

# La place des interventions percutanées dans les cardiopathies complexes?

Dr Oliver Stumper  
Birmingham Children's Hospital, UK



40<sup>ème</sup> SEMINAIRE DE CARDIOLOGIE  
CONGENITALE ET PEDIATRIQUE



*La place des interventions percutanées dans les cardiopathies complexes?*

# Disclosures

None to declare

Sept 1995 – Aug 1996

European Senior Research Fellowship  
in Interventional Catheterisation at Necker



# *La place des interventions percutanées dans les cardiopathies complexes?*

## Introduction

### **What is simple ?**

- one-off procedure to fix things for a life- time !

### **What is complex ?**

- univentricular circulation !
- duct dependant circulation !
- multiple / staged procedures to fix things !
- (multiple) reoperations are predictable !
- significant residual lesions after initial “correction” !
- significant co-morbidities / genetic syndromes
- Prematurity / very low birth weight
- Late presentation / pulmonary hypertension
- ....

# *La place des interventions percutanées dans les cardiopathies complexes?*

## “Standard Procedures”

Development of interventional cardiology in CHD

1962 - Balloon septostomy - Rashkind

1982 - Pulmonary balloon valvuloplasty

1986 - Aortic balloon valvuloplasty

1988 - Rashkind double umbrella for PDA

1990 - Stents for pulmonary arteries

1994 - detachable coils for PDA

1997 - Amplatz ASD device

2000 - Melody Catheter Pulmonary Valve Replacement

....

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## Simple lesions :

- Pulmonary valve stenosis
- Patent ductus arteriosus > 3 kg
- Secundum type atrial septal defect
- Partial AVSD
- Aortic valve stenosis
- Aortic coarctation
- Perimembranous ventricular septal defect
- Muscular ventricular septal defect.

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## Treatment of simple lesions:

### Simple shunt lesions

UK data 2000 – 2016

ASD, PFO, PDA, VSD

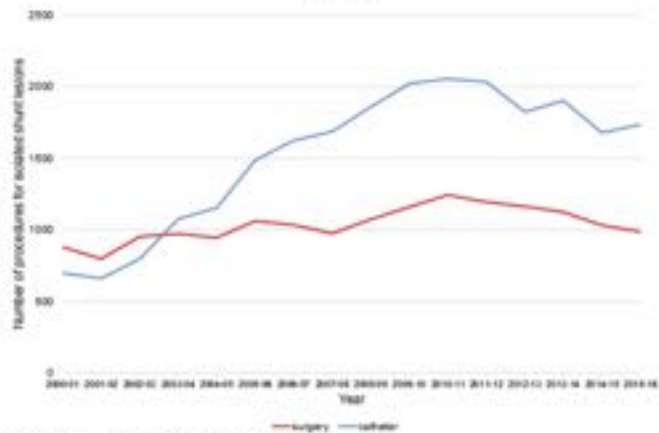
40911 procedures

16604 surgical

24307 catheter



Trends in the total number of surgical and catheter procedures performed for isolated shunt lesions.

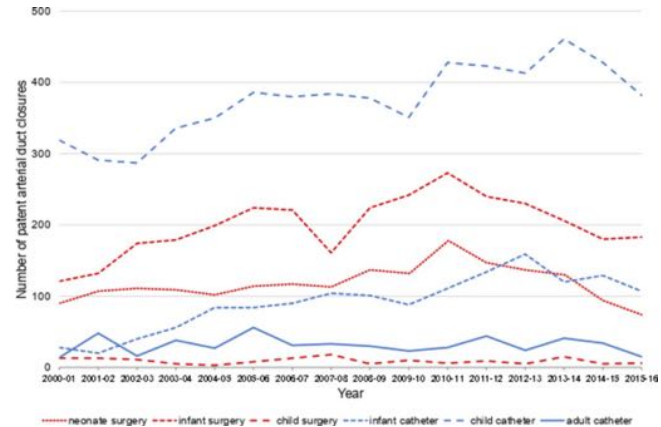
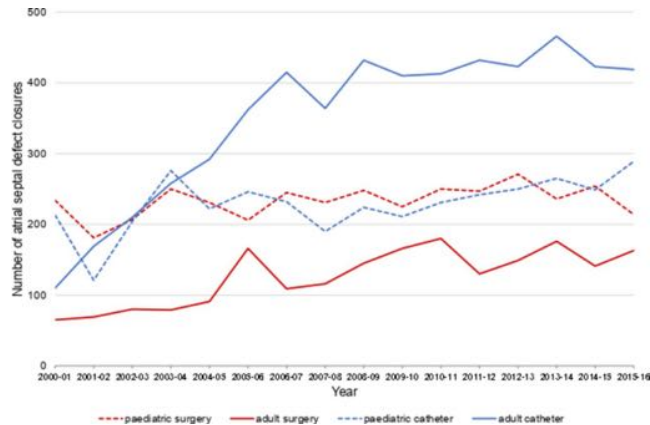


Mahreen Farooq et al. Heart doi:10.1136/heart-2015-021111

# La place des interventions percutanées dans les cardiopathies complexes? Treatment of ASDs and PDA

Most centres now > 80% catheter closure.

- Neonatal and premature PDA closures !?
- Sinus venosus ASD treatment by catheter



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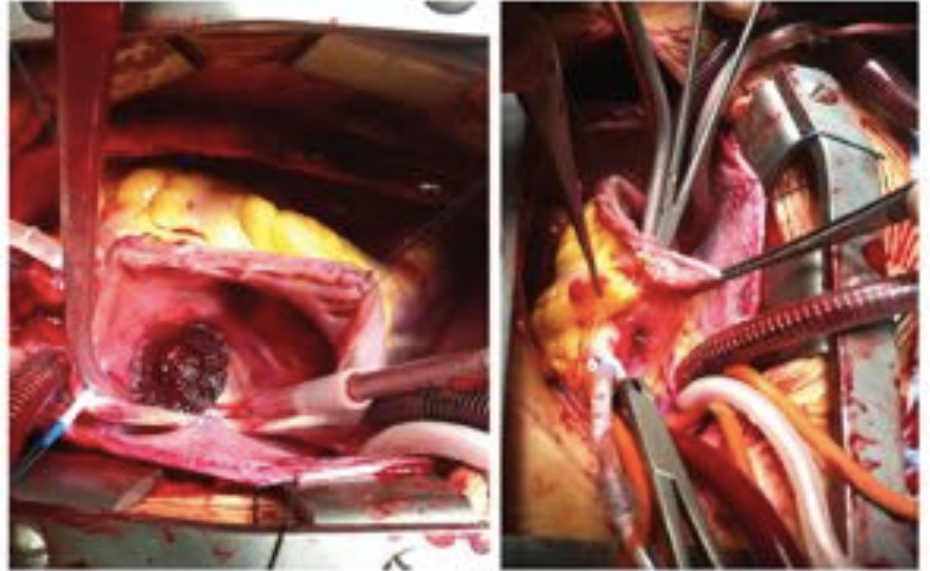
## Catheter ASD Closure

Has become standard of care !

Total number of procedures worldwide ?

Some reports over early or late CHB

Late ASD device erosion 0.1 – 0.3%



*J Thorac Dis* 2018;10(Suppl 24):S2923-S2930



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## Surgical response

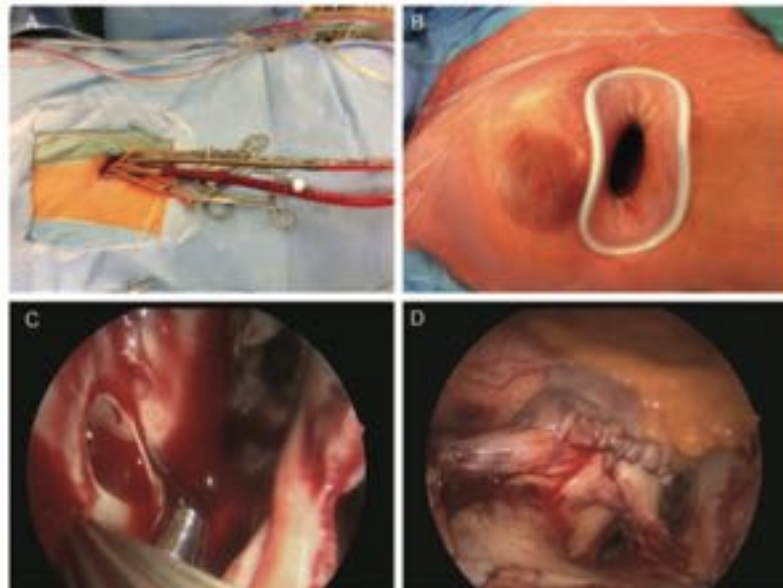
Development of minimally invasive endoscopic techniques !

Both for ASD and PDA !

- Partial AVSD, VSD, CoA to follow ?

**Minimally invasive endoscopic surgery versus catheter-based device occlusion for atrial septal defects in adults: reconsideration of the standard of care**

Yvonne Schneeberger<sup>A,\*,†</sup>, Andreas Schaefer<sup>A,†</sup>, Lenard Conradi<sup>A</sup>, Jens Brickwedel<sup>A</sup>, Hermann Reichenspurner<sup>A</sup>, Rainer Kozlik-Feldmann<sup>B,†</sup> and Christian Dettler<sup>A,†</sup>

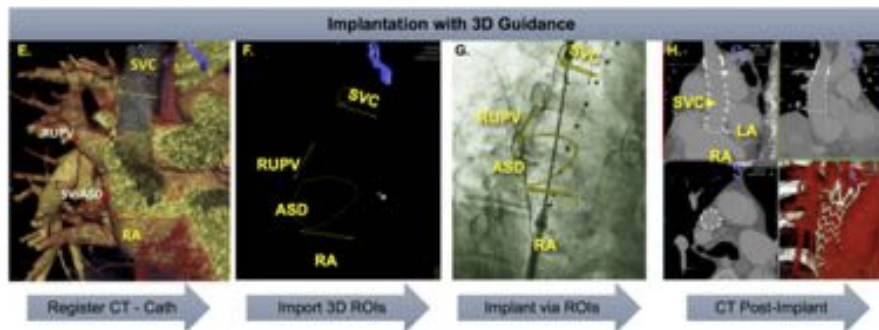
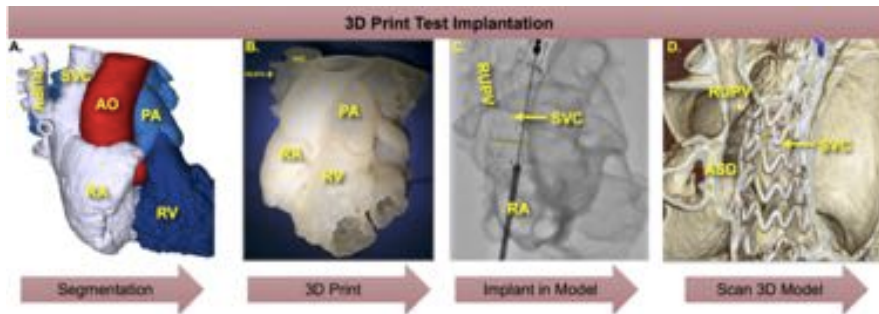


Interactive CardioVascular and Thoracic Surgery 24 (2017) 603–608

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## Sinus Venosus ASD

Numerous centers now embarking on transcatheter treatment of sinus venosus ASD in adult population !



