

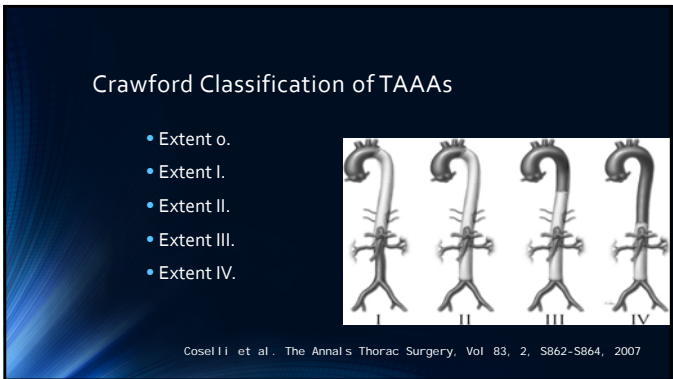
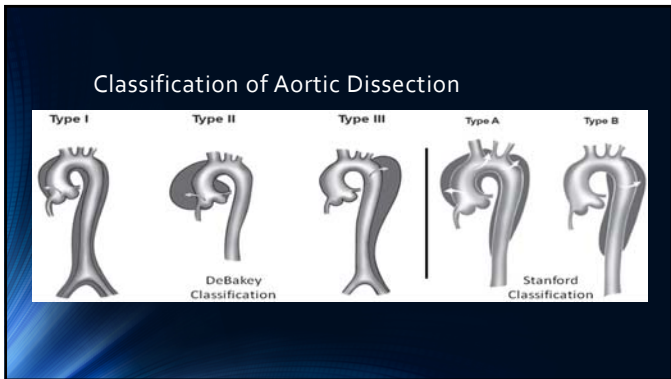
EVAR and TEVAR – Anesthetic Perspective

FERENC PUSKAS, MD, PHD

- ### Objectives
- Understand when to worry about spinal cord ischemia and what can we do about it
 - Develop a protocol for the most appropriate management of a patient undergoing TEVAR
 - Discuss risks vs. benefits of general anesthesia vs. regional anesthesia vs. local anesthesia with sedation for EVAR

- ### Abbreviations
- TAAA: Thoracoabdominal aortic aneurysm
 - SCI: Spinal cord injury
 - ER and SR: Endovascular and Surgical Repair
 - EVAR: Endovascular aneurysm repair for AAA treatment
 - TEVAR: Thoracic endovascular aneurysm repair

- ### Historical Perspective
- 1953, DeBakey and Cooley: first successful resection of TAAA
 - 1990s endovascular stents pioneered
 - 2005 FDA approves TEV(A)R for aneurysm stenting
 - September 13, 2013, FDA approves the GORE, January 28, 2014, the Medtronic Valiant endovascular stent system for type B dissection treatment



Extent Definition

Type	Definition
0	Distal to LCA to above diaphragm
1	Distal to LCA beyond diaphragm, above renal
2	Distal to LCA, below renal arteries
3	Distal 6 th intercostal space, below renal arteries
4	Below diaphragm to below renal arteries

Does endovascular surgery decrease the risk of spinal cord injury?

SCI after 2286 Open TAAAs

Extent of repair	Patients (n)	30-day survival, n (%)	Paraplegia/Paraparesis n (%)	Renal Failure, n (%)
I.	706	671 (95.0)	23 (3.3)	19 (2.7)
II.	762	716 (94.0)	48 (6.3)	63 (8.3)
III.	391	370 (94.6)	10 (2.6)	24 (6.1)
IV.	427	414 (97.0)	6 (1.4)	23 (5.4)
Total	2286	2171 (95.0)	87 (3.8)	129 (5.6)

Coselli et al. The Annals Thoracic Surgery, Vol 83, 2, S862-S864, 2007

Medtronic thoracic endovascular registry

- Aka MOTHER database
- From 5 prospective studies
- 1010 patients
 - 670 thoracic aortic aneurysm
 - 195 chronic type B dissection
 - 114 acute type B dissection

SCI outcome

Elective	Thoracic Aneurysm (n=625)	Chronic Type B (n=179)
Spinal Cord Injury, n(%)	30 (5)	6 (3)

Non-elective	Thoracic Aneurysm (n=38)	Chronic Type B (n=15)	Acute Type B (n=114)
Spinal Cord Injury, n(%)	5 (11)	0 (0)	2 (2)

	Paraplegia	Paraparesis	Resolution
Spinal Cord Injury (n=42)	15	27	12

Patterson B, et al. Circulation 127:24-32, 2013.

