Interventional Management of Coarctation of the Aorta

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Outline

* Anatomical implications
* Indications for intervention
* Balloon dilation/stenting of re-/native CoA
* Outcomes
Prevalence

82% of CoA are isolated lesions

(including patent arterial duct, stretched PFO, BAV)

• 11% associated with VSD
• 7% have important associated cardiac lesions
• 40/100,000 live births
• Rare in the presence of right sided lesions
Indications for intervention

The neonate

*CHF presentation ± associated cardiac lesions*

Infancy

*Arm to leg $\Delta P$ of $\geq 20$ mm Hg with or without arm hypertension*

Adolescents & adults

*Symptoms of exercise intolerance....resting gradient*

.....*associated lesion (LVH, LV dysfunction), CAD, AI*

Exercise gradient? Exercise hypertension? LVH? Diastolic dysfunction?
Therapeutic options

- medical management
- surgical repair
- balloon dilation
- stent implantation

Management options are dictated by

- the age of presentation
- the morphological substrate
Impact of morphology on management

- The lesion is a shelf, projection, or infolding of the aortic media into the lumen, opposite the site of the arterial duct.

- Externally, a localized indentation of the left aortic wall is frequently seen.

- Post-stenotic dilation & paradoxically the wall beyond the lesion is thicker than proximally.

- Ductal tissue forms sling around the aorta.
Morphology & management options
Beyond 3 months of age (±CHF):
  * balloon angioplasty: repeat dilation if isolated restenosis,
  * associated significant TAH; surgical repair

In the older child (>25 kg), adolescents & adults:
  * primary stent implantation
Balloon Angioplasty of Native Coarctation in Children
The Hospital for Sick Children Experience
Outcomes and Predictors of Success

100 patients, male:67, BAV:61, intracardiac anomaly:30

<table>
<thead>
<tr>
<th>Early results</th>
<th>before</th>
<th>after</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure gradient (mmHg)</td>
<td>30±12</td>
<td>7.9±8.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Asc/desc systolic pressure ratio</td>
<td>1.4±0.21</td>
<td>1.1±0.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>CoA dimension (LAO) (mm)</td>
<td>4.6±2.7</td>
<td>8.9±3</td>
<td>0.0001</td>
</tr>
<tr>
<td>CoA dimension (Lat) (mm)</td>
<td>4.8±2.9</td>
<td>9.2±3</td>
<td>0.0001</td>
</tr>
<tr>
<td>CoA/diaph Ao (Lat, LAO)</td>
<td>0.4±0.14</td>
<td>0.7±0.1</td>
<td>0.0001</td>
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Unsuccessful in 7 patients (7%):
6: early reinterventions (1 repeat angioplasty, 5 surgery)
1: medical treatment & later reintervention (surgery)
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Reintervention
9 pts (9%): 7 for unsuccessful procedures
2 for late restenosis (1 repeat balloon, 1 stent)
at a mean of 2±3 yrs (0.1 to 7.5) after the initial procedure

Aneurysm
*MRI or angiographic assessment in 61 patients (90%):
~0.7±0.7 years after BD
*1 pt (0.16%): aneurysm; stable, conservative management
4 pts (0.65%) mild dilation, stable
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Freedom from reintervention

Time Since Initial Balloon Dilation (years)
Disadvantages of balloon angioplasty

- residual stenosis
- recurrent coarctation
- residual hypertension
- aneurysm
- rupture
- femoral artery compromise
Costing concerns

Although it may seem intuitive that balloon dilation would be less expensive than surgery, superior efficacy could potentially overcome the initial BD savings.

In a study of hospital costs, mean dilation costs were $3,995 and surgery $21,393. Using a mean failure rate for BD of 31%, the mean hospital cost of BD/pt would be $10,627. Thus, BD would have to fail 81% of the time to cost more than a primary surgical strategy.

Shim et al. (AJC 1997)
Balloon angioplasty (reCoA)

The Hospital for Sick Children

JACC 1997

90 children

12% acute failures 88% acute success

72% - No reintervention after 12 yrs (ΔP <20 mm Hg)
What if angioplasty fails?