Transcatheter closure of a sinus venosus atrial septal defect using 3D printing and image fusion guidance

Akanksha N. Thakkar MD, Ponraj Chinnadurai MBBS, MMST, John P. Breinholt MD, C. Hule Lin MD.

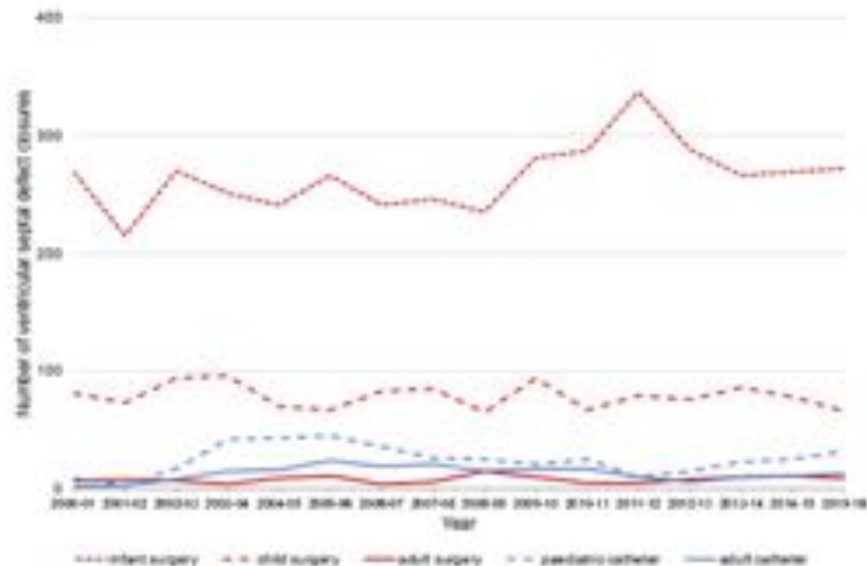
CCI 2018;92:353-357

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## VSD closure

Surgery remains the principal technique for closure of VSD

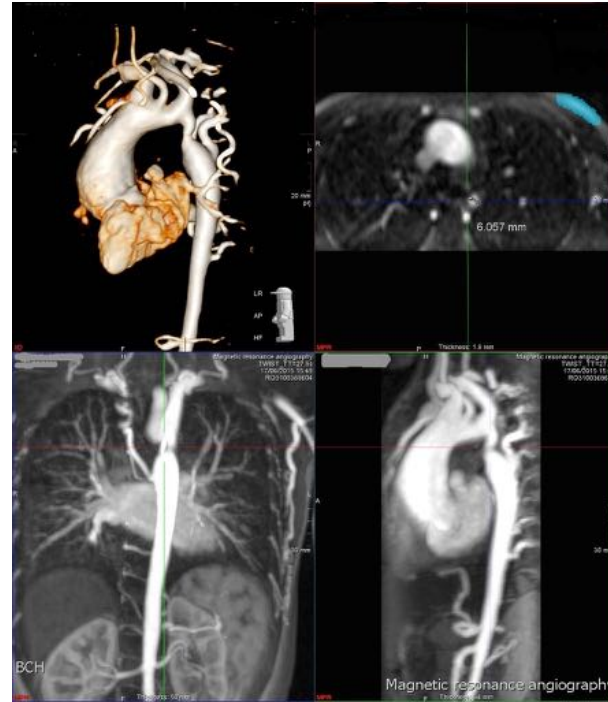
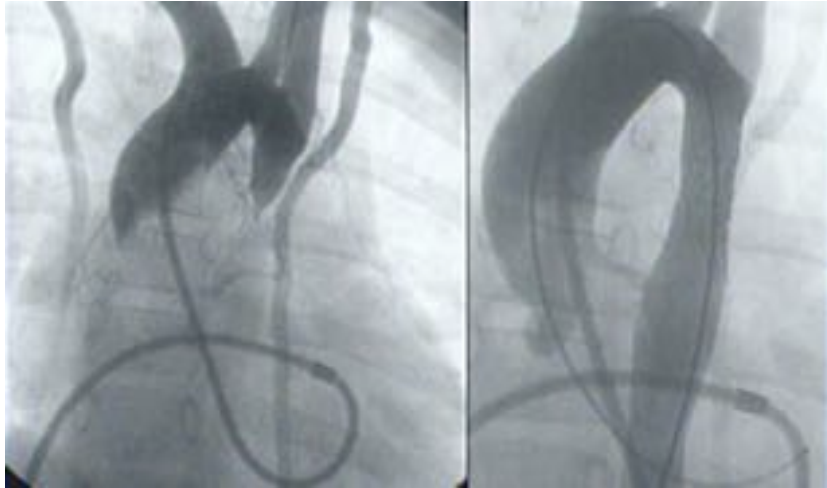
- trans catheter devices not ideal (at present)
- Risk of permanent heart block (3-8%)
- Influence of newer device design on future practice ?
- Learning from Asian experience / practice.



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## Coarctation/ Arch hypoplasia

Neonates and Infants – surgery !  
Older Children and Adults – catheter !



# *La place des interventions percutanées dans les cardiopathies complexes?*

## Coarctation

Some groups trial Coarctation stenting down to 5-10kg

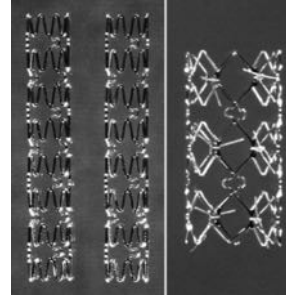
Better materials

- but no bio-resorbable – yet!

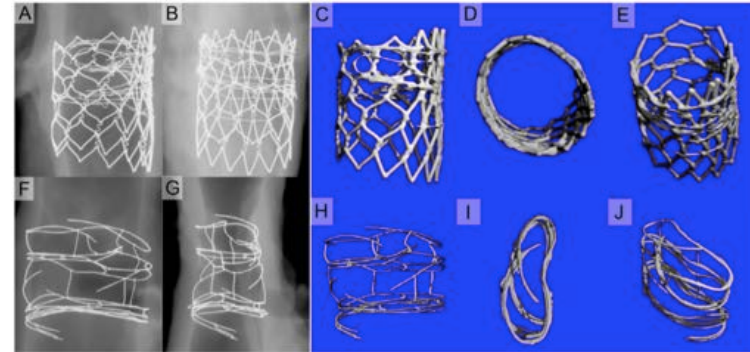
Smaller sheaths

Technically achievable – but desirable ?

Life long commitment to re-intervention !



Ewert, et al. CCI 2008



Bratincsak, et al. JSHD 2017

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# Complex lesions

## What is complex ?

- univentricular circulation !
- duct dependant circulation !
- multiple / staged procedures to fix things !
- (multiple) reoperations are predictable !
- significant residual lesions after initial “correction” !
- significant co-morbidities / genetic syndromes
- Prematurity / very low birth weight
- Late presentation / pulmonary hypertension
- ....



# La place des interventions percutanées dans les cardiopathies complexes? Supportive therapy / delay (further) surgery

Heart 1996;76:363-366

363

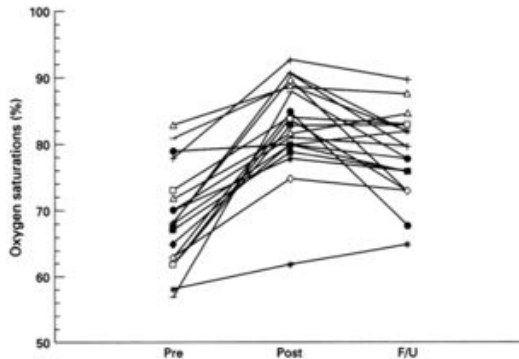
## Pulmonary balloon valvuloplasty in the palliation of complex cyanotic congenital heart disease

O Stümper, J F Piéchaud, P Bonhoeffer, D Bonnet, Y Aggoun, D Sidi, J Kachaner

Increase pulmonary blood flow,  
to defer surgery / Fontan

Table 1 Patient data

No	Age (yr)	Weight (kg)	Diagnosis	Atrial situs	Dextro-cardia	Previous palliation	B/A ratio	Saturation			PA pressures	
								Pre	Post	F/U	Pre	Post
1	1-9	8-0	DORV, TGA	Solitus	+	-	1-3	58	62	65	8	17
2	4-6	14-1	DILV, TGA (repeat PBV)	Solitus	-	-	0-9	63	85	68	8	17
3	7-2	24-2	DORV, TGA	Solitus	-	Bilat BTS	1-1	68	91	80	15	22
4	9-2	23-7	DORV, TGA	Solitus	-	-	1-1	81	89	82	17	20
5	1-5	10-2	cAVSD, DORV	Solitus	-	-	1-0	57	88	78	8	13
6	5-5	13-6	ccTGA, VSD	Inversus	+	-	1-1	68	90	73	12	16
7	2-3	11-7	ccTGA, VSD	Solitus	-	-	0-9	65	80	76	7	13
8	0-02	2-6	DILV, TGA	Solitus	-	-	1-1	62	83	83	8	22
9	2-9	12-1	cAVSD, DORV, TGA	RAJ	-	-	1-0	72	82	85	18	18
10	29-5	58	TGA, VSD	Solitus	-	-	1-1	73	84	83	10	15
11	7-3	25-3	TA, VSD	Solitus	-	Bilat CPS	1-0	83	89	88	8	10
12	14-1	33-2	DILV, TGA	Solitus	-	-	1-0	68	80	82	18	22
13	8-3	23-2	ccTGA, MA, VSD	Solitus	+	Left BTS	1-2	70	78	76	11	17
14	4-5	13-6	ccTGA, VSD	Solitus	+	Bilat BTS	1-0	79	80	78	12	12
15	3-3	14-0	ccTGA, VSD	Inversus	-	Left BTS	1-0	78	93	90	10	11
16	0-2	2-8	DILV	Solitus	-	-	0-9	62	84	73	7	11
17	0-4	5-2	DILV, TGA	Solitus	-	-	1-1	70	81	80	16	17
18	0-8	6-8	DILV, TGA	Solitus	-	-	1-2	63	75	73	11	12
18	0-3	4-1	TGA, VSD	Solitus	-	Left BTS	1-0	67	79	76	11	13



Change in oxygen saturation after pulmonary balloon valvuloplasty. F/U, oxygen saturation at last follow up or before surgical intervention; pre, pre procedure value; post, post procedure value.

