Nikaidoh Operation

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Disclosures

• NONE
Why do I use the Nikaidoh?

• I was introduced to this technique by my senior partner in 1997

• It works for the most complex cases of TGA/VSD/PS
  - RV hypoplasia,
  - Inlet or distant VSD
  - Abnormal AVV attachments (straddling)
The optimal procedure for the great arteries and left ventricular outflow tract obstruction. An anatomical study∗

Mark Hazekamp *, Francisco Portela, Margot Bartelings

Departments of Cardiothoracic Surgery and Anatomy, Leiden University Medical Center, Leiden, The Netherlands
Hazekamp et al.

• “the theoretical advantages of the Bex—Nikaidoh procedure or posterior translocation of the aorta are obvious: no volume reduction of the RV, an ‘anatomical’ connection of LV to aorta, orthotopic placement of the RV-to-PA conduit, and no right ventriculotomy.”

• Aortic translocation is the only technique that permits biventricular repair in case of inlet or distant muscular VSD, straddling mitral or tricuspid valve, or an already small RV.
Why do I use the Nikaidoh?

• It results in the creation of the “most normal” anatomy
  – LVOT
  – RVOT
The LVOT
Major Contribution

Posterior Translocation of the Aorta

Postop ECHO
LVOT

Nikaidoh

Rastelli

Children’s Hospital of Pittsburgh of UPMC
Sternal Compression

Rastelli / REV

Aortic Translocation
When to use it?

• Always?
  – No

• The diameter of PV is important
  – At least 5mm
PV diameter and size of the infundibular septum determines the distance of the Ao translocation
Initial Management

• Cyanotic neonate
  – Systemic to pulmonary artery shunt

• > 3 months
  – Full repair

• Ideal Age:
  – 6 to 12 months
Pre-op Assessment

• Look at the LVOTO/pulmonary annulus
  – Can it be resected and “switch”? 

• Location and size the VSD

• AVV
  – Straddling?

• Coronary arteries

• RV size
When to abort?

- Coronary artery problems
  - Preventing aortic root harvesting
    - Too close to the annulus
- Complex AVV issues
Complex Coronary Patterns

TYPE E

TYPE B
Abnormal AVV attachments
Operative Management

- Temp: 30 to 32 degrees C
- Bi-caval cannulation / LV vent
- Blood cardioplegia
- MUF
CA mobilization
Aortic Root Harvesting without detaching the CA
PA Transection
Outlet Septum Division
Division of the Outlet Septum
Aortic Translocation
VSD Closure
VSD Closure
Lecompte Maneuver
Aortic Shortening
The LVOT
RVOT Reconstruction
More Extensive Patch
RVOT Reconstruction
Original Technique
Recent Modifications
Circumflex CA from RCA
Circumflex CA from RCA
Abnormal Tricuspid Valve Attachments
Nikaidoh Registry

- Children’s Hospital of Pittsburgh, Pittsburgh, PA
- St. Joseph’s Children Hospital, Tampa, FL
- All Children’s Hospital, St. Petersburg, FL
- Seattle Children’s Hospital, Seattle, WA
- Mount Sinai Medical Center, New York, NY
- Kosair Children’s Hospital, Louisville, KY
- Fundacion Valle Lili, Cali, Colombia
## 32 Patients: D-TGA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Average</th>
<th>Standard Deviation</th>
<th>Range</th>
<th>Median</th>
<th>IQR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>25.5</td>
<td>40</td>
<td>0.2-195</td>
<td>11</td>
<td>7-37.5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>11.1</td>
<td>7.8</td>
<td>2.7-46</td>
<td>8.75</td>
<td>6-14.6</td>
</tr>
<tr>
<td>Bypass Time (min)</td>
<td>220</td>
<td>76</td>
<td>117-405</td>
<td>197</td>
<td>163-259</td>
</tr>
<tr>
<td>XClamp (min)</td>
<td>118</td>
<td>59</td>
<td>16-258</td>
<td>111.5</td>
<td>87.25-178</td>
</tr>
<tr>
<td>ICU LOS (days)</td>
<td>12</td>
<td>16</td>
<td>2-90</td>
<td>6.5</td>
<td>4.25-25</td>
</tr>
<tr>
<td>Hospital LOS (days)</td>
<td>18</td>
<td>17</td>
<td>4-90</td>
<td>13.5</td>
<td>8-21</td>
</tr>
</tbody>
</table>
D-TGA: CA Individual Transfer

- One: 3
- None: 19
- Both: 10

0 5 10 15 20
p<0.05
RV to PA connection

- Conduit: 41%
- None: 59%
Mortality

• In-hospital:
  • 1 hospital mortality
    * 1 patient required cardiac transplantation

