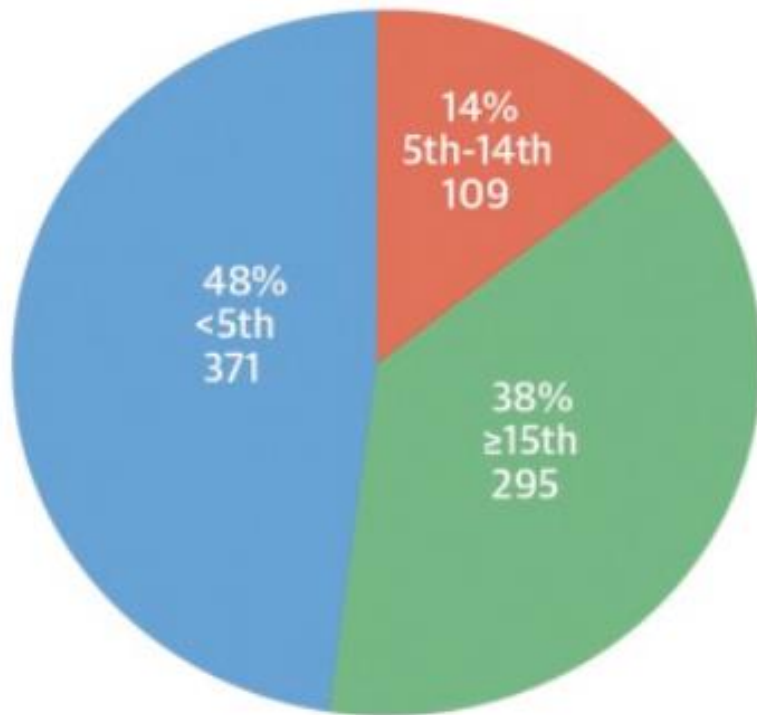
David N. Schidlow MD, MMus^a ✉, Kathy J. Jenkins MD, MPH^b, Kimberlee Gauvreau ScD^b, Ulisses A. Croti MD, PhD^c, Do Thi Cam Giang MD^d, Rama K. Konda DCH^e, William M. Novick MD, MS^f, Nestor F. Sandoval MD^g, Aldo Castañeda MD, PhD^h



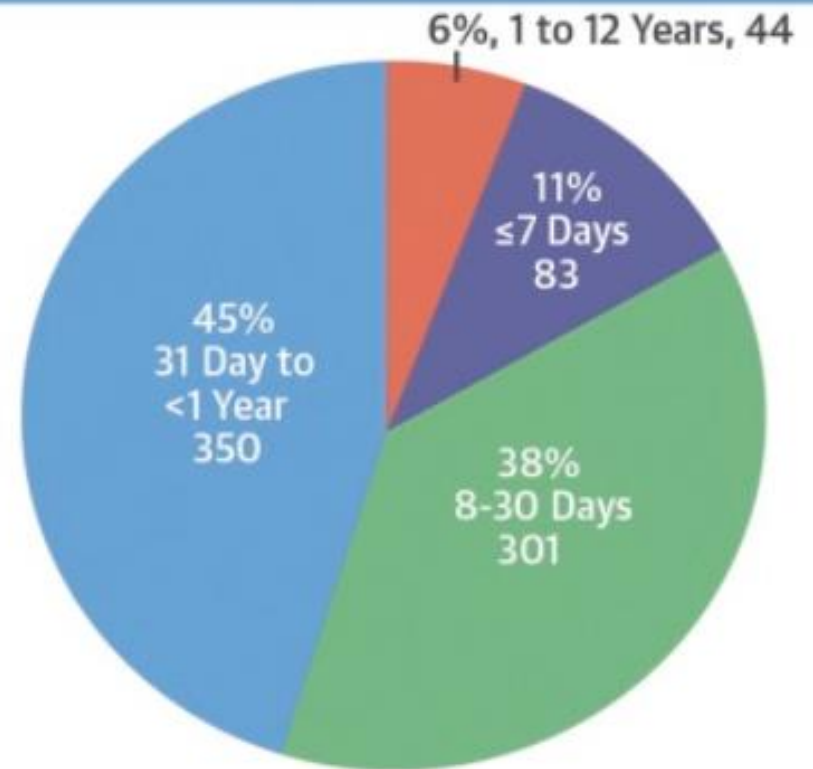
Twenty-six IQIC sites in 15 countries

Transposition of the Great Arteries in the Developing World: Surgery and Outcomes