Cleveland Clinic Comparison of Endo (ER) versus Surgical (SR) Repair

- Roy Greenberg et al.
- Consecutive cohort of patients between 2001 to 2006
- Treated electively
- 724 patients (352 ER v. 372 SR)

SCI by Extent of Aneurysmal Diseases

Extent	Repair	n	SCI n	SCI %
None	ER	163	1	1
	SR	136	1	1
I.	ER	82	8	10
	SR	51	7	14
II.	ER	16	3	19
	SR	59	13	22
III.	ER	22	1	5
	SR	42	6	10
IV.	ER	49	2	3
	SR	64	1	2
All	ER	352	15	4
	SR	372	28	8

Circulation, Volume 118(8):808-817, August 19, 2008

Author's Conclusions

- Extent to extent the risk of SCI between ER versus SR is not significantly different
- TEVAR patients tend to be sicker
- The most important factor is the extent of disease and required repair procedure
 - Extent II. being the highest risk
- Prior distal aortic repair preceding ER, increases risk of SCI (compromised iliac circulation)
- Patients with SCI are more likely to die

Author's Conclusions

- SCI is more likely to manifest early after SR
- SCI after ER is characterized by a 'delayed' manner and associated with postoperative hypotension:
 - delayed: the appearance of paraparesis or paraplegia in 24 to 48 hours

Thus understanding the type and planned anatomical extent of aortic surgery is critical in assessing the risk of SCI

TAKE HOME MESSAGE

In addition, clinical experience and research have shown us that the most effective approach to decrease spinal cord injury is to thoroughly understand the spinal cord circulation and its response to arterial occlusion

Spinal cord blood supply

TWO MAJOR ARTERIES AND THE COLLATERALS

Important concepts

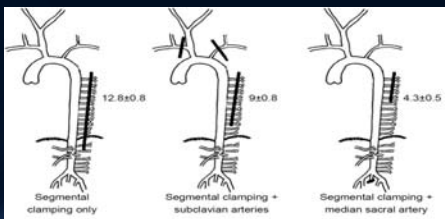
- 2 major arteries
 - Subclavian artery
 - Hypogastric artery (internal iliac)
- Segmental Arterial Network
 - Only 6 to 8 segmental feeder from the aorta, penetrate the dura, mostly from the left
 - Extensive collaterals (paraspinal muscles)

Spinal Cord Collaterals



Bischoff MS et al. Perspectives in Vascular Surgery and Endovascular Therapy 23 (3) 214-222, 2011

Number of clamped SA before MEP loss



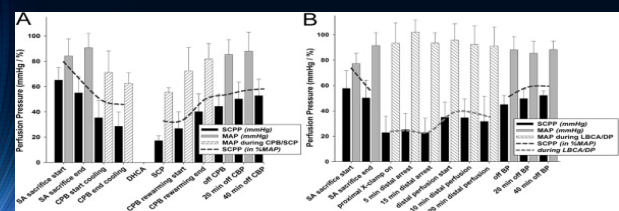
Bischoff MS et al. Perspectives in Vascular Surgery and Endovascular Therapy 23 (3) 214-222, 2011

Spinal or CSF drain

- Initial CSF pressure usually 12-20 mmHg
- Recommendation is to drain CSF to 10 -12 mmHg
- Traditional teaching: SCP=MAP-CSFP
- Does decreasing CSF pressure by 5 - 10 mmHg really has a significant effect on spinal cord perfusion?

Direct Spinal Cord Perfusion Pressure Monitoring in Extent 2 Aortic Aneurysm Repair

- Randall B. Griepp, MD
- Ann Thoracic Surg, 2009;87:1764
- Mount Sinai, Cardiothoracic Surg
- 13 patients had SA pressure directly monitored
- Intraoperatively and up to 48 hrs



Collateral Network Pressure (CNP)

- 75 % of mean arterial pressure at baseline
- It falls variably with X-clamp down to 20 – 40 mmHg
- True spinal cord perfusion pressure?
 - $SCPP = CNP - CSF$ (or CVP) pressure
 - Decreasing CSF pressure from 12-20 down to <10 mmHg does have a significant perfusion effect

Bischoff MS et al. Perspectives in Vascular Surgery and Endovascular Therapy 23 (3) 214-222, 2011.

