Thoracic endovascular aneurysm repair

A novel method of assisting deployment

RLH

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Michael Cunningham
Going to talk a little about TEVAR and specifically about an interesting and new technique used in a case in the heart 4 a couple of weeks ago.

The patient was a 74 year old gentleman who required a graft from the middle of the thoracic arch. As a result, his left carotid and subclavian arteries were to be compromised and he required a 2-stage procedure, initially a carotid cross-over graft and then the thoracic grafting.

In order to introduce the talk, I'm going to talk very briefly about ...
Plan

- Thoracic aortic aneurysms
- Overview of TEVAR
- Anaesthetic management
- Published outcomes data
- Novel methods of assisting deployment
Aortic aneurysm count for 2% of all deaths in men > 60yrs

There are two treatment options. Medical and surgical.

For AAA,

Risk of rupture < 1% p.a. If AP diameter less than 55mm

17% p.a. if > 60mm

So cut-offs of 45-55 mm are used to whether to pursue medical or surgical treatment
Major, thoracic procedure with significant mortality (approx 5%) and prolong convalescence (6 months).

A less invasive approach has long been discussed ...
History of EVAR

- Initial experiments 1960’s
- 1991 Parodi et.al. reported results of first five human trials in AAA. Three successes.
  - Dacron tubes anchored with stents
  - Used balloon expansion to secure the grafts
- 1999 FDA approval of 2 endovascular stents for repair of infra-renal aortic aneurysm
- 2005 FDA approval of thoracic stent for descending aneurysm repair.
- Initially reserved for patients regarded as being unfit for open procedures.

  2001-2004 accounted for 29,542 of 61,598 elective AAA in US

Requirement for balloon fixation resulted in similar physiological insult as cross-clamping.

The grafts were secured with barbs into the wall of the aorta and were prone to complications such as migration. In order to reduce this, induced hypotension, adenosine-induced asystole or even induced VF were applied.

Current grafts are fully stented ...
EVAR

• Aortic stent introduced via femoral artery
• Must achieve tight fit above and below aneurysm to exclude from circulation

• Limited by anatomical constraints
• Straight neck > 15mm in length
• Minimal atherosclerotic plaque
• Femoral artery > 8mm diameter (introduced 7.5mm)

They are inserted with an introducer via the femoral arteries and expand at the time of deployment, pressing against the walls of the aorta to exclude the aneurysm sac from the circulation ....
Procedure

- Expose femoral arteries
- Angiogram
- Graft delivery system introduced via arteriotomy
- When in correct position, deployed under fluoroscopic guidance.
- Deployment may compromise left subclavian / common carotid
Anaesthetic management for TEVAR

• Pre-op
  • As for open procedure

• Intra-op
  • Right radial arterial cannula
  • Two large-bore peripheral cannulae
  • LA (6%) / Regional (25%) / GA (69%)
  • 5000 IU heparin once femoral arteries exposed
  • Good hydration (contrast media)
  • Control of blood pressure at deployment

• Post-op
  • HDU monitoring

• Left brachial may be required for
  • Angiography catheter
  • Balloon occlusion of aorta

Preparation as for open because there is a 2% conversion rate

Left brachial artery may be required for angiography catheter or, rarely balloon occlusion of the aorta to control haemorrhage.

Where the graft will occlude the left subclavian, there will be loss of meaningful pressure monitoring.
Anaesthetic management for TEVAR

- **Pre-op**
  - As for open procedure
- **Intra-op**
  - Right radial arterial cannula
  - Two large-bore peripheral cannulae
  - LA (6%) / Regional (25%) / GA (69%)
  - 5000 IU heparin once femoral arteries exposed
  - Good hydration (contrast media)
  - Control of blood pressure at deployment
- **Post-op**
  - HDU monitoring

EUROSCORE (2006)

GA remains the most common approach, but regional and LA are used.

Claims that there is reduced morbidity and mortality with regional techniques.

GA remains the most common as reported by the EUROSTAR registry in 2006 [Report 2006]

GA may be preferable, as it allows controlled ventilation which can improve the quality of DSA and even permits periods with 'lungs off'
As the femoral artery is exposed, 5000 U of heparin is given.

Good hydration is important as the patient receives significant volumes of contrast media.

At the time of deployment, hypotension may be induced with GTN, nitroprusside or bolus propfol. Where the landing zone is small, adenosine induced asystole may be required, or occasionally, other techniques.
Complications

- Myocardial dysfunction
- Neurological deficit
- Bleeding
- Conversion to open procedure (2%)
- Dissection
- Embolization
- Renal failure

- Endoleak 5-10%
- Migration
- Post-implantation syndrome
- Rupture
- Spinal cord ischaemia

Endoleak – inability to obtain or maintain complete exclusion of the aneurysm sac from the circulation. Demands long-term follow-up to exclude.