A. WHO Weight/BMI for Age Percentile

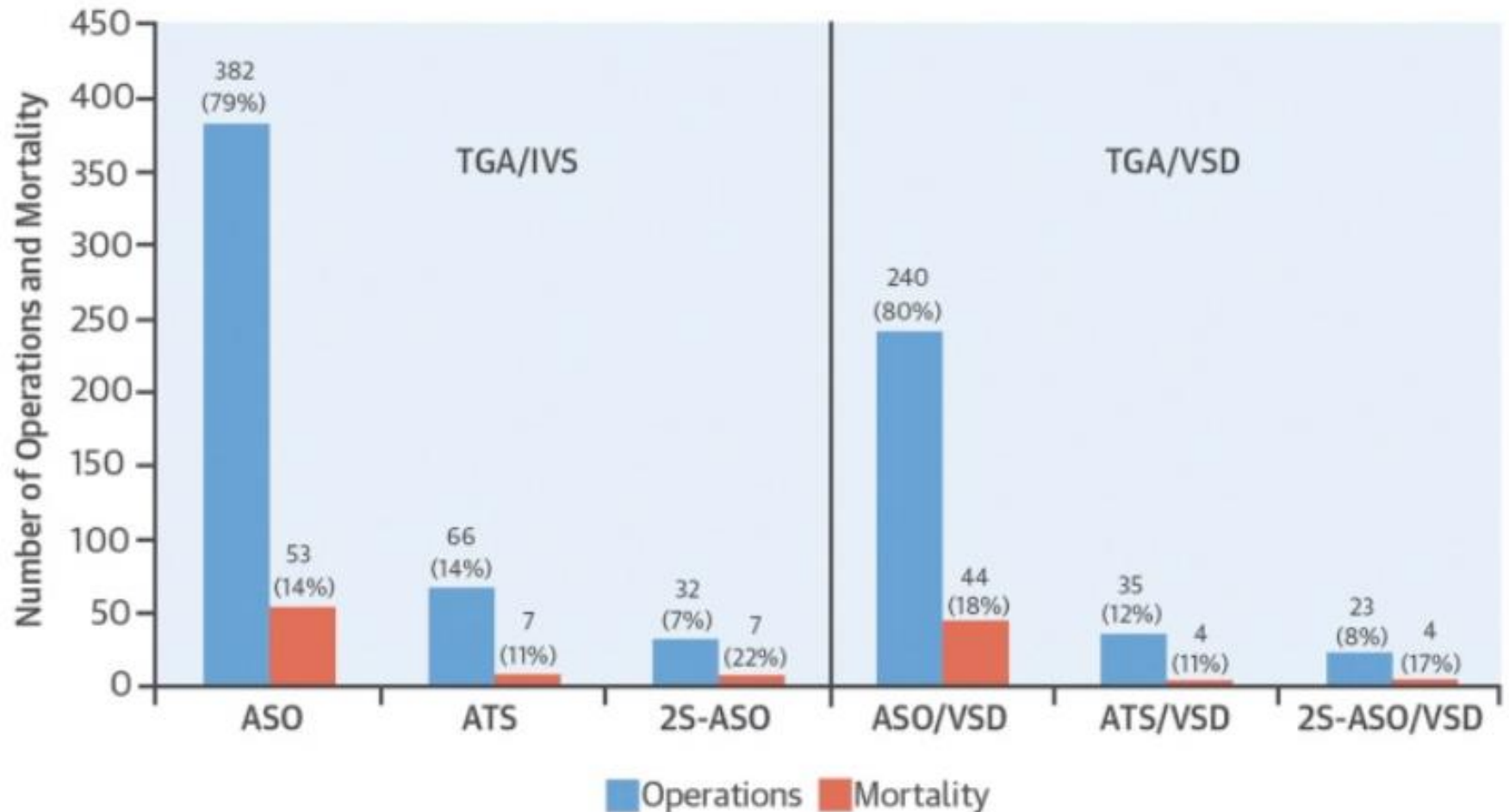


B. Age at Surgery



Transposition of the Great Arteries in the Developing World: Surgery and Outcomes

C. TGA Operations and In-Hospital Mortality



Univariate Associations with Mortality

	OR	95% CI	p Value
Diagnosis			
TGA/IVS	1.00	—	—
TGA/VSD	1.30	1.00–1.69	0.05
Male	1.35	1.04–1.74	0.02
WHO weight/BMI-for-age percentile			
<5th	2.20	1.48–3.29	<0.001
5th–15th	1.69	0.92–3.10	0.09
≥15th	1.00	—	—
Weight <3 kg	1.71	1.09–2.68	0.02
Prematurity	2.26	1.13–4.53	0.02
Open chest post-surgery	1.82	0.90–3.69	0.10
Average annual volume of TGA repair			
<10	4.66	2.08–10.4	<0.001
10–19	2.82	1.12–7.09	0.03
≥20	1.00	—	—

Multivariate Associations with Mortality

	OR	95% CI	p Value
Patient characteristics			
WHO weight/BMI-for-age percentile			
<5th	2.23	1.48–3.33	<0.001
5th–15th	1.66	0.91–3.04	0.10
≥15th	1.00	—	—
Male	1.36	1.07–1.75	0.01
Adding annual TGA volume			
WHO weight/BMI-for-age percentile			
<5th	1.98	1.30–3.02	0.002
5th–15th	1.60	0.91–2.82	0.10
≥15th	1.00	—	—
Male	1.45	1.10–1.90	0.008
Average annual volume of TGA repair			
<10	4.71	2.10–10.5	<0.001
10–19	2.41	0.91–6.41	0.08
≥20	1.00	—	—

Dr Baffes wrote in 1987:

“History tends to judge a human being on two counts: the use made of the time allotted to him and what, if anything, he leaves behind for the generations that follow”.

The surgeons who developed the atrial operations for transposition left behind them the inspiration for the subsequent impressive advancements in congenital heart surgery.

Are There Indications for Atrial Switch
(or Atrial Inversion Surgery) in the 21st
Century?

Are There Indications for Atrial Switch
(or Atrial Inversion Surgery) in the 21st
Century?

YES!!

- In 1987, Senning wrote:

“I think that the arterial switch—a real anatomical correction—will be the ‘golden standard’ in the near future and that the atrial switch will be used only for the few patients who are not suitable candidates for the arterial switch”