Coronary arterial fistula interventions

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Coronary arterial fistulas

- Symptoms occur at the extremes of life
- Symptoms due to CCF in newborn or early infancy
- Beyond 3\textsuperscript{rd} and 4\textsuperscript{th} decades – symptoms of angina, breathlessness, palpitations
- In between, asymptomatic murmur may be the only finding
Coronary arteriovenous fistulas

Some fistulas close spontaneously
Coronary artery fistulas

20 pts – Spontaneous closure up to 15 yrs later (mostly 10 yrs)

Table 1  Presentation, clinical findings, and outcome in seven patients with congenital coronary artery fistulas

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age at diagnosis (months)</th>
<th>Continuous murmur</th>
<th>Fistula course</th>
<th>QP:QS</th>
<th>Age at closure (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Female</td>
<td>3</td>
<td>2/6</td>
<td>RCA/LAD → RV</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
<td>7</td>
<td>2/6</td>
<td>RCA/LCX/LAD → RV</td>
<td>1.3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Female</td>
<td>11</td>
<td>3/6</td>
<td>RCA → RV</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Female</td>
<td>9</td>
<td>3/6</td>
<td>RCA → RV</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Male</td>
<td>18</td>
<td>3/6</td>
<td>LAD → RV</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>6</td>
<td>Male</td>
<td>2</td>
<td>3/6</td>
<td>LAD → RV</td>
<td>–</td>
<td>1.5</td>
</tr>
<tr>
<td>7</td>
<td>Male</td>
<td>3</td>
<td>2/6</td>
<td>LAD → RV</td>
<td>–</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 2  Presentation, clinical findings, and outcome in seven patients with congenital coronary artery fistulas

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sex</th>
<th>Age at diagnosis (months)</th>
<th>Murmur</th>
<th>Fistula course</th>
<th>QP:QS</th>
<th>Age at closure (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morgan et al²</td>
<td>Male</td>
<td>3.5 years</td>
<td>Continuous 4/6</td>
<td>LAD → RV</td>
<td>–</td>
<td>4.5</td>
</tr>
<tr>
<td>Jaffe et al³</td>
<td>Female</td>
<td>29 years</td>
<td>–</td>
<td>RCA → RV</td>
<td>1.1</td>
<td>44</td>
</tr>
<tr>
<td>Mahoney et al⁴</td>
<td>Female</td>
<td>6 months</td>
<td>Continuous 3/6</td>
<td>LCA/RCA → RV</td>
<td>1.4</td>
<td>5</td>
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<tr>
<td>Shubrooks et al⁵</td>
<td>Male</td>
<td>10 years</td>
<td>S-D 4/6</td>
<td>LAD → RV/RA</td>
<td>1</td>
<td>15</td>
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<tr>
<td>Griffiths et al⁶</td>
<td>Female</td>
<td>2 months</td>
<td>Continuous 3/6</td>
<td>LAD/RCA → RV</td>
<td>–</td>
<td>5.5</td>
</tr>
<tr>
<td>Hackett et al⁶</td>
<td>Female</td>
<td>1 year</td>
<td>Continuous 4/6</td>
<td>RCA → RV</td>
<td>1.4</td>
<td>4</td>
</tr>
<tr>
<td>Mühler et al⁸</td>
<td>Male</td>
<td>5 months</td>
<td>Continuous</td>
<td>LAD → RV</td>
<td>1.05</td>
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<tr>
<td>Muthusamy et al⁹</td>
<td>Male</td>
<td>41 years</td>
<td>–</td>
<td>LAD → PA</td>
<td>1</td>
<td>42.5</td>
</tr>
<tr>
<td>Tomita et al¹⁰</td>
<td>Female</td>
<td>1 year</td>
<td>Continuous 3/6</td>
<td>LAD → RV</td>
<td>1.4</td>
<td>4</td>
</tr>
<tr>
<td>Nakatani et al¹¹</td>
<td>Male</td>
<td>55 years</td>
<td>–</td>
<td>RCA/LAD → PA</td>
<td>1</td>
<td>59</td>
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<tr>
<td>Farooki et al¹²</td>
<td>–</td>
<td>10 months</td>
<td>Continuous 3/6</td>
<td>RCA → RV</td>
<td>1.5</td>
<td>Between 8 and 10</td>
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<tr>
<td>–</td>
<td>–</td>
<td>2 months</td>
<td>S-D 2/6</td>
<td>LAD → PA</td>
<td>2.8</td>
<td>4</td>
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<tr>
<td>–</td>
<td>–</td>
<td>35 years</td>
<td>Continuous</td>
<td>LCA → RV</td>
<td>–</td>
<td>36</td>
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<tr>
<td>Jazra et al¹³</td>
<td>Male</td>
<td>4 years</td>
<td>Systolic</td>
<td>RCA → RV</td>
<td>1.1</td>
<td>–</td>
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<tr>
<td>Wong et al¹⁴</td>
<td>Female</td>
<td>4 months</td>
<td>Continuous</td>
<td>LCA → RV</td>
<td>1</td>
<td>–</td>
</tr>
</tbody>
</table>
Coronary arterial fistulas - classification