# La place des interventions percutanées dans les cardiopathies complexes?

## Duct dependent circulation

### Blalock Taussig shunt:

- Remains high risk surgery
- Limited time of palliation

Consider primary repair.

Consider catheter alternatives !

Consider surgical alternatives !

1273 BT shunts, from 70 institutions (STS database)

Overall discharge mortality: 7.2%

Composite morbidity: 13.1%

unexplained re-operation: 7.6%

postoperative low cardiac output: 5.3%

mechanical circulatory support: 3.1%

Discharge mortality stratified by diagnosis:

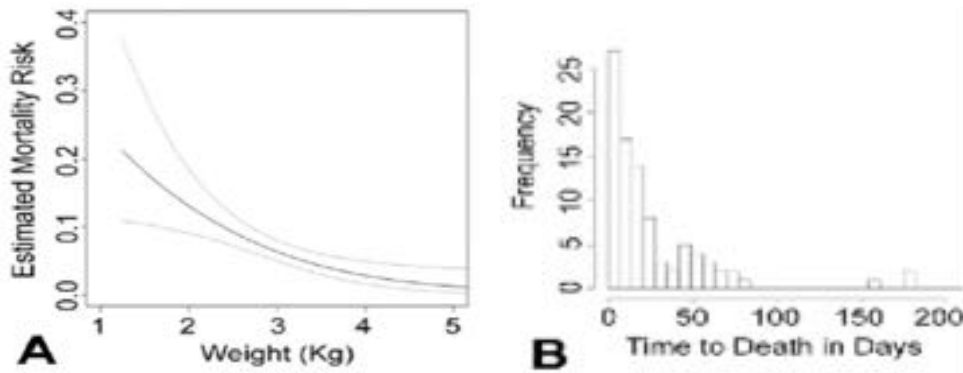
PA/IVS: 15.6%

Univentricular: 7.2%

Biventricular: 5.1%

### Risk Factors for Mortality and Morbidity After the Neonatal Blalock-Taussig Shunt Procedure

Orlando Petrucci, MD, PhD, Sean M. O'Brien, PhD, Marshall L. Jacobs, MD, Jeffrey P. Jacobs, MD, Peter B. Manning, MD, and Pirooz Eghtesady, MD, PhD



*Ann Thorac Surg.* 2011;92:642–651.



# *La place des interventions percutanées dans les cardiopathies complexes?*

## Pulmonary valve stenosis / atresia

**PS – cath treatment first (? and only) choice !**

**PAIVS – catheter treatment !**

RF/CTO wire perforation of pulmonary valve + stent PDA

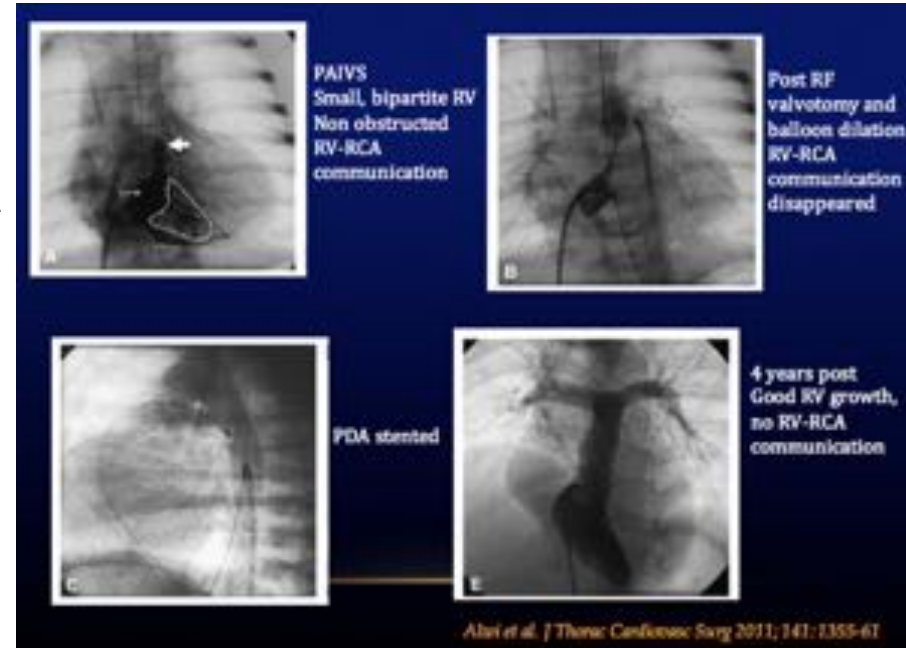
2001-2009

143 pts (10d, 3.1 kg)

No procedural mortality !

1 conversion to BT shunt

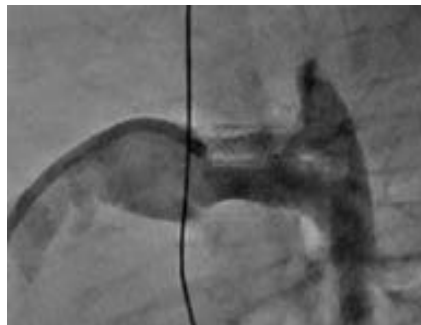
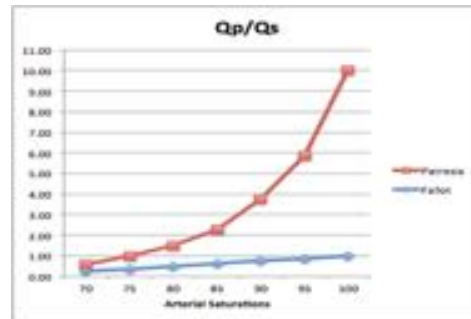
2 early deaths due to LCOS (1.4%)



# Duct dependent circulation

## PDA stenting - general considerations:

- Complete mixing
- Drop in diastolic pressure
- Coronary steal
- Neo-intima formation
- Short-term palliation
- Univentricular pathway vs.
- Biventricular repair ?
  - ? with conduit



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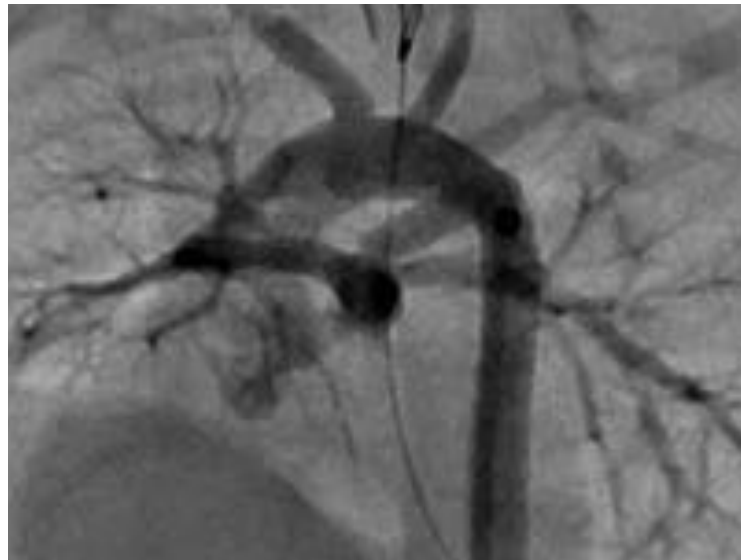
## Duct dependent circulation

**5weeks, 2.8kg, Sats 73%**

- Severe Fallot
- Hypoplastic PAs
- Straight duct
- Early LPA stenosis

### **Options:**

- Early complete repair
- BT shunt
- Ductal stent
- RVOT stent



# La place des interventions percutanées dans les cardiopathies complexes?

## PDA stenting vs BT shunt

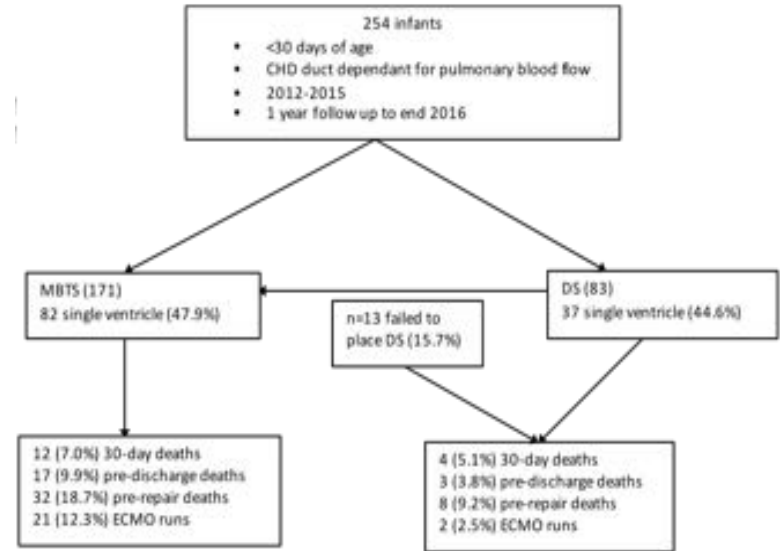
### UK study on PDA stenting

254 pts – 171 BTS / 83 DS

4 year period (- Dec 2015)

Minimum 1 year F/U

- Improved early and long-term survival
- Higher re-intervention rate
- Comparable PA growth



Bentham JR, et al. Circulation 2018;137(6):581-588.

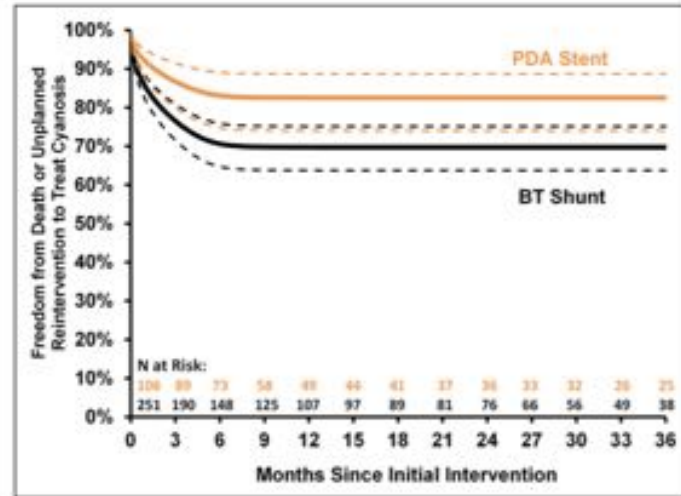
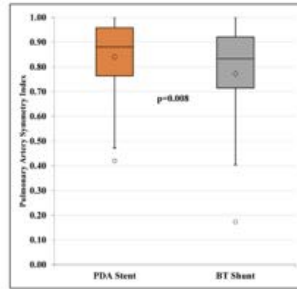
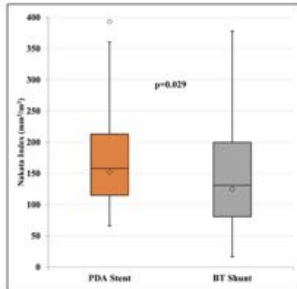
# La place des interventions percutanées dans les cardiopathies complexes?

