TAAA open repair: new techniques to improve outcomes

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Disclosures

- I do not have any potential conflicts of interest

Outcomes of 3309 thoracoabdominal aortic aneurysm repairs

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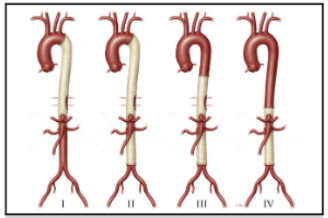
ABSTRACT

Objective: Since the pioneering era of E. Stanley Crawford, our multimodal strategy for thoracoabdominal aortic aneurysm repair has evolved. We describe our approximately 3-decade single-practice experience regarding 3309 thoracoabdominal aortic aneurysm repairs and identify predictors of early death and other adverse postoperative outcomes.

Methods: We analyzed retrospective (1986-2006) and prospective data (2006-2014) obtained from patients (2043 male; median age, 67 [59-73] years) who underwent 914 Crawford extent I, 1066 extent II, 660 extent III, and 669 extent IV thoracoabdominal aortic aneurysm repairs, of which 723 (21.8%) were urgent or emergency. Repairs were performed to treat degenerative aneurysm (64.2%) or aortic dissection (35.8%). The outcomes examined included operative death (ie, 30-day or in-hospital death) and permanent stroke, paraplegia, paraparesis, and renal failure necessitating dialysis, as well as adverse event, a composite of these outcomes.

Results: There were 249 operative deaths (7.5%). Permanent paraplegia and paraparesis occurred after 97 (2.9%) and 81 (2.4%) repairs, respectively. Of 189 patients (5.7%) with permanent renal failure, 107 died in the hospital. Permanent stroke was relatively uncommon (n = 74; 2.2%). The rate of the composite adverse event (n = 478; 14.4%) was highest after extent II repair (n = 203; 19.0%) and lowest after extent IV repair (n = 67; 10.2%; $P < .0001$). Estimated postoperative survival was 83.5% ± 0.7% at 1 year, 63.6% ± 0.9% at 5 years, 36.8% ± 1.0% at 10 years, and 18.3% ± 0.9% at 15 years.

Conclusions: Repairing thoracoabdominal aortic aneurysms poses substantial risks, particularly when the entire thoracoabdominal aorta (extent II) is replaced. Nonetheless, our data suggest that thoracoabdominal aortic aneurysm repair, when performed at an experienced center, can produce respectable outcomes. (J Thorac Cardiovasc Surg 2016;151:1323-38)



Outcomes of TAAA repair differ by Crawford extent.

Central Message

Open TAAA repair produces respectable outcomes, but there is clearly room for improvement. Outcome differs by repair extent.

Perspective

We present the results of 3309 open TAAA repairs to elucidate operative risk. These repairs require interrupting blood flow to vital organs, which incurs the risk of postoperative paraplegia, renal failure, and other complications. Our data suggest that open TAAA repair performed at an experienced center can produce respectable outcomes, but further improvement is needed.

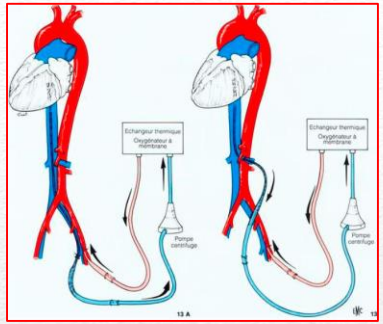
See Editorial Commentary page 1339.

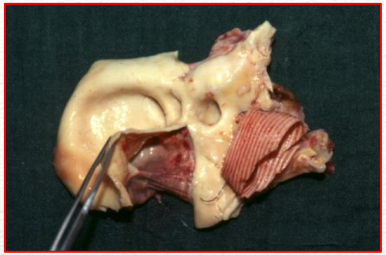
See Editorial page 1232.

