State of Art Hybrid Approach for Complex Aorta Diseases

Won Ho Kim, MD
Division of Cardiology, Eulji University Hospital
Eulji University School of Medicine, Daejeon, Korea
Introduction

Hybrid procedure in the modern era:

Combination of surgery & percutaneous intervention, staged by minutes, hours, or at most, days

Hybrid CABG/PCI, hybrid PCI/valve, hybrid AF procedure

Hybrid approach for complex aorta Dz

J Am Coll Cardiol Intv 2008;1:459-68
Hybrid procedure for complex aorta Dz

- Thoracic aortic aneurysm / dissection (TAA-D)
- Thoraco-abdominal aneurysm / dissection
- Abdominal aortic aneurysm / dissection
Hybrid approach in TAA & TAD

Limitation of endovascular stent grafting

Goal of hybrid approach:

- Maintain flow to supra aortic trunk (prevent stroke)
- Prevent the significant morbidity, mortality associated with these complex arch pathology & surgery

J Cardiovasc Surg 2010;51:807-19
Zone 0:
- Confined to the ascending aorta
- Necessity for achieving a proximal seal in the ascending aorta

Zone 1:
- Region between IA & Lt.CCA

Zone 2:
- Region between Lt.CCA & Lt.SCA

Zone 3:
- Region between Lt.CCA & DTA

Zone 4:
- Confined to DTA
Hybrid Aortic Repair

2 components:

Open surgical procedure:
- Based on the extent of the arch that is involved with Dz
- Allows proximal extension of SGs into the aortic arch

Thoracic endovascular aortic repair (TEVAR)
(or open stent graft)
Various surgical procedures

- Ascending aorta to innominate artery (IA) & Lt.CCA bypass
- Ascending aorta replacement with reimplantation IA & Lt.CCA
- Ascending aorta replacement & graft to IA & CCA bypass
- Rt.CCA to Lt.CCA bypass with or without Lt.CCA to LSA bypass
- Rt.axillofemoral bypass & Rt.CCA to Lt.CCA bypass
- Bilateral axillofemoral bypass & Lt.CCA to LSA bypass

Proposed classification-1 (TAAD)

-Classified based on:
  - Anatomy of the lesion (extent of the lesion)
  - Suitability of the proximal & distal landing zones
  - Type I, type II, & type III hybrid arch repairs

By Szeto W, et al.
Type I: Isolated aortic arch aneurysm

Brachiocephalic bypass with endovascular repair of the aortic arch

Arch debranching procedure:
After debranching, exclusion of the lesion with TEVAR

Eliminating hypothermic circulatory arrest & potentially CP-bypass

Type II:

Aortic arch reconstruction with the stented-elephant trunk.

Surgical proximal aortic reconstruction combined with SG of the distal arch & DTA.

Not aneurysmal at DTA (normal distal landing zone).
Typically, SG is deployed during hypothermic arrest:

- Frozen elephant trunk creation
- Antegrad via the open arch into the DTA

Following SG deployment:

- Repair the ascending aortic aneurysm & arch
- Using a standard Dacron grafts

Ann Thorac Surg 2007;83:S819-23
Type III:

Elephant trunk repair with completion endovascular repair of the thoraco-abdominal aorta

Typically, 2 staged procedure:

- First stage, similar to that of type II repair:
  - Open arch surgery, or frozen elephant procedure
  - Secondary placement of a thoracic SG
Maximal diameter:
- 6.3 cm in the aortic arch
- 4.6 cm in the ascending aorta
- 4.3 cm in the DTA
Elephant trunk completion & CABG

Trifurcated graft
Valiant® Thoracic Stentgraft (Medtronic, Santa Rosa, California):
Made of 40-36 mm tapered diameter & 150mm length
Post-stent graft-CT-Aorta
Proposed classification-2 (TAAD)

Classified based on:

- Whether the arch is surgically replaced or excluded with a stent-graft

Type I, type II hybrid arch repairs

By Koullias GJ, et al.
Type I hybrid repair:

- Arch should be treated with surgery
- SG extends treatment area by exclusion
- Role of TEVAR is secondary
- Ex) Frozen elephant trunk procedure
Type II hybrid repair:

Arch is retained but SG excludes the arch

Role of TEVAR is primary

Open surgical component:

An adjunctive for revascularizing the great vessels

Safety & efficacy (in TAA / TAD)

- Acceptable mortality & morbidity
- Higher incidence of early endovascular leaks:
  - High resolution at 6 months of follow-up (90%)
- Long term results are unknown
State-of-the-Art of Hybrid Procedures for the Aortic Arch: A Meta-Analysis

15 studies with 463 patients

Outcomes:
- 30-day mortality (8.3%)
- Stroke (4.4%)
- Paraplegia (3.9%)
- Endoleak rates (9.2%)

Results compare favorably with surgery.
Hybrid repair of thoracic aortic lesions for zone 0 and 1 in high-risk patients

N=38 (Zone 0; n=27, zone 1; n=11), follow-up of 28 months

Outcomes:
- Post op HD (7.9%)
- Paraplegia (2.7%)
- Stroke (13.1%)
- Overall 30-day mortality (23.7%)

Midterm results of a hybrid approach to DeBakey type I AD

Outcomes:

Hospital mortality (4.2%)

Complete thrombosis of the residual distal FL (95.6%)