## PDA stenting vs BT shunt

A Comparison Between Patent Ductus Arteriosus Stent and Modified Blalock-Taussig Shunt as Palliation for Infants with Ductal-Dependent Pulmonary Blood Flow: Insights From the Congenital Catheterization Research Collaborative

Comparison 106 PDA stents  
and 251 BT shunt patients

4 institutions  
8 year period



Glatz A, et al Circulation 2018;137:589-601

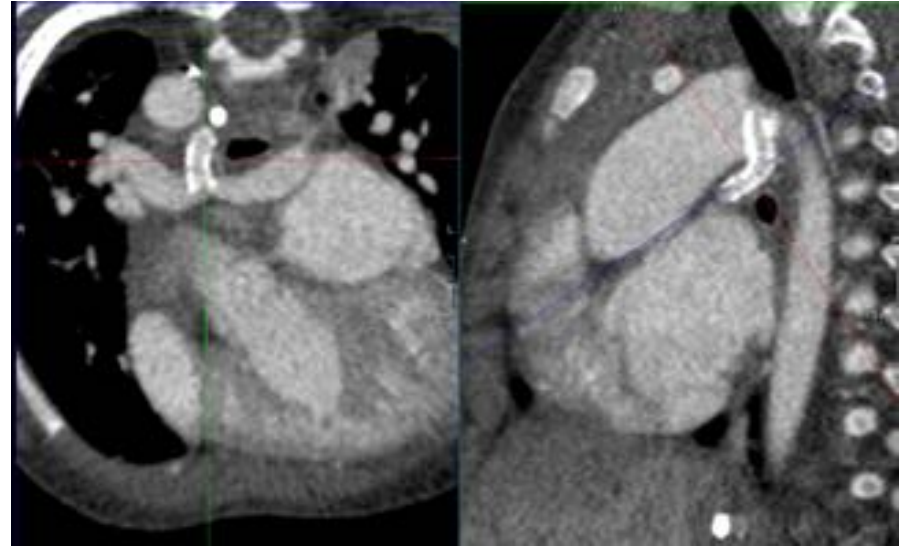
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## PDA stenting vs BT shunt

### **PDA stenting:**

#### **Need to cover entire PDA length:**

- Frequent protrusion into the aorta/innominate artery
- Frequent protrusion into the branch pulmonary arteries
- Tissue reaction at distal end may result in severe stenosis / occlusion



# *La place des interventions percutanées dans les cardiopathies complexes?*

## Initial Palliation-Fallot

### **Pulmonary balloon valvuloplasty** - unpredictable results

Qureshi SA, et al. Br Heart J. 1988;60(3):232-5.

Sluysmans T, et al. Circulation 1995;91:1506-11

### **Stenting of the RVOT**

Hausdorff G, et al. 1993

Gibbs JL, et al. Heart 1997;77:176-9.

Sugiyama H, et al. Heart 2005;91:1058-63.

Laudito A, et al. Ann Thorac Surg 2006;81:744-6.

Dohlen G, et al. Heart 2009;95:142-7.

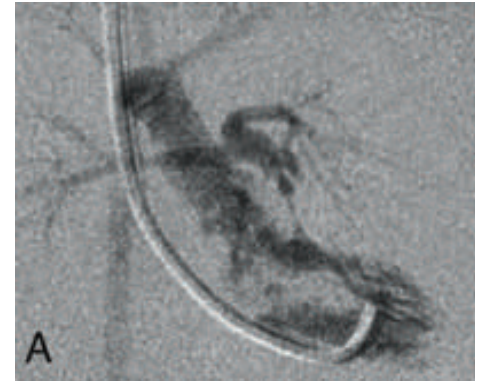
Stumper O, et al. Heart 2013;99:1603-8.

Castleberry D, et al. Ped Cardiol 2014

Sandoval JP, et al. Circ 2016

Quandt D, et al. JACC 2017.

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# La place des interventions percutanées dans les cardiopathies complexes?

## Initial Palliation - Fallot

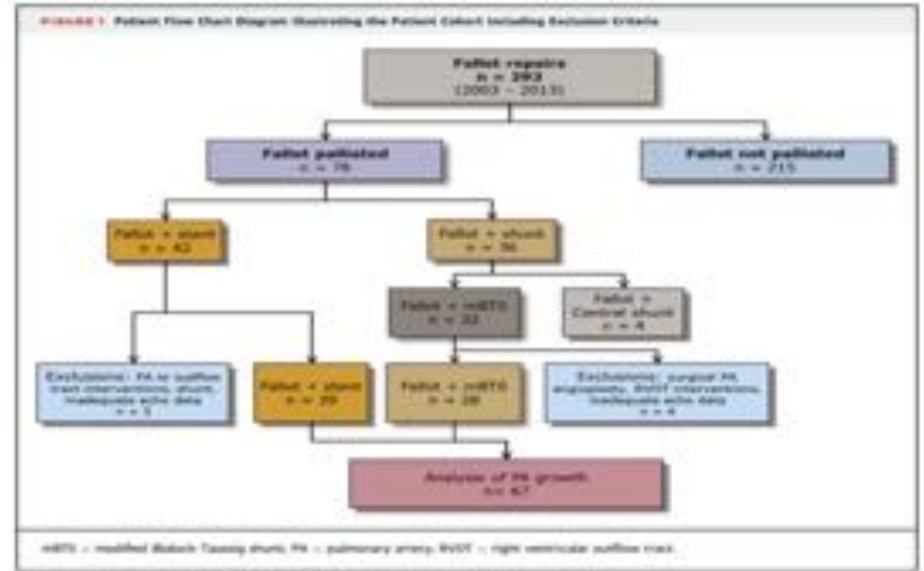
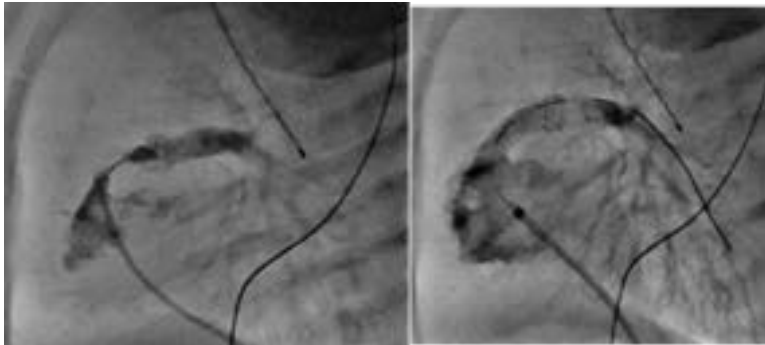
### BCH practice:

Since 2005 RVOT stenting

Initially very selective

Now 1st line of palliation if needed

75% undergo primary repair



Quandt D, et al JACC Int 2017;10:1774-84



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## Initial Palliation- Fallot

**2 weeks, 2.9 kg, Sats 75%, spells**

No duct, No MAPCAs

### **Options:**

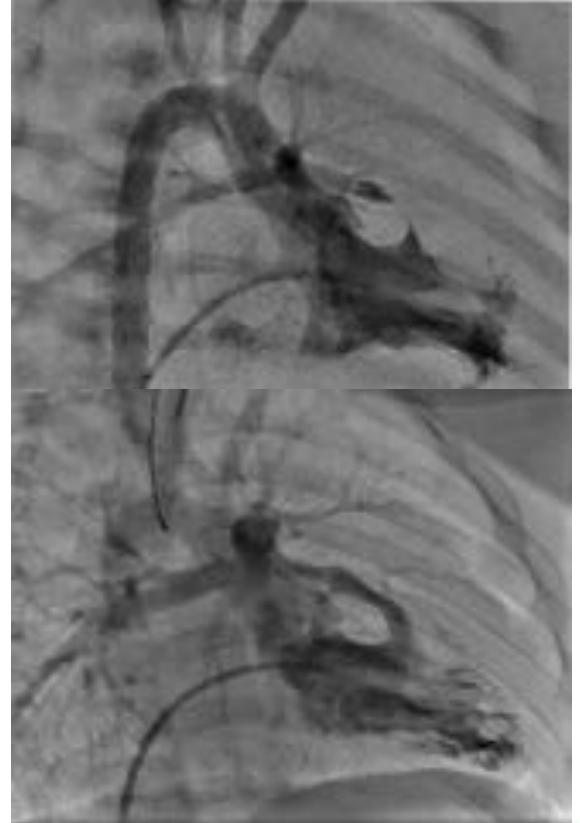
Early complete repair

BT shunt

Ductal stent

RVOT stent

5mm coronary stent - Sats 94% (28min proc, extubated, Dx 38 hours)



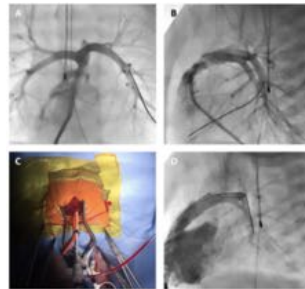
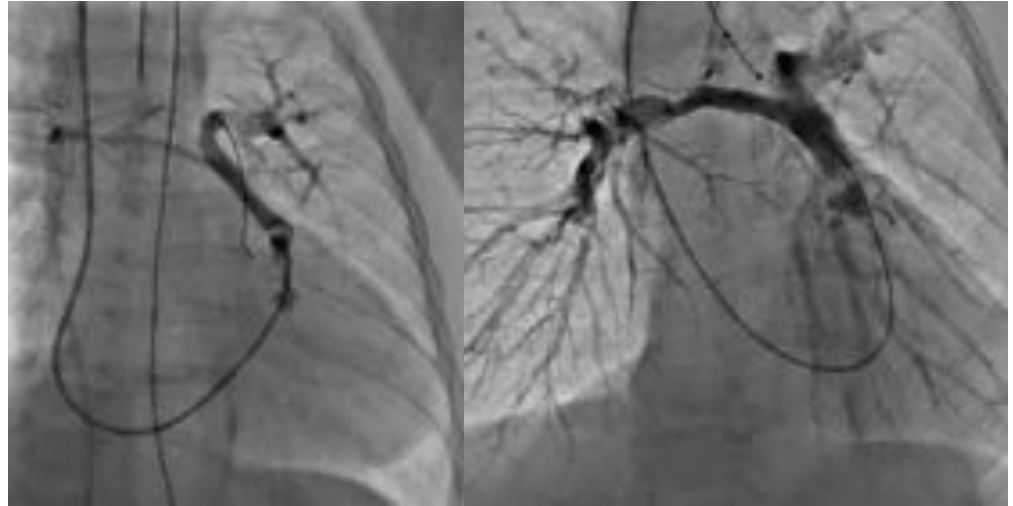
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## Initial Palliation- Fallot / PAVSD + MAPCAs

Baseline diagnostic technique at BCH remains cardiac cath !