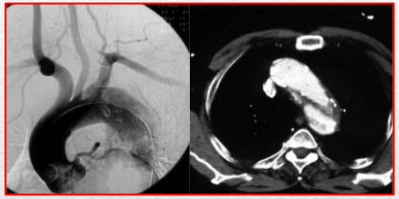
Methods of protection / clamping

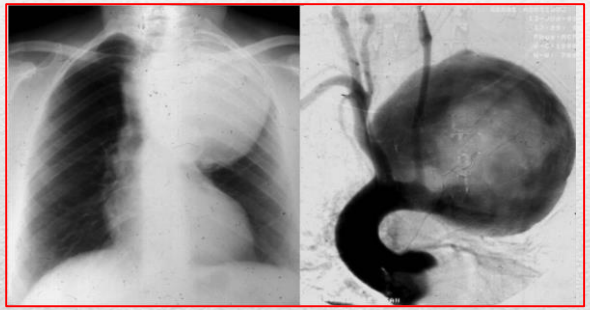
- Simple cross-clamping
- Atrio-femoral left bypass
- PARTIAL CPB

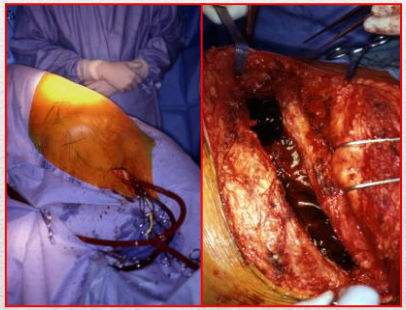
  (fem-fem >> Pulm A or LRV – fem A)
- DHCA