Overall actuarial survival at 28 months (92.1 ± 7.9%)
Thoracoabdominal aneurysm-dissection

A fundamental problem in the surgery:

Extensive aortic exposure & prolonged interruption of aortic flow to the visceral branches while excluding the aneurysm itself from circulation

Associated with remarkable morbidity & mortality rates
Benefit of hybrid approach

- Not require thoracotomy:
  - Fewer systematic & cardiac complications
  - Less postoperative pain & blood loss
  - Fewer coagulation disorders
  - Reduced rate of spinal cord injury
  - Reduced duration of mesenteric & visceral ischemia
  - Reduced renal failure

Ann Thorac Surg 2010;89:1475-81
Various surgical procedures

- Iliac-celiac-superior mesenteric artery (SMA) bypass
- Retrograde aortoceliac-SMA bypass
- Aorto-innominate & aorto-Lt.CCA bypass
- Ascending aorta to innominate artery (IA) & Lt.CCA bypass
- Visceral or renal re-routing (bypass)
Single or staged (2nd stage) procedure

Single stage strategy:
- Eliminate the risk of intersurgical aortic rupture
- Offer a prompt iliac or aortic access site
  (when femoral accesses are not adequate)

Two staged approach:
- Reduces the burden of procedure
- Theoretically, reduces the risk of coagulopathy

J Cardiovasc Surg (Torino) 2010;51:821-32
Safety & efficacy (in thoracoabdominal aortic pathology)

.Reduce complications in the average, low risk patient

 Extend the indications for repair to patients considered higher risk based on age, co-morbidities, or anatomic considerations

.Debate – high risk patients (outcomes of meta-analysis)

J Am Coll Surg 2007;205:420-31
Hybrid procedures for thoracoabdominal aortic aneurysms and chronic aortic dissections – A single center experience in 28 patients

Mean follow up 22 months, upto 6 years

Outcomes:

- 30 days mortality rate (14.3%)
- Overall survival rate at 3 years (70%)
- Type I endoleak rate (8%)
- Permanent paraplegia rate (11%)

Combined endovascular and surgical approach (CESA) to thoracoabdominal aortic pathology: A 10-year experience

Mean follow up of 16.6 months (range, 1-119 months) with a hybrid approach in 20 patients

Outcomes:
- No perioperative mortality
- Cumulative survival at two years (76%)
- Two stage approach is preferable

In high risk patients:
- Acceptable morbidity & mortality
Hybrid Open Endovascular Technique for Aortic Thoracoabdominal Pathologies

To assess the safety & efficacy of these technique:

- 19 studies with a total of 507 patients

- Technical success, visceral graft patency, spinal cord ischemia, renal insufficiency, & 30 days mortality

Circulation 2011;124:2670-80
Primary technical success: 96.2%  
Visceral graft patency: 96.5%  
30 days mortality: 12.8%  
Paraplegia: 4.5%  

No significant differences compared with surgery
LSA coverage during TEVAR

Or
Up 40% of patients undergoing TEVAR:

Pathology that extends near the LSA

Debate regarding the operative management of the LSA:

Satisfactory outcomes with intentional coverage

Revascularization to reduce the incidence of complications such as stroke, paraplegia, arm ischemia

Rec 1:

In elective TEVAR (coverage of LSA for SG sealing)

Suggest routine pre-op revascularization

Rec 3:

In urgent TEVAR (life threatening condition)

Suggest that revascularization should be individualized

Recommendation, but very low evidence
Rec 2:

In anatomy that compromises perfusion to critical organ

**Strongly recommended** routine pre-op revascularization:

- Presence of a patent LIMA to CABG
- Stenotic or poor developed Rt.VA
- Functioning AVF in the Lt.arm (HD patient)
- Prior infra-renal aortic repair with ligation of lumbar artery
- Hypogastric artery occlusion
- Abnormality of Lt.VA or vertebrobasilar collaterals

Outcomes of the endovascular management of aortic arch aneurysm: Implications for management of the left subclavian artery

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Revascularized (n = 35)</th>
<th>Not revascularized (n = 43)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke, No. (%)</td>
<td>0</td>
<td>5 (11.6)</td>
<td>.061</td>
</tr>
<tr>
<td>Paraplegia, No. (%)</td>
<td>0</td>
<td>3 (6.98)</td>
<td>.248</td>
</tr>
<tr>
<td>Death, No. (%)</td>
<td>0</td>
<td>6 (14.0)</td>
<td>.03</td>
</tr>
<tr>
<td>Combined outcome, No. (%)</td>
<td>0</td>
<td>12 (27.9)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
Left subclavian artery coverage during thoracic endovascular aortic repair and risk of perioperative stroke or death

30 days-stroke or mortality (no cover, n=454 vs cover, n=279):

Stroke rate 5.7%, mortality rate 7.0%

Odds ratio

OR 2.17, p=0.019

OR 1.70, p=0.057
Post-traumatic aortic pseudo-aneurysm
Left hemothorax with multiple rib fracture
Modified TEVAR with chimney technique
SG deployment
Conclusion

Selection of hybrid approach:

- High-risk for surgery
- Inadequate length of the landing zone

Results compare favorably with surgery (in TAA / TAD)

Debate in patients with thoracoabdominal aortic pathology

Revascularization of LSA before endovascular stenting
Thanks yours attention