La place des interventions percutanées dans les cardiopathies complexes?

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

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
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Treatment of ASDs and PDA

Most centres now > 80% catheter closure.
- Neonatal and premature PDA closures !?
- Sinus venosus ASD treatment by catheter
La place des interventions percutanées dans les cardiopathies complexes?

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
La place des interventions percutanées dans les cardiopathies complexes?

Surgical response

Development of minimally invasive endoscopic techniques!

Both for ASD and PDA!
- Partial AVSD, VSD, CoA to follow?
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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. Huie 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.
La place des interventions percutanées dans les cardiopathies complexes?

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
La place des interventions percutanées dans les cardiopathies complexes?

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

Increase pulmonary blood flow ,
to defer surgery / Fontan

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

Table 1 Patient data

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<th>No</th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Diagnosis</th>
<th>Atrial situs</th>
<th>Dextrocardia</th>
<th>Previous palliation</th>
<th>Bi/A ratio</th>
<th>Saturations Pre</th>
<th>PA pressures Pre</th>
<th>Saturations Post</th>
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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%

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%)
La place des interventions percutanées dans les cardiopathies complexes?

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

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

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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
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Initial Palliation-Fallot

**Pulmonary balloon valvuloplasty** - unpredictable results

**Stenting of the RVOT**
Castleberry D, et al. Ped Cardiol 2014
....
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
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)
La place des interventions percutanées dans les cardiopathies complexes?

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.
La place des interventions percutanées dans les cardiopathies complexes?

Initial Palliation- Fallot

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

Total BCH experience now some 120 cases
La place des interventions percutanées dans les cardiopathies complexes?

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!
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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
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\textsuperscript{nd} shunt procedure till bigger / complete repair

Penford G et al. CCI 2018;91:71-80
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!
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!
La place des interventions percutanées dans les cardiopathies complexes?

After Unifocalization of MAPCAs

Abnormal pulmonary vasculature remains!

Some complex cases are not amenable to treatment!

Only shifting the obstruction downstream

Aneurysms etc
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After Unifocalization of MAPCAs

BCH data
Freedom from Re-intervention
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After Conduit RV-PA Repair

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


Ewert P et al, 2017
Stents in Pulmonary Arteries

Stents do not last forever!
- Reintervention mandatory
- Neo-intima
- Stent collapse!
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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!
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Stenting branch PAs after arterial switch

Risk of aorto-pulmonary fistulae!

• Some 25 cases described in literature
  • Preminger 1994
  • Takayamo 2002
  • Chiostri 2010
  • Tzifa 2013
  • Vida 2013
  • Page 2015
  • Marini 2015
  • Sato 2015

• Risk factors:

  UHP balloons, fracturing / unzipping stents!
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

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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?
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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
Post-operative arrhythmias

Post surgical rhythm problems

Now:
Almost exclusively treated with percutaneous interventions / medication.
Hybrid biventricular pacing systems.
Subcutaneous ICD

...
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-resorbarbable 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!
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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...
La place des interventions percutanées dans les cardiopathies complexes?
The Future?

A Simplified Technique for Interventional Extracardiac Fontan

Sudesh Prabhu, MCh\textsuperscript{1,2,3}, Ben Anderson, FRACP\textsuperscript{1,2,3}, Cameron Ward, FRACP\textsuperscript{1,2,3}, Tom Karl, FRACS\textsuperscript{2,4}, and Nelson Alphonso, FRACS\textsuperscript{1,2,3}
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!
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