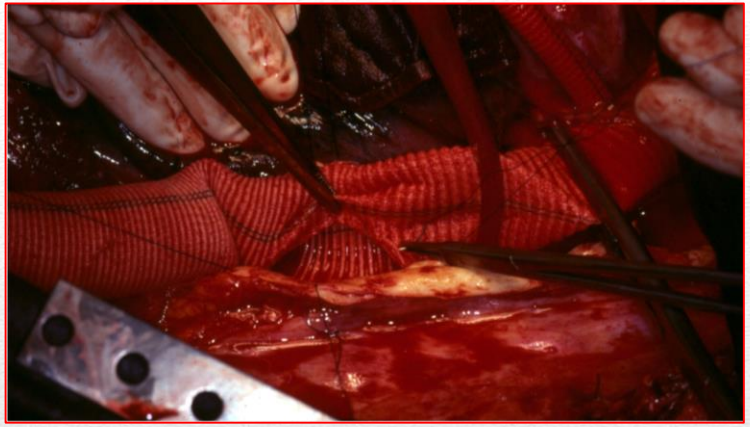


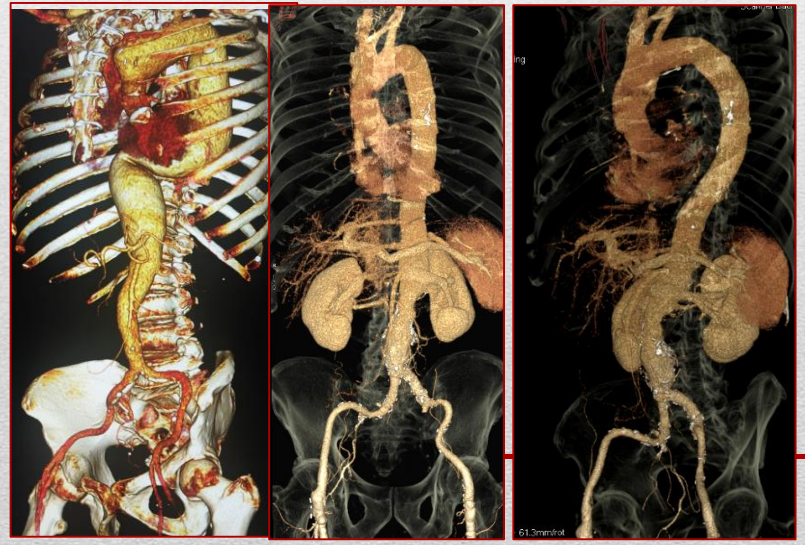


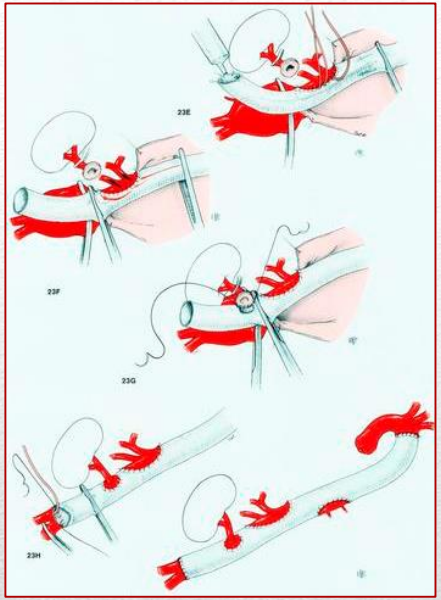




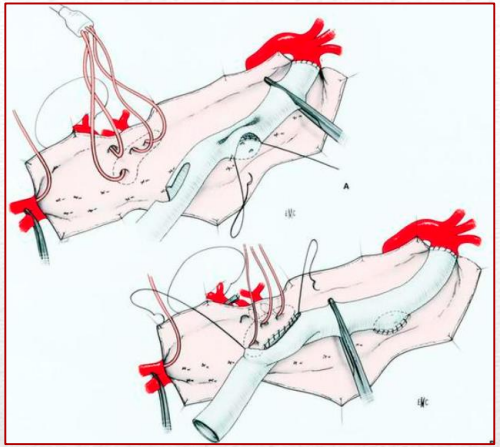
DHCA Advantages	DHCA Drawbacks
Routine technique of open repair	Coagulation disorders
Bloodless operative field	Respiratory complications
Avoid proximal aortic control and clamping	
Spinal cord and visceral protection	







Sequential clamping

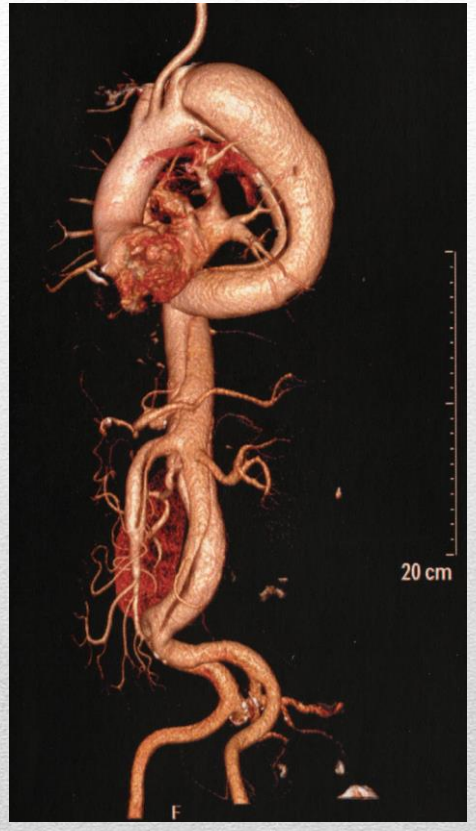


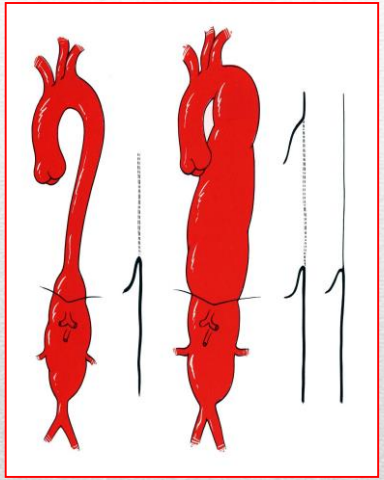
Selective visceral perfusion

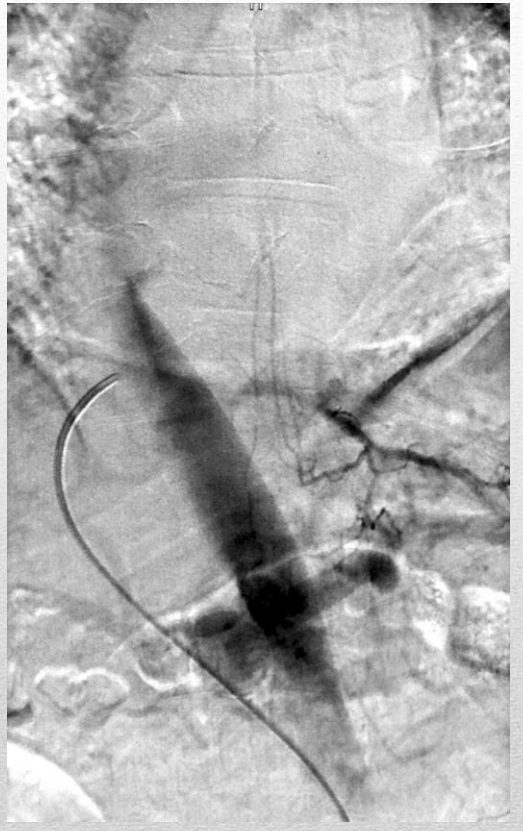
No technical possibility of sequential clamping