Post-implantation syndrome – fever, raised CRP and WCC in the absence of infection. Usually last 2-10 days and responds well to NSAIDs.

Spinal cord ischaemia has been reported and appears to be associated with concomitant or previous AAA repair, long-segment thoracic aortic exclusion appear to be important risk factors. CSF drainage procedures have been shown to reverse delayed-onset neurological deficit and some centres use peri-operative CSF drainage in all high-risk patients [Miller 2010]
Outcomes

Relatively new technique

Initially applied to patients deemed unfit for open repairs, so trial data is relatively limited.

To data, 3 major trials have reported, they are:
EVAR-1 Trial

- Reported 2004
- Randomized 1082 patients to endovascular or open repair
- AAA > 5.5 cm
- Age > 60 yrs
- 30 day operative mortality 1.7 v 4.7% and sustained to 4 years (26 v 29%)
- Secondary interventions more common in EVAR group (9.8% v 5.8%)
- Rates of complications (41% v 9%) and reinterventions (20% v 6%) lower in open repair group
- No significant differences in quality of life
- 30% increase in hospital costs for endovascular group.

Results consistent with DREAM, but not increased operative costs for no clear benefit.
DREAM Trial

- Reported 2005
- Randomised 351 patients to open / endovascular management.
- AAA > 4.9 cm
- 30 day operative mortality 1.2 v 4.6%
- At 2 years, no difference in cumulative mortality (10%) or survival free of complications (66%)
- Better quality of life in open-repair group from 6 months on.

Dutch randomized endovascular aneurysm management trial (DREAM)

Netherlands and Belgium

Patients deemed suitable for either form of treatment.
EVAR-2 Trial

- Reported 2005
- Randomised 338 patients to endovascular repair or medical management
- AAA > 5.5 cm
- Age > 60 years
- Unfit for open repair
- 30 day operative mortality 9%
- 4-year mortality rate for both groups 64%
- Significant increase in costs.
The problem!

- 74 yr old male for TEVAR
- COPD

- Small landing zone (15mm)
- Proximal surgery
- Request for transient hypotension!
Induced hypotension

- Adenosine
- Dipyridamole
- Esmolol
- Vasodilators
- Induced VF
- Overdrive pacing
- Balloon occlusion

Adenosine can provide transient asystole, but individual response is variable and typically only 5s which may be inadequate.

GTN, nitroprusside and esmolol are relatively long acting

Induced VF or overdrive pacing are effective, but unfamiliar, run the risk of persisting arrythmias and result in increase cardiac work during the time of hypotension.

In our patient, the use of adenosine, esmolol or dipyridamole were undesirable as all are associated with a risk of provoking bronchospasm.

That leaves balloon occlusion!
Induced hypotension

- Adenosine
- Dipyridamole
- Vasodilators
- Induced VF
- Overdrive pacing
- Balloon occlusion
Partial RA inflow occlusion

- Mechanical means of inducing rapidly reversible hypotension
- Balloon introduced via femoral vein
- Inflated with 15-25 mls contrast-saline mixture (25-30mm)
- Position by angiogram or appearance
- Traction applied
- Rapid onset of hypotension
Inflow occlusion

Occludes to IVC only. As a result, about 20% of venous return (IVC) is unimpaired
### Inflow occlusion

<table>
<thead>
<tr>
<th>Results</th>
<th>Complications</th>
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<tbody>
<tr>
<td>• 2007-2009 22 cases</td>
<td>• None reported</td>
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<tr>
<td>• Rapid (60-90s) attainment of ABP of 50-60mmHg</td>
<td>Anticipated</td>
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<td>• Rapid 60-120s reversal</td>
<td>• DVT</td>
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<td>• Haemorrhage</td>
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<td>• IVC avulsion</td>
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Paper presented by W.A. Lee, associate professor of surgery at the University of Florida, College of Medicine.

Presented results of 22 cases between September 2008 and August 2009.

DVT is a recognized complication after femoral vein access for IVC filter placement. Although clinically asymptomatic, duplex imaging has identified clot in 25-40%. This may be indicative of this, special population and there were no reports of thrombosis in the study group.
Conclusion

In a case series of 1 ...

- The technique worked as described
- It would be interesting to collect a series.
Questions ?