Recommendations for Spinal Cord Protection

Open and endovascular thoracic aortic repair with high risk for spinal cord ischemic injury (Class I)

2010 Guidelines for the Diagnosis and Management of patients with thoracic aortic disease. Circulation, 2010; 121:e266-e369

High Risk for SCI Endovascular Repair

- Emergent Surgery
- Perioperative Hypotension
- Extent II. coverage
- Subclavian coverage without revascularization
- Previous distal aortic surgery
- Iliac artery injury
 - Distal spinal cord perfusion

Lowers SCI risk

- CSF drain for Extent 2 or High Risk repairs
 - < 10mmHg CSF pressure and CVP
- Distal aortic perfusion (SR)
 - Iliac artery perfusion (SR and ER)
- MAP > 90 mmHg
- Staged procedure
 - Maintaining subclavian patency
 - Avoid Iliac injury!!!

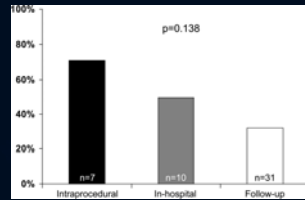
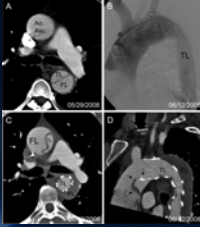
Spinal cord protection protocol

- Place CSF drain the day before surgery
- Record opening pressure, zero to RA
- If pressure exceeds 12 mmHg, pressure goal < 10mmHg
- Limit CSF drain to less than 20 ml over 1st-hr
- Limit CSF drain to less than 40 ml over 4-hours
- If SSEP signal decrease drain 10 ml
- MAP > 90 hgmm post-surgery
- Clamp drain after confirming bilateral lower extremity function
- Remove drain after 24 hrs of clamping
- Reopen/Drain if delayed paraparesis/paraplegia
- If CSF turns bloody turn off drain, consider, CT or MRI

TEVAR Anesthetic Protocol

- Always a GA
- Assess risk of SCI
 - Consider spinal drain
 - And neuromonitoring
- Arterial line
- Two 16G IVs
- Let the MAP run up after stent placement
- TEE (risk of retrograde dissection, risk 1.33%)

Retrograde Dissection after Type B Dissection Stenting and its mortality



Eggebrecht H et al. *Circulation*. 2009;120:5276-5281

What about EVARS?

Why????

TO PUT A TUBE AND A COUPLE OF IVS???



Choice of Anesthetic

- No prospective randomized controlled trial
- None of the outcome studies considered anesthesia to be a factor
- Evidence from retrospective and observational studies

Anesthetic techniques for EVAR

- General Anesthesia
- Regional Anesthesia (epidural alone or spinal or combined)
- Local Anesthesia (local groin infiltration) with sedation

Risk-adapted Outcome after Endovascular Aortic Aneurysm Repair: Analysis of Anesthesia Types Based on EUROSTAR data

- Ruppert et al. *Journal of Endovascular Therapy*, 14 (1), 2007.
- 1997 and 2004, 164 centers, 5557 patients
- Patients were divided into low-risk (ASA I or II.), high-risk (ASA III or IV), LA, GA, RA into 6 groups.
- Low-risk group: 78.8% GA, 15.9% had RA, 5.3% LA
- High-risk group: 60.4% GA, 33.7% RA, 5.9% LA

Outcomes

- GA vs. RA or LA: less systemic complications (cardiac, cerebral, pulmonary, renal, hepatobiliary, sepsis)
- GA versus RA: less 30 days early death in the RA group
- Less ICU admission with local and regional (low risk and high risk)

	ICU admission %	Systemic Complications	Early death
GA	13.6/19.2	18.3%	4.3%
RA	9.5/7.8	10.7%	3.0%
LA	2.9/1.2	9.0%	3.6%

Locoregional anesthesia for endovascular aneurysm repair

- J Vasc Surgery 2011
- Ten studies, 13,455
- No difference in 30-day mortality
- LA patients are older postoperative comorbidities

GA < RA < LA

SHORT TERM OUTCOMES
TAKE HOME MESSAGE

Observation from the IMPROVE trial

- Trial concerning the clinical care of patients with ruptured abdominal aortic aneurysms (BJS 2014; 101:216-224)
- Prospective multicenter, mostly UK, observational
- Anesthesia type on the discretion of the care team
- 558 with a symptomatic or ruptured aneurysm
- Lowest blood pressure (<70 Systolic) was strongly and independently associated with 30-days mortality (51 versus 34.1)
- EVAR with local anesthesia (adjusted to variables) alone had greatly reduced (4 fold) 30 days mortality

