WHAT IS NEW IN THE MANAGEMENT OF AORTIC DISSECTION (EARLY SEPTOTOMY MAY BE THE FUTURE OF TYPE B AORTIC DISSECTION)

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HYPOTHESIS: FALSE LUMEN DILATION IN PATIENTS WITH TYPE B AORTIC DISSECtIONS IS RELATED TO THE DIASTOLIC PRESSURE AND NOT TO THE THICKNESS OF THE OUTER WALL

Development of false lumen dilation in aortic dissections

Potential Causes:

- Less resistance to dilation of thinner outer wall of the false lumen.
- Inflammation of the wall, degradation of collagen and elastin by MMPs
- Persistent high pressure in the false lumen, mainly diastolic.

Figure 1

Figure 2

Figure 3
In patients with acute dissection the diameter of the false lumen in the abdominal aorta increased after 24 months of treatment.
False Lumen in Type IIIb dissections after EVAR
- Chemelli-Steingruber* reported that after 60 months diameters of the false lumen in Type IIIb TBAD were almost equivalent comparing patients treated with endografts or with medical treatment.
- They concluded that TEVAR delays but does not stop the natural course of the disease.

Chemelli-Steingruber IR MD, Chemelli A, MD, Alexander Straub, MD, Rudy Hugl, MD, Renate Hiemetzberger, MD, Benedikt V. Czermak, MD

Aortic and visceral arteries endarterectomy
- 19 patients underwent aorto-visceral endarterectomy.
- In most of the patients trap-door technique described by Wylie was used.
- No dilatation of the aorta was found. Longest follow-up at the time of publication of the article was 8 years.

Innominate Artery Endarterectomy
- Included the trunk of the innominate artery and the plaque of the thoracic aorta at the ostium of the innominate artery in 34 patients.
- Mean follow-up of 6 years (seven months to 16 years)
- No dilatation seen

Endarterectomy of the Aortic Arch
- Andre Thevenet did not encounter aneurysmal dilatation in any of the 14 patients in whom, under deep hypothermic arrest, he did an endarterectomy of the entire aortic arch through a longitudinal incision. He followed these patients for up to 25 years (Personal communication to Ramon Berguer MD April 2014)

Trans-aortic Endarterectomy and lack of long term wall dilatation
- Forty seven patients underwent trans-aortic visceral endarterectomy of the aorta and visceral arteries.
- This technique provided long term relief of symptoms and didn’t develop dilatation in the endarterectomized area.

Lack of secondary aneurysms after aorto-iliac endarterectomy (AIE)
- Areas of endarterectomy of the aorta and iliac arteries don’t dilate over time.
- In a meta-analysis of 1940 patients* who underwent aorto-iliac endarterectomy between 1963 and 1996, Minimum follow up was 10 years. Secondary aneurysm of the endarterectomy site did not occur in any patient in the 11 articles analyzed.
* Review of Direct Anatomical Open Surgical Management of Atherosclerotic Aorto-Iliac Occlusive Disease
EVS11(2)6, ISSN Davies PC, Nightmare, AW Bradbury,2M Adam, Eur J Vasc Endovasc Surg, (2010) 39, 460-471
Several series of surgical aortic fenestrations (septectomy) performed to treat visceral or limb ischemia in the setting of acute aortic dissection, showed no dilation of the segment of the aorta in which fenestration was performed. Mean follow-up was 10 years with a range of 6 months to 25 years. Total analysis of 62 patients. There were two exceptions of mild dilatation in patients with Marfan disease.


Arteries don’t dilate after endarterectomy or septectomy, including aorta and branches.

Deep femoral veins have been used by Clagett to replace infected aortic prosthesis and infected aorta with great success. No failures in the long term have been reported.

Of note, we have not encountered aneurysmal dilatation of an FV graft so far, a finding also made by Daenens and Ali (Journal of Vascular Surgery).

Thus, dilatation of the false lumen is unrelated to wall thickness.
In patients with partial thrombosis of the false lumen, the risk of death is increased by a factor of 2.7 in comparison with patients with patent false lumen.

Most of the series in which patients are followed for more than 5 years after TEVAR and belong to the IIIb dissection group develop false lumen dilatation in the non stented segment.

Dilatation is related to the presence of open re-entry sites that were transformed in entry sites.

About 60% of the patients treated with TEVAR have partial thrombosis of the false lumen but many of them have persistent flow.
1,129 consecutive patients with TBAAD enrolled in IRAD (International Registry of Acute Aortic Dissection) between 1995 and 2012 who received medical (n . 853, 75.6%) or TEVAR (n . 276, 24.4%) therapy. Adverse events during follow-up: aortic growth/new aneurysm: 73.3% of patients with medical therapy and in 62.7% of patients after TEVAR.

Persistent Entry-Flow
Continued perfusion via pre-existing secondary tears prevents complete thrombosis.
Pressures in the true and false lumen in three cases of aortic dissections:

<table>
<thead>
<tr>
<th>Condition</th>
<th>True lumen</th>
<th>False lumen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruptured</td>
<td>105/72</td>
<td>89/81 mm Hg</td>
</tr>
<tr>
<td>Enlarging</td>
<td>160/95</td>
<td>134/99 mm</td>
</tr>
<tr>
<td>Stable</td>
<td>154/80</td>
<td>98/65 mm</td>
</tr>
</tbody>
</table>

Study of patients with Type B aortic dissections. Evolution of the volume of the false lumen in relationship to the size of the entry and re-entry sites.

Collection of data in relation to diastolic and systolic pressures in the false and true lumen.

The absence of a proximal tear in the presence of distal tear (C) correlated with a significant decrease in systolic pressure in the FL and an elevation of diastolic pressure. This is comparable with Type BIII ATBD after TEVAR.