- **72% fistulas: large 5 – 20mm diameter**
  - 95% single feeding vessel, less tortuous
  - 44% originated from RCA, 56% from LCA
  - 61% drained into RA, 28% into RV, 11% to LV
  - Closed with Gianturco coils or occlusion devices

- **28% fistulas: small <5mm**
  - 88% multiple feeders and more tortuous
  - 88% originated from LCA, 12% from RCA
  - 66% drained into RV, 34% into PA
  - Closed with controlled-release coils
Coronary arterial fistulas

Complications if untreated

- Myocardial ischaemia
- Myocardial infarction
- Arrhythmias
- Endocarditis/endarteritis
- Aneurysm rupture
- Thrombus formation

Indications for closure

- Increased/increasing L ->R shunt
- LV volume overload
- Myocardial ischaemia
- LV dysfunction
- CCF
- Prevention of endocarditis
Coronary artery fistulas

Equipment needed for catheter closure

- Selection of non-tapered catheters
- Berman/Swan-Ganz balloons
- Tracker or Ferret catheters
- Guidewires (0.014” and 0.018”)
- Coils – conventional and controlled-release
- Disc type of occlusion devices
Technique of embolisation

- Aim for complete occlusion
  - Many coils may be needed
  - Consider vascular plugs or similar devices in larger vessels (>3-4 mm)
- Anticoagulation with heparin during procedure
- Vessel access
  - Plugs or other devices may require larger sheaths
- Tortuous routes, acute angles
  - Soft tip catheters, wide range of curves
  - Various wires both soft and stiff
Device choice

- Controlled release devices preferable
- Device choice
  - Vessel diameter
  - Vessel length
  - Vessel tapering (embolisation risk)
  - Risk of unwanted occlusion of side branches
- Device/vessel size ratio (1.3-1.5)
Embolisation devices - coils

- **Standard coils (0.035-0.052”)**
  - Gianturco (various sizes/lengths)
  - Tornado

- **Controlled release coils (0.035”)**
  - Jackson and Flipper coils (Cook)
  - Nit-occlud (PFM) coils

- **Micro coils* (0.014-0.018”)**
  - Target GDC/IDC coils (F3 catheter)
  - Cook DCS coils
Emboliastion Techniques

**Scaffold technique** In high-flow fistulas with large arteries, cross-sectional occlusion achieved by creating a matrix of long high radial force fibered stainless steel.

First coils 2 mm larger than the artery & anchored in a side branch if there is concern about fixation.

With high-flow or very large diameter arteries, embolisation procedure controlled by occlusion balloon (eg Berman) temporarily inflated to stop flow.
Embolisation devices - plugs

Vascular plugs (AGA)

Other AGA devices

The Duct Occluder

ADO II

The Septal Occluder

The Muscular VSD Occluder
Plug devices for embolisation

- Various Amplatzer devices can be used to close fistulas
- ADOs and vascular plugs are useful for some vessels
- Nitinol mesh plug with radio-opaque marker bands at each end, stainless steel microscrew attached to one of the marker bands
- Precise placement but residual flow is common and takes some time to occlude
- **Diameter 4 mm to 16 mm (AVP I), 3 – 22 mm (AVP II)**
- **Need 5 Fr to 9 Fr introducing catheter**
- Stiff delivery cable/sheath may cause difficulties in tortuous routes
Catheter closure of coronary arterial fistulas

Selection of technique determined by:

- Patient:
  - Age and size
  - Catheter size that can be used
- Fistula:
  - Size of the vessel to be occluded
  - Tortuosity of vessels and catheter course
  - High flow in the fistula
  - Aneurysmal fistulas
  - Multiple feeding vessels
Coronary arterial fistulas