Search for blind ending RVOT !  
If present: perforate and stent into MPA.

In less than 2 kg - ? Hybrid approach.



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## Initial Palliation- Fallot

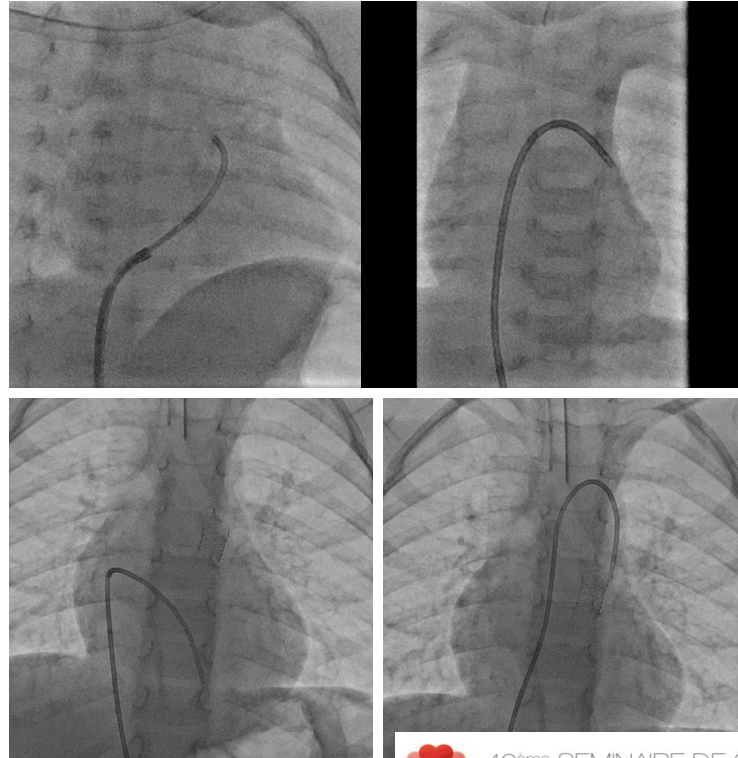
	BTS (n=28)	RVOT stent (n=39)	p
Bypass	6/28 (21%)	0	p < 0.001
PICU admission	28/28 (100%)	8/39 (21%)	p = 0.0001
PICU lenth of stay (median)	69h (15 - 175)	0h (0-362)	p = 0.0001
PICU complications	9/28 (32%)	4/39 (10%)	p < 0.01
Shunt / stent thrombosis	6/28 (21%)	0/39 (0%)	p < 0.001
Surgical reintervention	5/28 (18%)	3/39 (8%)	p < 0.05
Cath Reintervention	1/28 (3.6%)	14/39 (36%)	p = 0.001
NEC	5/28 (18%)	1/39 (2.6%)	p < 0.01
Vocal Chord palsy	2/28 (7.1%)	0/39 (0%)	p < 0.05
Diaphragmatic palsy	1/28 (3.6%)	0/39 (0%)	p < 0.05

Total BCH experience  
now some 120 cases

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## RVOT stenting

- Spelling Fallot – too young for repair
- Hypoplastic PAs
- Syndromes
- Severe comorbidities
- AVSD + Fallot
- LSVC to LA
- Severe RSV
- Anomalous coronaries
- MAPCAs
- ...
- Not: DC VSD !

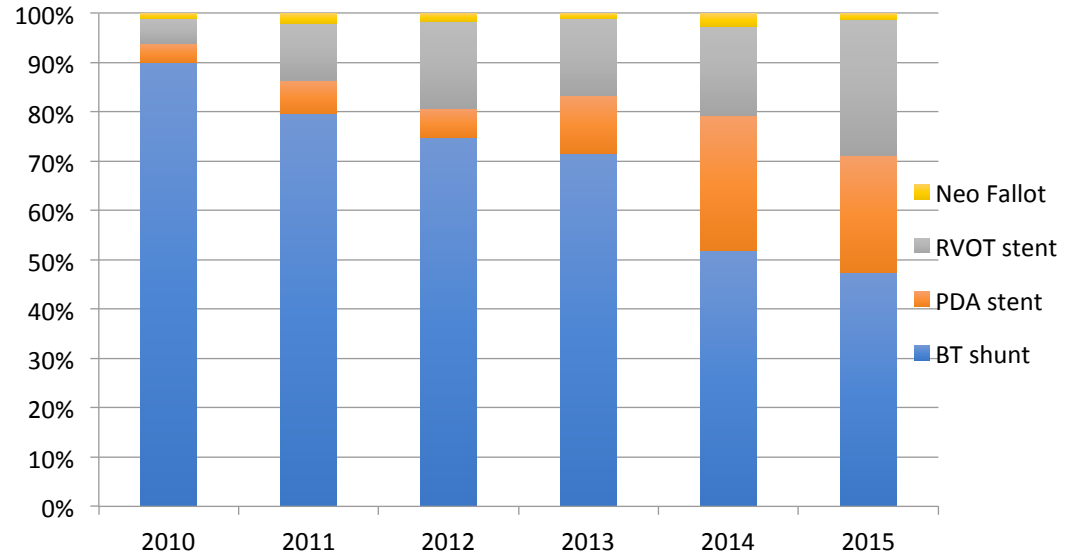


# La place des interventions percutanées dans les cardiopathies complexes? Transcatheter Palliation

## Current UK practice & trends

### 2010- 2016 CCAD data

- Neonatal repair of Fallot remains the exception !
- Catheter interventions (PDA stent and RVOT stent) have overtaken surgical systemic – PA shunts.

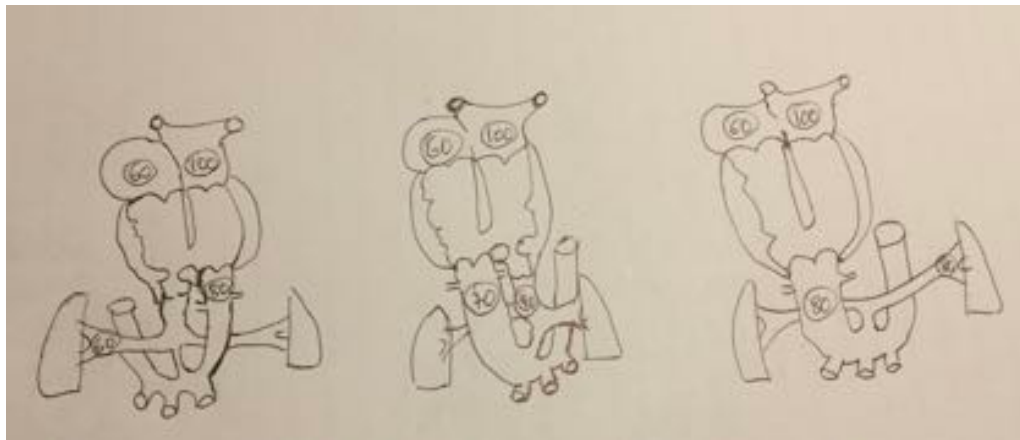


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## Initial Palliation

Wider choice of techniques !  
Consider underlying physiology !

BT Shunt  
PDA stent  
RVOT stent  
RV-PA conduit / patch

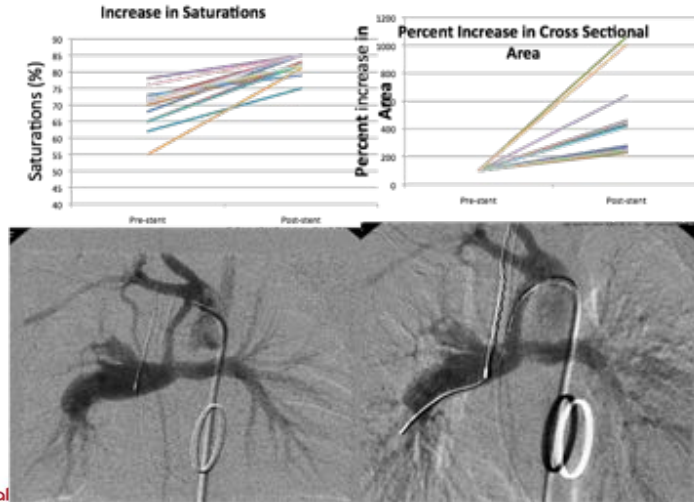


# La place des interventions percutanées dans les cardiopathies complexes?

## Upsizing surgical implants / GoreTex tubes

Catheter upsizing of GoreTex grafts / shunts

- 3.5 mm shunt can be stented to some 4.8 mm
- 4mm shunt to some 5.7 mm
- Avoid 2<sup>nd</sup> shunt procedure till bigger / complete repair



Penford G et al. CCI 2018;91:71-80

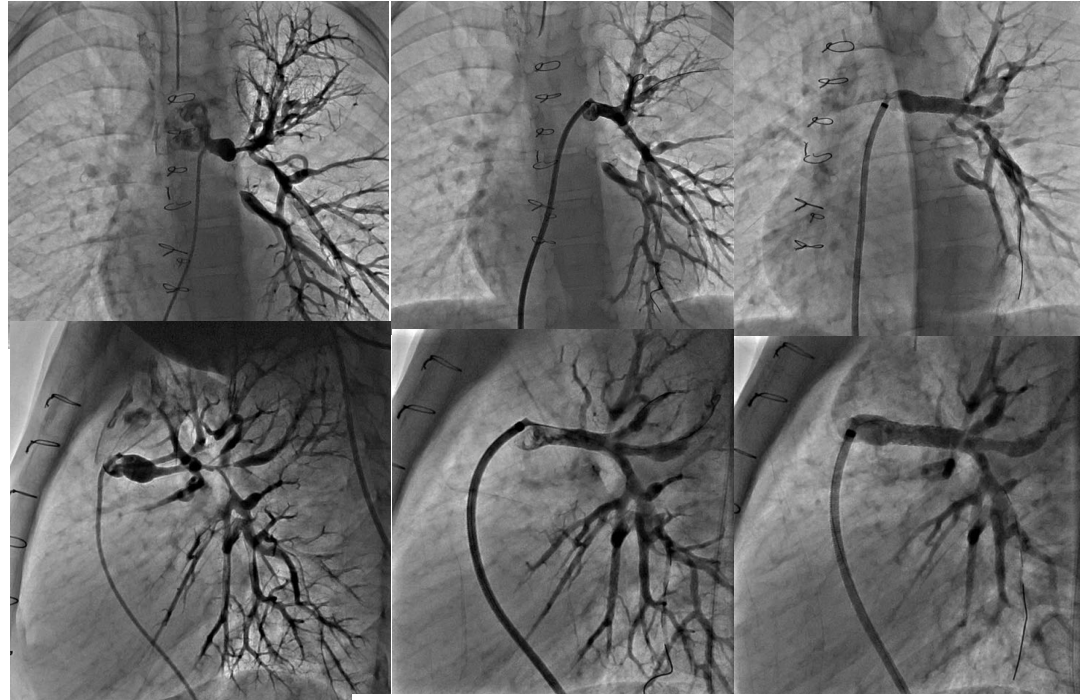


# *La place des interventions percutanées dans les cardiopathies complexes?*

## Staged procedures in PAVSD + MAPCAs

Catheter:

Ability to work on distal vessels !  
Increase shunt size with patient  
growth !  
Beyond surgical reach !