• Due to recurrence (no aneurysm)............................... repeat procedure

• If child >25kg and recurrence........................................ consider stent implantation

• Presence of aneurysm.............................................. if >25 kg consider stenting surgery
Stenting aortic obstructions

Stent implantation for treatment of aortic obstructions has increased over the last 2 decades

- native aortic coarctation
- post surgical or post-intervention recoarctation
- middle aortic syndrome
- hypoplastic aortic arch
CoA stent implantation
Stent implantation extends the percutaneous treatment

Advantages:
- dilatable stenosis which recoil after BD
- tubular CoA
- CoA coexisting with hypoplastic isthmus
- CoA & reCoA resistant to balloon angioplasty

Disadvantages:
- may alter vessel wall compliance, pressure wave propagation & blood pressure
- in the young additional dilations to adjust for growth
Stenting aortic obstructions

Various types of balloon expandable, self expandable & covered stents are available for different types of arch obstructions.
CoA - stent on BIB balloon

CP stent

BIB balloon

Native CoA

Inner balloon inflation

Outer balloon inflation

CP stent mounted on BIB balloon
CoA- stent implantation
CoA complications:

Stent migration or malposition

Neointimal hyperplasia: stent restenosis provoked by over dilating stent at implantation treatment - balloon redilation

Recurrence, persistent CoA under expansion of stent at implantation relative stenosis caused by patient growth stenosis resistant at implantation
CoA complications:

Stent fracture:
  treatment:
  - additional stents
  - covered stent implantation (in-stent stenosis)
CoA complications:

Aortic wall disruption, rare occurs primarily in the adult
CoA – stent implantation results

Over 800 patients have been treated with stent implantation:

- suboptimal gradient reduction <5%
- restenosis <5%
- aneurysm formation, vascular complications, & stent migration <5%

In many centre, stents (& BD) have replaced surgery as the primary management strategy for CoA outside the neonatal period
“There are things we know that we know.

There are known unknowns.

........there are things that we now know we don't know.

But there are also unknown unknowns.

There are things we do not know we don't know.”

Donald Rumsfeld June 6, 2002
CoA Stenting

What we know

Safe to place aortic stents in children >15 kg
Excellent stenosis relief occurs with near abolition of the gradient

However,

Resolution of stenosis may not be curative in regards to:
- long term blood pressure control
- impact on cardiac functional reserve
What do we not know?

What is....

- ...the impact on morphometry of a rigid metal tube in the aorta?
- ...the impact on systolic reserve and diastolic function?
- ....the indication for intervention & reintervention?
- ...the impact on blood pressure homeostasis?
Studied

- Cohort of 31 patients with aortic stent insertion (<18yrs old): 20 native CoA, 20; 11 recurrent CoA

- Study employed echocardiography; vascular ultrasound; ambulatory blood pressure monitoring & exercise testing

- Median age 13.1 yrs (range 4.5 to 17.8 yrs); time from stent implantation median 6 yrs (range 0.2 to 14.1 yrs)

- All had haemodynamically successful treatment, residual invasive gradient median = 1 mm Hg; (range 0 to 14)
Observations

**On ABPM:** 45.2% (n=14) were hypertensive with a median average BP percentile at 84.5% (range 6 to 99%).....despite a median resting arm to leg BP ΔP of only 1 mmHg

**Exaggerated ET** BP response in 80%

Diurnal variation of BP was maintained in all but 6

**LV hypertrophy** was seen in 36% (median LV mass = 88.6 g/m² (range 54.9 to 147.56 g/m²)) & correlated with the mean ABPM systolic percentile (r=0.51;p<0.05)
Observations

ABPM hypertension was independent of the resting arm to leg BP ∆P or exercise hypertension

There were correlations between:

resting arm to leg BP ∆P & the resting ECHO Doppler gradient (r=.44; P<0.05);

LV mass & peak ET BP (r=.51; p<0.05);

ECHO gradient and ABPM percentiles (r=.51; p<0.05)
Observations

Satisfactory anatomical and haemodynamic results in the cath lab do not constitute long-term control of BP

Even in the absence of a significant resting arm to leg or ECHO Doppler gradient;

the proportion of patients with hypertension on the basis of ABPM or exercise testing criteria was high

Whether resting hypertension will evolve in this cohort and the impact of pharmacological intervention requires further study
Summary

Balloon angioplasty for CoA can be performed as a safe & effective treatment, especially for a discrete stenosis without aortic arch hypoplasia.

In older children, when compared to surgery, angioplasty has a similar incidence of ReCoA & complications.

Stent implantation is effective in gradient reduction, long-term blood pressure control remains elusive.
Shokran
شكرا (جزيلا)