Technique of closure

• Access via 2 femoral arteries and 1 femoral vein
• 5 Fr sheaths, appropriate coronary catheters for selective angiography
• Appropriate coronary guiding catheter or cobra catheter
• Can use Gianturco or Cook PDA coils through these
• Tracker 18 *(Target)* or Micro-Ferret catheter *(Cook)* through the guiding catheter if IDC *(Target)* or DCS *(Cook)* coils to be used
• This technique can be used for tortuous fistulas approached via femoral artery
• If Amplatzer devices being considered, then either femoral venous or IJV access needed
• Arteriovenous circuit for Amplatzer devices usually essential
Coronary artery fistulas

**Technique**

- Select appropriate projection of coronary artery anatomy
- Temporary balloon occlusion
  - to test for ischaemia
  - site of occlusion
  - if stop-flow technique needed for coil placement
- First coil placement crucial – fill the dilated vessel by using 30% larger diameter coil than the dilated vessel
- Other coils same size or smaller until aneurysm or dilated vessel filled by a nest of coils
Closure of coronary arterial fistulas – negotiating bends

- Some CAVFs have dilated but straight feeding arteries
- Others have numerous bends
- Is it safe to negotiate these?

- Can use coils, or occlusion devices
Coronary arterial fistulas

When to use Gianturco coils?

• When the route to the occlusion site has few bends
• When guiding catheter can be passed to point of occlusion
Coronary arterial fistulas

When to use controlled-release coils?

- When many bends (usually small fistula)
- When guiding catheter cannot be passed to point of occlusion
- When high flow
- When there is a stenosis at exit point
- Always pack coils to form a nest
Closure of coronary arterial fistulas – negotiating bends

Cook PDA coils delivered by guiding catheter
Closure of coronary arterial fistulas – negotiating bends

Cook PDA coils delivered by guiding catheter
Closure of coronary arterial fistulas – negotiating bends

Numerous bends and smaller size vessels tend to have multiple feeding vessels

Tracker or Micro-Ferret catheter and controlled-release DCS coils
Coronary arterial fistula

Tracker or Micro-Ferret catheters and controlled-release DCS coils
Large coronary arterial fistulas

When to use Amplatzer devices?

- When venous route relatively straight, so access is easier
- Large aneurysmal fistula near point of entry into right heart
Closure of coronary artery fistulas

Amplatzer PDA occluder

AGA sheath placed over A-V circuit

ADO delivered
Closure of coronary artery fistulas

Amplatzer PDA occluder

AGA sheath placed over A-V circuit

ADO delivered
Closure of coronary arterial fistulas – negotiating bends

Temporary balloon occlusion
Closure of coronary arterial fistulas – negotiating bends

RCA to CS CAVF closed with Amplatzer VSD device
Closure of large coronary arterial fistulas

Sluggish blood flow after closure with VSD device

Sudden death 9 months later
Complications of CAVF closure

IDC coils embolised to LPA
Complications of CAVF closure

Persevere in retrieving coils and closing the fistula

Cook PDA coils in good position
Thrombosis of a coronary artery

Occlusion of circumflex artery after coil occlusion of CAVF
Large coronary arterial fistulas – late sequelae

Aneurysms obliterated and normal RCA at 1 yr follow up angiography

Liang et al, Ped Card, 2006
Coronary arterial fistulas – late sequelae

LCA to CS fistula closed with a detachable balloon - 12 yrs FU
Coronary arterial fistulas – late sequelae

LCA to RA fistula – follow up angiogram 2 years later

Masood Sadiq, Lahore
Coronary artery fistulas – follow up

Immediately post

8 yrs later
Catheter closure of large coronary arterial fistulas

• In symptomatic newborn or infant, large fistulas may need to be closed early
• In asymptomatic children, can delay closure until child is old enough to make the procedure technically easier
• In adults, large fistulas need to be closed to treat symptoms or to prevent complications
CONCLUSIONS

• Wide selection of equipment needed in the catheter laboratories
• In large fistulas with easy access by venous approach, Amplatzer devices have an important role
• Sluggish blood flow in the dilated fistula vessel remains a concern about late sequelae
• In most cases, the late results are good
• More studies with follow up angiography and other detailed evaluation are needed

Catheter closure of large coronary arterial fistulas