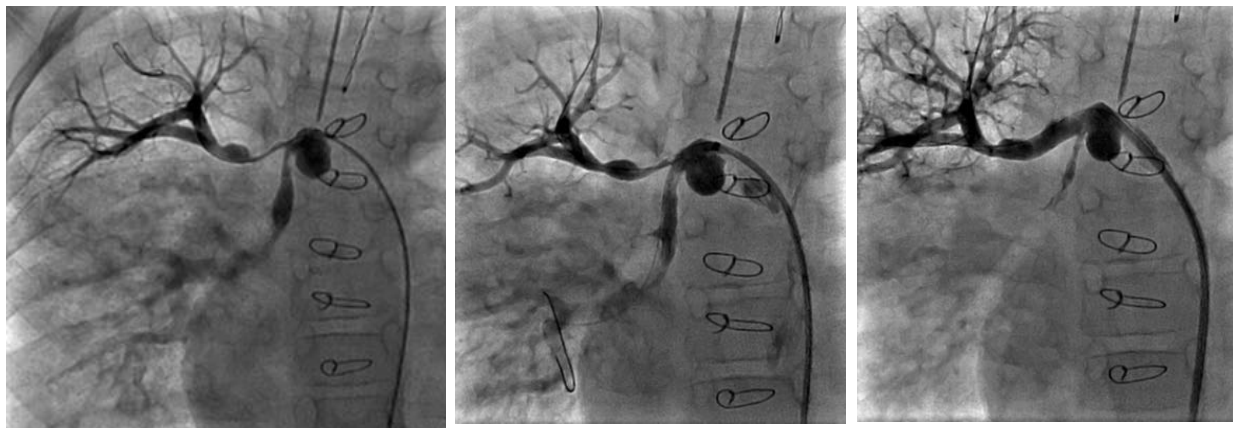


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# Staged Interventions in PAVSD MAPCAs

## Cath Interventions on MAPCAs:

- Balloon angioplasty of MAPCAs
- Cutting balloon angioplasty of MAPCAs
- Stenting of stenosed MAPCAs



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# After Unifocalization of MAPCAs

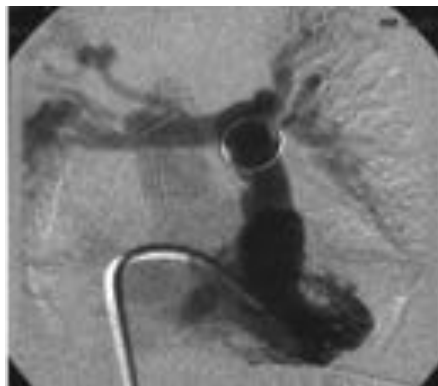
Exit angio / early post op / pre discharge

All catheter intervention will result in redistribution of flow - depending on size and vascular resistance of distal vessels !

Choose your targets!

There are risks !

Avoid working on both lungs!



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# After Unifocalization of MAPCAs

Repeat catheter interventions even on hypoplastic pulmonary arteries.

Surgeon can only get into the hilum !

Avoid stents as long as possible

Coronary stents are bad!



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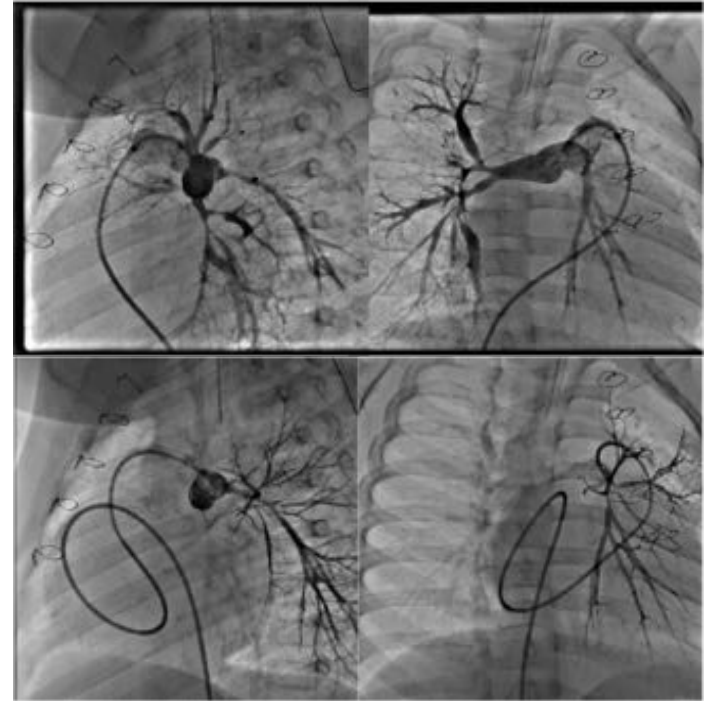
## After Unifocalization of MAPCAs

Abnormal pulmonary vasculature remains !

Some complex cases are not amenable to treatment !

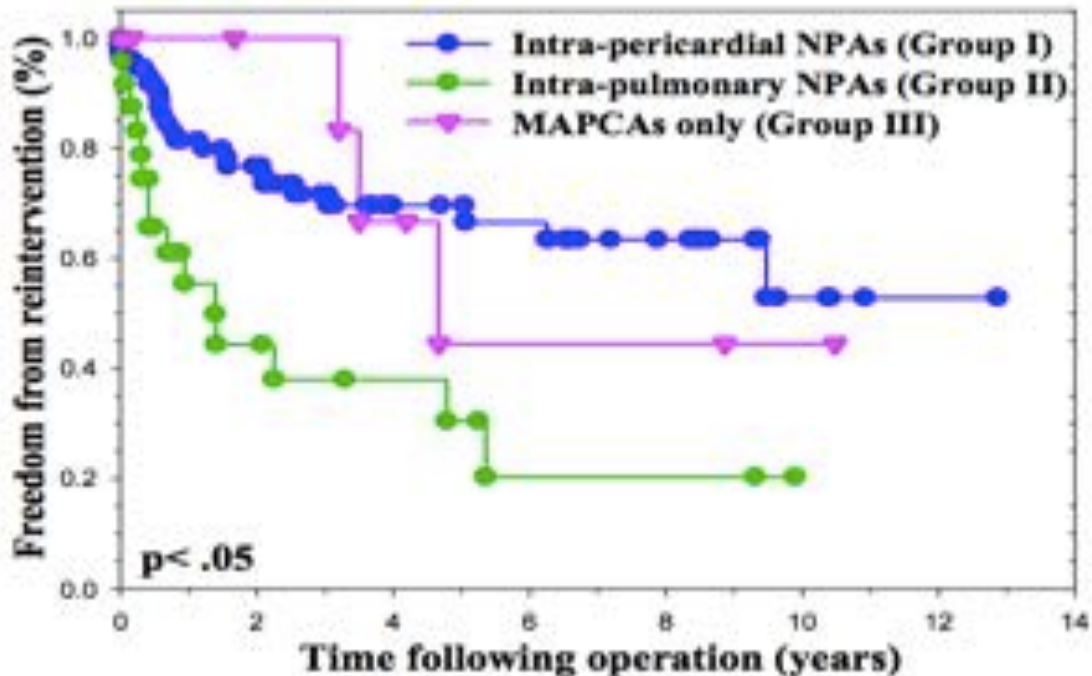
Only shifting the obstruction downstream

Aneurysms etc



# La place des interventions percutanées dans les cardiopathies complexes? After Unifocalization of MAPCAs

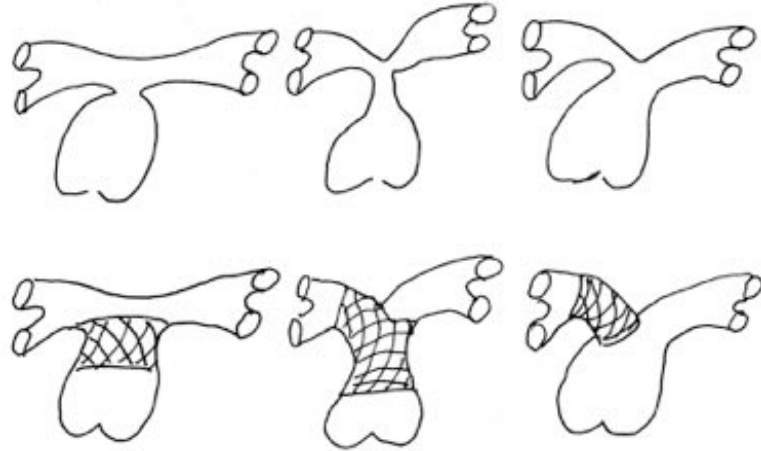
BCH data  
Freedom from Re-  
intervention



*La place des interventions percutanées dans les cardiopathies complexes?*

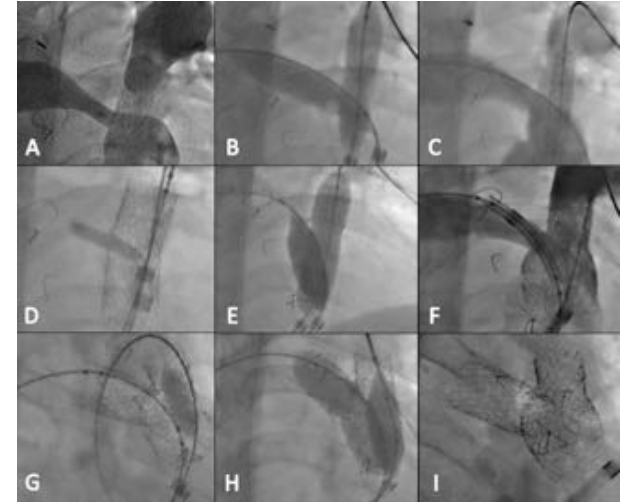
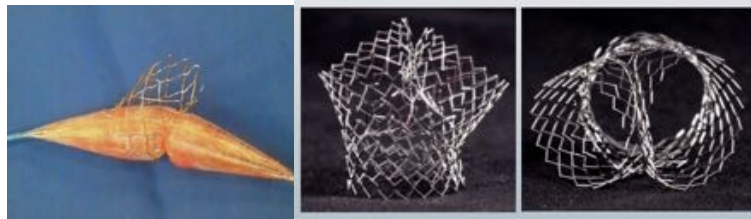
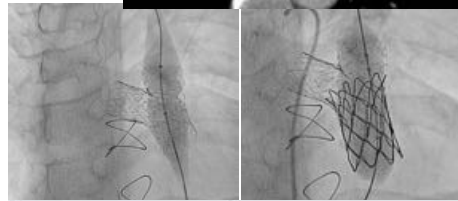
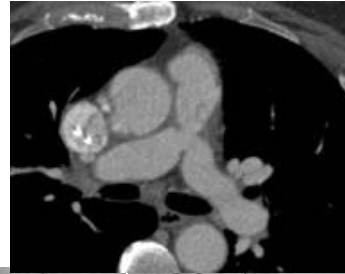
## After Conduit RV-PA Repair

- Judge the morphology
- consider other stent techniques first
- Use tandem technique when there are good branch PAs



# *La place des interventions percutanées dans les cardiopathies complexes?* Things got easier – but are we going too far ?