• Late:

  1. 10 years latter
     • NI LVF and no AI
     • Severe RV dysfunction secondary to Pulmonary disease
     • Sudden death

  2. 1 months latter
     • Cardiac tamponade

  3. 6 years latter
     • During reoperation for AI
Freedom from LVOT Intervention

Cum Sum

Survival Time (Months)

Censored
Survival Function
LV Function

- Normal: 28
- Mild: 1
- Mod-severe: 2
Aortic valve Insufficiency

- none/trace: 20
- mild: 6
- mod/sev: 5
AI Group

• All patients with moderate to severe AI had both coronary arteries reimplanted (50% of that specific group)

• All operated
  • 3 repairs
  • 2 replacements
  • Time from surgery to repair: 2m, 4y, 5y, 5y, 6y

• Findings:
  • Annular dilatation, leaflet prolapse
• Technical issues?
• Aortic root devascularization?
  • Similar to “Ross procedure” results
• Yeh/Nikaidoh 2007:
  • AI was mild in 9 patients (50%)
  • 63% incidence of aortic annular dilatation
• Emani 2009
  • 25% pts with Aortic root dilatation with Z-score >3
Freedom from AI
Table 5: Primary procedure by anomaly, Last 4 Years (Jul 2008 - Jun 2012) - cont.

<table>
<thead>
<tr>
<th>Primary Procedure</th>
<th>Participant</th>
<th>Mortality</th>
<th>STS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall</td>
<td>Mortality</td>
<td>STS</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>% of All</td>
<td>N</td>
</tr>
<tr>
<td>Fontan, TCPC, External conduit, Nonfenestrated</td>
<td>7</td>
<td>0.4%</td>
<td>0</td>
</tr>
<tr>
<td>Fontan revision or conversion (Re-do Fontan)</td>
<td>19</td>
<td>1.2%</td>
<td>0</td>
</tr>
<tr>
<td>Fontan, Other</td>
<td>5</td>
<td>0.3%</td>
<td>0</td>
</tr>
<tr>
<td>Fontan + Atrioventricular valvuloplasty</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>Ventricular septation</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td><strong>Transposition of the great arteries</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congenitally corrected TGA repair, Atrial switch and ASO (double switch)</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>Congenitally corrected TGA repair, Atrial switch and Rastelli</td>
<td>1</td>
<td>0.1%</td>
<td>0</td>
</tr>
<tr>
<td>Congenitally corrected TGA repair, VSD closure</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>Congenitally corrected TGA repair, VSD closure and LV to PA conduit</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>Congenitally corrected TGA repair, Other</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>Arterial switch operation (ASO)</td>
<td>26</td>
<td>1.5%</td>
<td>0</td>
</tr>
<tr>
<td>Arterial switch operation (ASO) and VSD repair</td>
<td>13</td>
<td>0.8%</td>
<td>0</td>
</tr>
<tr>
<td>Arterial switch procedure + Aortic arch repair</td>
<td>1</td>
<td>0.1%</td>
<td>0</td>
</tr>
<tr>
<td>Arterial switch procedure and VSD repair + Aortic arch repair</td>
<td>2</td>
<td>0.1%</td>
<td>0</td>
</tr>
<tr>
<td>Senning</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>Mustard</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>Atrial baffle procedure, Mustard or Senning revision</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>Rastelli</td>
<td>2</td>
<td>0.1%</td>
<td>0</td>
</tr>
<tr>
<td>REV</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>Aortic root translocation over left ventricle (Including Nikaidoh procedure)</td>
<td>2</td>
<td>0.1%</td>
<td>0</td>
</tr>
<tr>
<td>TGA, Other procedures (Kawashima, LV-PA conduit, other)</td>
<td>0</td>
<td>0.0%</td>
<td>-</td>
</tr>
<tr>
<td>TGA, Other procedures (Nikaido, Kawashima, LV-PA conduit, Other)</td>
<td>1</td>
<td>0.1%</td>
<td>0</td>
</tr>
</tbody>
</table>
Conclusions

• The Nikaidoh procedure is being utilized more often for the management of D-TGA/VSD/PS
  – Representing 10% of “all” procedures

• It is indicated in TGA/VSD/PS with
  – Hypoplastic RV
  – Distant or inlet type VSD
  – Straddling AVV
Conclusions

• The hospital mortality quite acceptable
  – 5%

• There is an incidence of postop AI
  – Avoid reimplanting both CA if possible

• The short, mid and long term follow-up data is encouraging........good!
  – Not a single case of postop LVOTO
  – More data is needed