AJAX trial

RANDOMIZED CONTROLLED TRIAL

Endovascular Repair Versus Open Repair of Ruptured Abdominal Aortic Aneurysms

A Multicenter Randomized Controlled Trial

Jorik J. Reimerink, MD,* Liselot L. Hoornweg, MD, PhD,* Anco C. IJth, MD, PhD,† Willem Wisselink, MD, PhD,‡
 Ted A. A. van den Broek, MD, PhD,§ Dionk A. Legemate, MD, PhD,* Jim A. Reekers, MD, PhD,¶
 and Ron Balm, MD, PhD* on behalf of the Amsterdam Aortic Aneurysm Trial Collaborators

AJAX trial

- Primary outcome: Death and severe complications
- Secondary outcomes: Morbidity
- 116 patients randomized
- 26 of 57 patient EVAR was started with local, 13 of them were converted to general (5 converted to open repair, 8 discomfort)

AJAX trial

- Death and severe complications at 30 days:
 - EVAR: 42%
 - Open repair: 47% (N.S.)
- 30 days mortality
 - EVAR: 21%
 - Open: 25% (N.S.)
- Occurred less often in the EVAR group: renal insufficiency

AJAX trial

- The low open repair mortality was very surprising:
 - 65% expected, 47% actual
- **Introduction of round-the-clock aneurysm service**
 - Centralization of care
 - Routine preoperative CTA
- Average open repair
 - OR time: 157 min
 - Surgery time: 125 min
 - EBL: 3500 ml

Cost of EVAR

- Mean cost difference between EVAR and open repair:
 - 30 days: 5306 euro
 - 6 months: 10189 euro
- Cost effectiveness ratio per prevented death at 6 month:
 - 424,542 euro
- No benefit in Quality of Life

Conclusion: EVAR may be more effective for rAAA, but its increased costs mean that it is unaffordable based on current standards of societal willingness-to-pay for health gains.

EVAR Anesthetic Plan

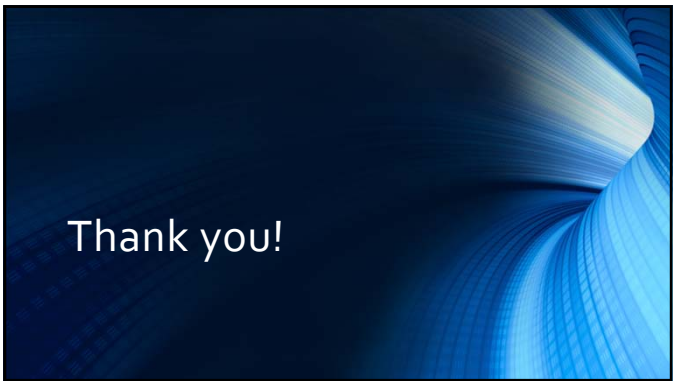
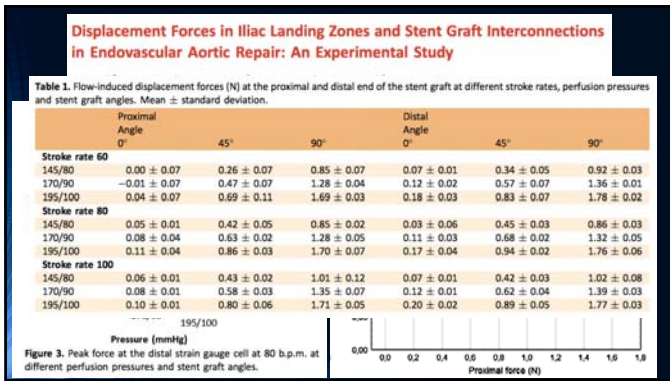
- Do not need Cardiac Anesthesia
- Local for emergent until rupture is controlled
- Keep MAP > 70
- LA > RA > GA
 - Arterial line
 - Couple of big IVs
- 'Outpatient EVARS'

Limitations to Local or Regional

- Pre-existing anticoagulation - unable to bridge
- Obesity
- OSA
- Patient compliance
- Potential need for iliac access

Stent migration and BP?

WHAT SHOULD BE THE BLOOD PRESSURE BE AT DEPLOYMENT?



Final session of the Cardiac block..

- Case presentations
- Quick Question:
 - Preload (volume) management , General Anesthesia cases in patients with RV dysfunction?
 - Hypertrophied or dilated RV, with PS and PI?
 - With or without pulmonary hypertension?
- Limit fluids? Use inotropes first?
- Give fluids, inotropes second?
- How about phenylephrine?