Bifurcation stenosis post surgery !  
Do-able with current kit !  
But reoperation will be needed !  
Risk of endocarditis ...



Narayan et al. *CCI*. 2015; 86(4): 714–718.

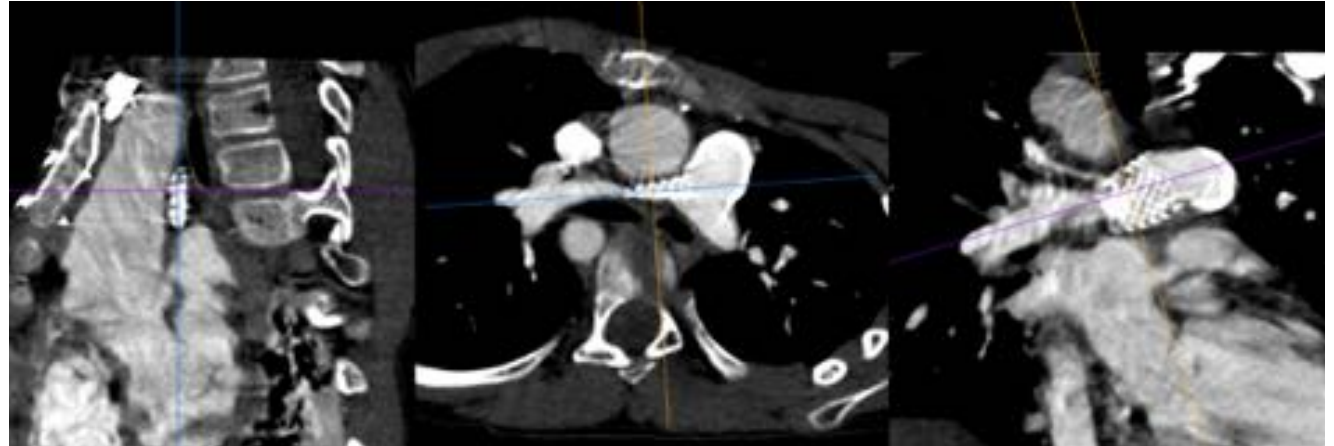


*La place des interventions percutanées dans les cardiopathies complexes?*

# Stents in Pulmonary Arteries

Stents do not last forever !

- Reintervention mandatory
- Neo-intima
- Stent collapse!





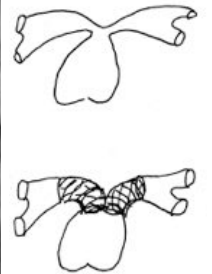
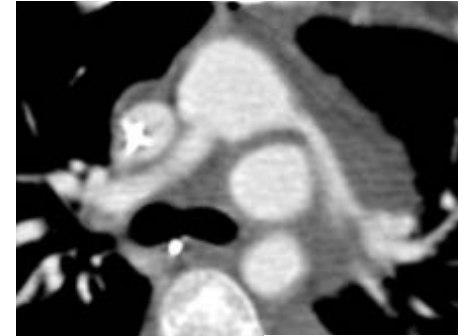
# *La place des interventions percutanées dans les cardiopathies complexes?*

## Stents in Pulmonary Arteries

These lesions are mostly post surgical.

First choice of treatment should be surgical !

Any surgery after bilateral stenting is likely to require hilum-to-hilum reconstruction !



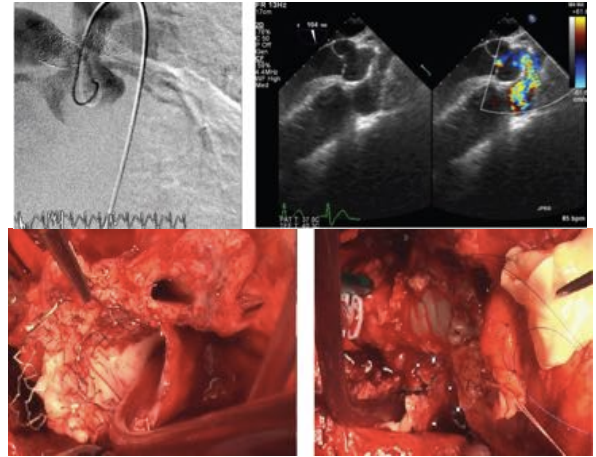
# *La place des interventions percutanées dans les cardiopathies complexes?*

## Stenting branch PAs after arterial switch

### Risk of aorto-pulmonary fistulae !

- Some 25 cases described in literature
  - Preminger 1994
  - Takayama 2002
  - Chiostri 2010
  - Tzifa 2013
  - Vida 2013
  - Page 2015
  - Marini 2015
  - Sato 2015
- Risk factors:

UHP balloons, fracturing / unzipping stents!

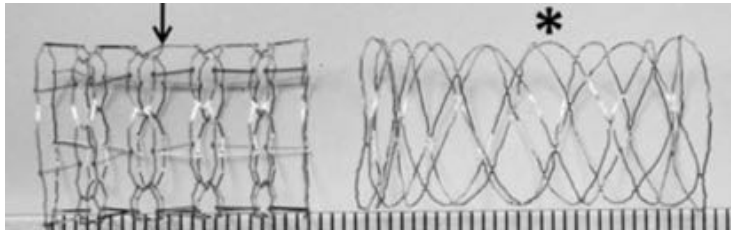


*La place des interventions percutanées dans les cardiopathies complexes?*

## Dealing with post-surgical PA stenosis – CP shunt

### Choice of stents:

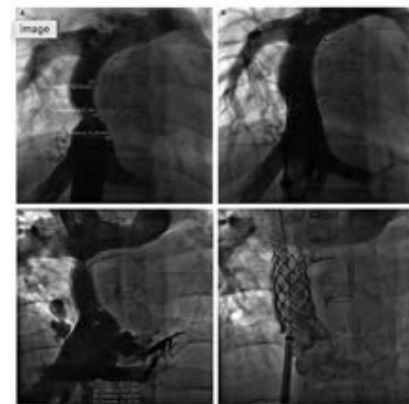
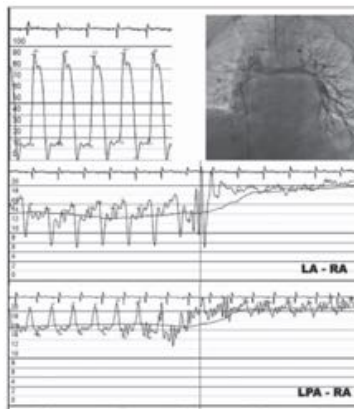
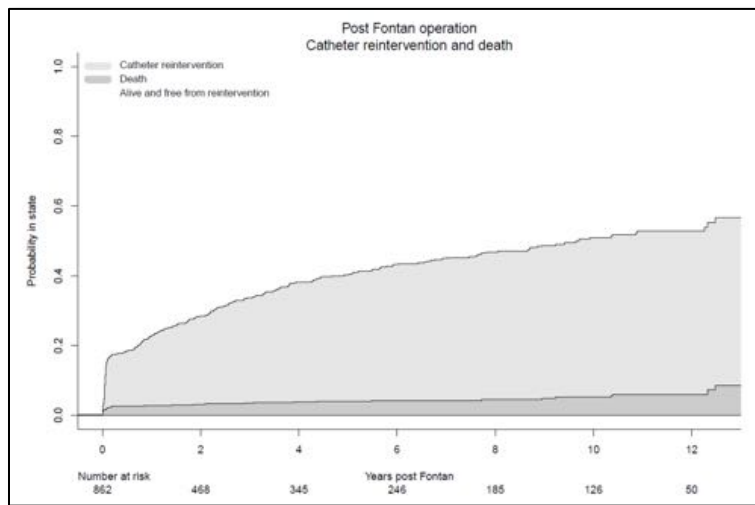
- Coronary – never!
- Closed cell stents shorten with over-expansion! - avoid
- Open/ hybrid design !
  - Cook Formula
  - Bard Valeo
  - Abbot Omnilink



# *La place des interventions percutanées dans les cardiopathies complexes?*

## Optimizing the Fontan circulation

All re-intervention post Fontan should be catheter !  
Including Take-down !  
- As a bridge to transplant ?



# *La place des interventions percutanées dans les cardiopathies complexes?*

## Re-Intervention after Bioprosthetic Valves

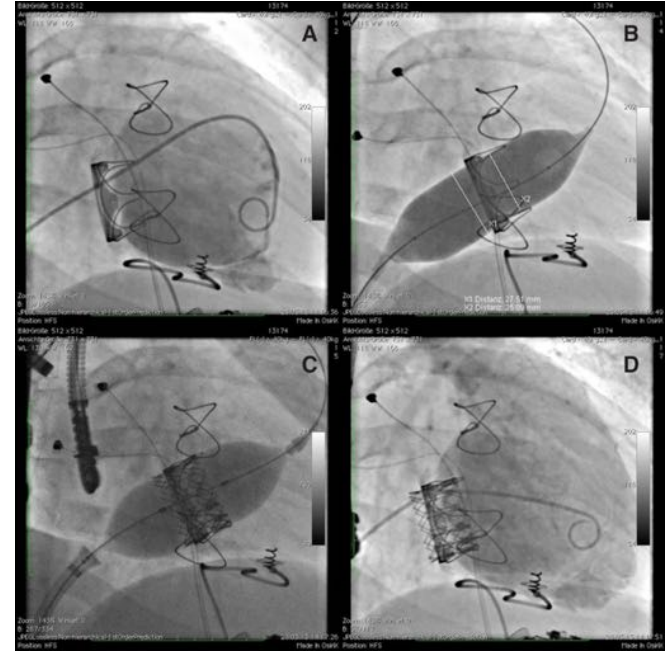
Surgical bio-prosthetic Valves good choice for

- Tricuspid Valve replacement
- Pulmonary valve replacement

But limited durability !

Patient choice in aortic and mitral position

Increasing transcatheter Valve-in-Valve replacement



# La place des interventions percutanées dans les cardiopathies complexes?

## Post-operative arrhythmias

Post surgical rhythm problems








Now:

Almost exclusively treated with percutaneous interventions / medication.

Hybrid biventricular pacing systems.