Maximum diastolic pressure in the false lumen was found in the model with a small proximal entry site and no re-entry site, less, but high distolic pressure in the false lumen was found in the presence of a large entry site and a small re-entry site. The case in which the proximal entry site was small with a larger distal re-entry the distolic pressure was lower than the former model.

The absence of a proximal tear in the presence of distal tear (C) correlated with a significant decrease in systolic pressure in the FL and an elevation of diastolic pressure. This is comparable with Type BIII ATBD after TEVAR.

Conclusions: In this model of chronic type B aortic dissection, diastolic false lumen pressure was the highest in the setting of smaller proximal tear size and the lack of a distal tear.

In the absence of proximal tear and a 3.2 cm distal tear the diastolic pressure was significantly higher in the FL compared with the TL (Situation similar than TEVAR in Type III B aortic dissection).
Type B dissection model inserted in flow rig

Acute Type B dissection

Chronic Type B dissection

A good numerical model of a vessel predicts the mechanical events of its physical counterpart

Bench-Top Dissection Model

Elasticity Values and MMP-2 and MMP-9 Levels in Aortic Dissection

Table 1. Relationship between MMPs levels and the Elastic Modulus

<table>
<thead>
<tr>
<th>Patient</th>
<th>MMP-2 (ng/ml)</th>
<th>MMP-9 (ng/ml)</th>
<th>Elastic Modulus (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient #1</td>
<td>8.61</td>
<td>12.37</td>
<td>4.04</td>
</tr>
<tr>
<td>Patient #2</td>
<td>26.21</td>
<td>15.3</td>
<td>8.37</td>
</tr>
</tbody>
</table>

Inverse relationship between the maximum elastic modulus and the levels of MMP-2 and a direct correlation between this modulus and the levels of MMP-9
Elasticity Values and MMP-2 and MMP-9 Levels in Aortic Dissection

MMPs upregulation after septectomy is similar to upregulation occurring after spontaneous dissection.

Methods to prevent dilatation of the false lumen in type IIIb dissections after TEVAR

- Petticoat technique
- Candy-Plug
- Knicher Blocker technique
- Coils in the false lumen
- Stabilize approach
- Occlusion of the re-entry/ entry sites
- Endovascular septotomy and stenting.

Outcomes after false lumen embolization with covered stent devices in chronic dissection

Jahanzaib Idrees, Eric E. Roselli, Susan Shafii, Joshua Reside, Bruce W. Lytle
p1507–1513
Journal of Vascular Surgery. Published online: October 24, 2014

Covered stent devices included iliac plugs in 18, nitinol embolization plugs in two, and occluded stent graft in one. More than one device was used in 15 patients.

Presence of back-flow to the false lumen due to incomplete aposition of the distal end of the endograft. Treatment of type A aortic dissection with replacement of the ascending aorta arch and placement of an elephant trunk graft, extended with an endograft.

Eric Roselli’s Technique developed at the Cleveland Clinic

Fig 2

Covered stent devices included iliac plugs in 18, nitinol embolization plugs in two, and occluded stent graft in one. More than one device was used in 15 patients.

Fig 1. Chronic aorta with aneurysm after first stage repair. A. The arrows show the dissection in panel A. B marks distal landing zone for the second-stage thoracic repair. Panel C shows distal landing zone proximally 10 cm. Panel D shows distal landing zone peripherally 5 cm and proximally 10 cm. Panel E shows distal landing zone peripherally 10 cm and proximally 5 cm. Panel F shows distal landing zone peripherally 5 cm and proximally 10 cm.
Fenestration done at the level of the visceral segment of the aorta. Fenestration allows apposition and sealing of the distal endograft.

Eric Roselli's Technique developed at the Cleveland Clinic

Relamination

Aortic Dissection

ENDOVASCULAR FENESTRATION

- Minimally invasive alternative to surgical fenestration
- Complex endovascular procedure
  Role of IVUS/adjuvant stenting
- Local expertise a definite factor!

Using 10 mm diameter balloon to create a fenestration between the two lumens did not prevent false lumen dilatation.

Potential advantages of Septotomy with percutaneous Cutter

- We have proven in an experimental model that an extensive percutaneous septotomy done in the distal aorta that opens at least 250 square millimeters equalizes pressures in true and false lumens.
- The procedure is simple and cheap

<table>
<thead>
<tr>
<th>PRESSURE DIFFERENCE (FALSE – TRUE) in mmHg</th>
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<tbody>
<tr>
<td>MODEL (proximal area – distal area in mm²)</td>
</tr>
<tr>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>40-9</td>
</tr>
<tr>
<td>40-20</td>
</tr>
<tr>
<td>40-40</td>
</tr>
<tr>
<td>155-40</td>
</tr>
<tr>
<td>155-40 with Partial TL Occlusion</td>
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</tbody>
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Correlation between size of tear (s) and pressure difference between FL and TL utilizing 40% glycerin perfusion.
Complete treatment for Type IIIB, C, and D Aortic dissection could include TEVAR and an extensive septotomy performed percutaneously in the acute phase if the dissection is complicated or after a month in the rest of the cases. Stents can be used in addition in cases of static malperfusion associated with the condition.

Late failures caused by dilation of the false lumen will not occur and chronic dissections will not represent a problem any more.

Complementary treatment with extensive septotomy could be needed in most of IIIb TBAD to prevent long term dilatation of the false lumen.
Conclusions:

- In the future many, if not all Type B aortic dissections will be treated with TEVAR occluding the entry site.
- Complementary treatment with extensive septotomy could be needed in most of IIIb TBAD to prevent infra-diaphragmatic aortic dilatation.