Subcutaneous ICD

...

CURRENT STATE	FUTURE POTENTIAL	THINK OUTSIDE THE BOX
<b>Supraventricular Tachycardia</b> <ul style="list-style-type: none"> <li>• Radiofrequency catheter ablation</li> <li>• Pharmacologic therapy</li> </ul>	 <ul style="list-style-type: none"> <li>• Non-fluoroscopic imaging</li> <li>• Multi-center regions</li> <li>• Drug trials</li> </ul>	 <ul style="list-style-type: none"> <li>• Cardiac resynchronization for clinical outcomes</li> <li>• Combine multiple-site technology to connect with one another</li> <li>• Support interventional cardiac</li> </ul>
<b>Atrioventricular Node</b> <ul style="list-style-type: none"> <li>• Managing post-operative arrhythmias</li> <li>• Congenital complete AV block</li> <li>• Pacemakers</li> </ul>	 <ul style="list-style-type: none"> <li>• Understand the physiology/pathophysiology of the AV node</li> <li>• Predict and prevent post-operative AVT heart block</li> </ul>	
<b>Cardiac Rhythm Devices</b> <ul style="list-style-type: none"> <li>• ICDs</li> <li>• Pacemakers</li> </ul>	 <ul style="list-style-type: none"> <li>• Leadless technology</li> <li>• Patient's preference</li> <li>• Battery longevity</li> </ul>	
<b>Congenital Heart Disease</b> <ul style="list-style-type: none"> <li>• Atrial septal defects</li> <li>• Complex anatomy</li> <li>• Atrial fibrillation</li> <li>• Atrial tachycardia</li> </ul>	 <ul style="list-style-type: none"> <li>• Define individual interventions to prevent arrhythmias</li> <li>• Pacing with ACD operations</li> <li>• Longitudinal data</li> </ul>	
<b>Isolated Heart Rhythm Problems</b> <ul style="list-style-type: none"> <li>• Family screening</li> <li>• Multi-disciplinary clinics</li> <li>• Exercise guidelines</li> </ul>	 <ul style="list-style-type: none"> <li>• Reduce pharmacologic side effects</li> <li>• Risk stratification</li> <li>• Specific pacing for complex genetic arrhythmic syndromes</li> </ul>	
<b>Autonomic Nervous System</b> <ul style="list-style-type: none"> <li>• Implantable cardioverter-defibrillator</li> <li>• Left cardiac sympathetic denervation</li> <li>• Resectomy</li> </ul>	 <ul style="list-style-type: none"> <li>• Elucidate the physiology</li> <li>• Predict occurrence of arrhythmias</li> </ul>	

Sanatani, S. et al. J Am Coll Cardiol EP. 2017;3(3):195-206.



# *La place des interventions percutanées dans les cardiopathies complexes?*

## So where are we now?

- Simple lesions are the domain for catheter intervention !
- Newer VSD devices will become available
- Bio-resorbable technology is some way off !
- Possible some things got too easy / too accessible !
- Joint care is essential !
- Who does what and at what stage ?
- We need one another !





# La place des interventions percutanées dans les cardiopathies complexes? The Future ?

Transcatheter creation of a cavopulmonary shunt !

- Technically achievable !
- But is it desirable?
  - Repeat re-interventions !
  - Risks vs CP shunt surgery !
  - Loss of RUPA etc...

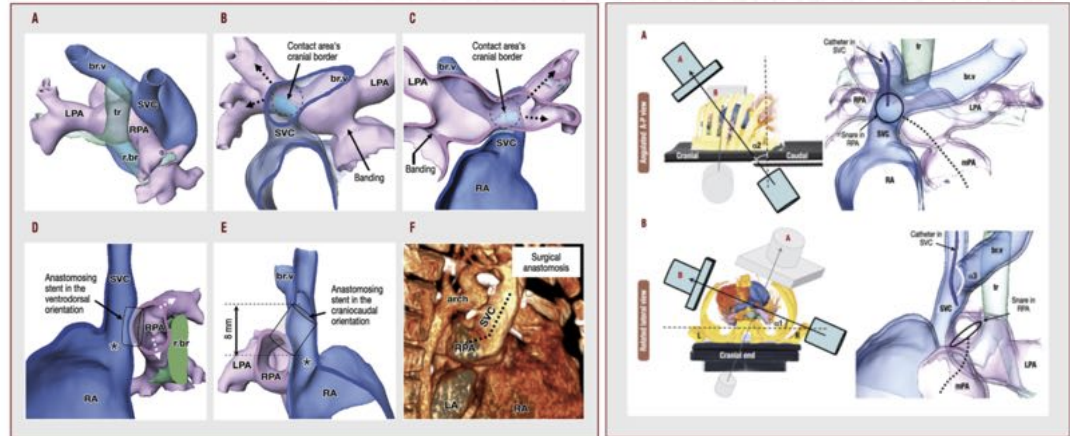
## Vascular anatomy in children with univentricular hearts regarding transcatheter bidirectional Glenn anastomosis



Anatomie vasculaire chez les enfants avec des cœurs univentriculaires concernant la dérivation cavopulmonaire partielle par voie percutanée

Aleksander Sizarov<sup>a</sup>, Francesca Raimondi<sup>a,b</sup>,  
Damien Bonnet<sup>a,c</sup>, Younes Boudjemline<sup>a,c,\*</sup>

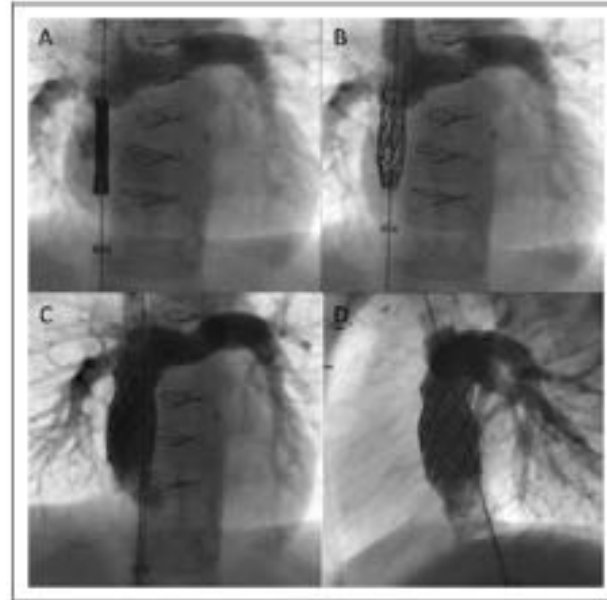
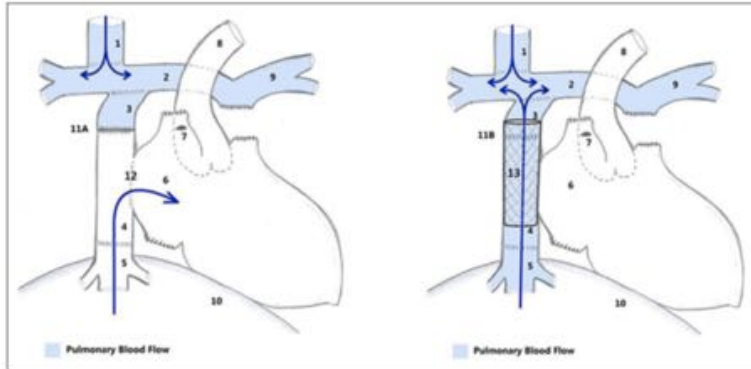
Archives of Cardiovascular Disease (2017) 110, 223–233



# *La place des interventions percutanées dans les cardiopathies complexes?* The Future?

## A Simplified Technique for Interventional Extracardiac Fontan

Sudesh Prabhu, MCh<sup>1,2,3</sup>, Ben Anderson, FRACP<sup>1,2,3</sup>,  
Cameron Ward, FRACP<sup>1,2,3</sup>, Tom Karl, FRACS<sup>2,4</sup>,  
and Nelson Alphonso, FRACS<sup>1,2,3</sup>



*La place des interventions percutanées dans les cardiopathies complexes?*





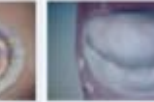
# Transcatheter AV valve repair

Rapid development in adult structural interventional cath !

We need to keep in touch of these !

Growing number of grown-up congenital patients!

Strict implications for training the next generation of interventional paediatric cardiologists !

Company	Abbott	NeoChord	CardiacDin	VaTech	Mitralign
Name	MitraClip	DS1000	Carillon	CardioBand TA and TF	Bident and Tricuspid
					
Description	Affert technique	Neochoetal implant from the TA approach	Coronary sinus cinching	Surgical ring implanted percutaneously	Plication device
Strengths	<ul style="list-style-type: none"><li>• Minimal invasiveness</li></ul>	<ul style="list-style-type: none"><li>• Strong surgical background</li></ul>	<ul style="list-style-type: none"><li>• simplicity</li></ul>	<ul style="list-style-type: none"><li>• Strong surgical background</li><li>• Atrial delivery</li></ul>	<ul style="list-style-type: none"><li>• simplicity</li></ul>
Weaknesses	<ul style="list-style-type: none"><li>• Lack of annuloplasty</li></ul>	<ul style="list-style-type: none"><li>• TA approach</li><li>• Lack of annuloplasty</li></ul>	<ul style="list-style-type: none"><li>• Limited efficacy</li></ul>	<ul style="list-style-type: none"><li>• Complexity</li><li>• imaging</li></ul>	<ul style="list-style-type: none"><li>• Efficacy limited in mitral position</li><li>• Ventricular delivery</li></ul>
Status	>35000	>300 pts	• 500 pts	• 100 pts	• 100 pts

## *La place des interventions percutanées dans les cardiopathies complexes?*

# Conclusions !?

Majority of complex CHD can't be fixed as a one-off procedure!

- Ongoing care and intervention is needed
- We are in this together (surgery and cardiology)
- Close relationships between teams are needed.
- Patient specific discussions + Individual case based decisions!
- Interventional techniques have become too easy!
- Yet, materials are not perfect!
  
- It is an evolving pathway of Care !
- We need surgical buy-in to develop the field further !
- There will be training needs in structural intervention for the next generation !

# *La place des interventions percutanées dans les cardiopathies complexes?*

a

b

# *La place des interventions percutanées dans les cardiopathies complexes?*

a

b

## Novel method of surgical preparation for transcatheter completion of Fontan circulation: Creation of an extracardiac pathway

Younes Boudjemline <sup>a,b,c</sup>, Sophie Malekzadeh-Milani <sup>a</sup>,  
Mathieu Van Steenberghe <sup>a</sup>, Yann Bögli <sup>a</sup>, Mehul Patel <sup>a</sup>,  
Regis Gaudin <sup>a</sup>, Damien Bonnet <sup>a,b</sup>, Sébastien Gerelli <sup>a</sup>

Archives of Cardiovascular Disease (2014) 107, 371–380