Critical segmental arteries supplying the spinal cord close to the visceral arteries

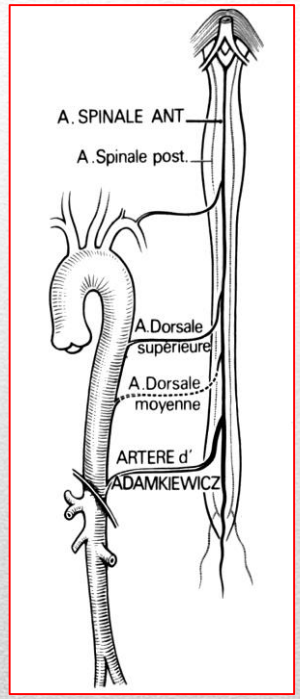
Preservation of spinal cord blood supply

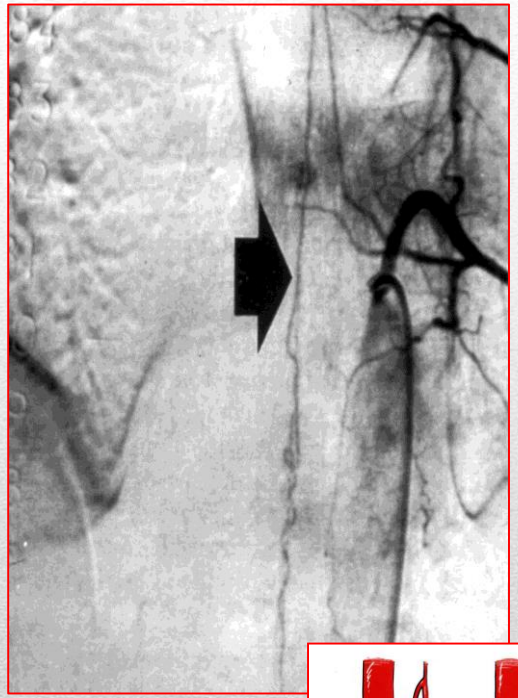


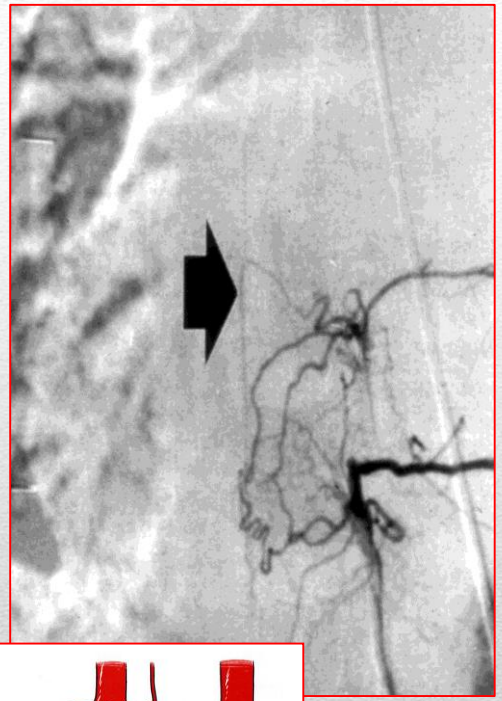


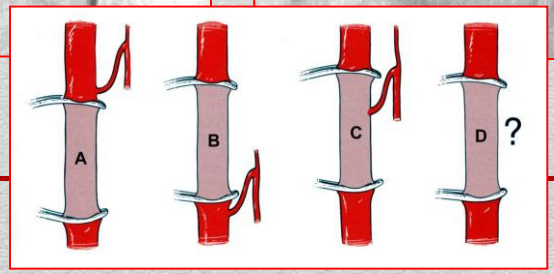


Prevention of spinal cord ischemia









The impact of preoperative identification of the Adamkiewicz artery on descending and thoracoabdominal aortic repair

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ABSTRACT

Objective: To investigate the impact of preoperative identification of the Adamkiewicz artery (AKA) on prevention of spinal cord injury (SCI) through the multicenter Japanese Study of Spinal Cord Protection in Descending and Thoracoabdominal Aortic Repair (JASPAR) registry.

Methods: Between January 2000 and October 2011, 2435 descending/thoracoabdominal aortic repairs were performed, including 1998 elective repairs and 437 urgent repairs, in 14 major centers in Japan. The mean patient age was 67 ± 13 years, and 74.2% were males. There were 1471 open repairs (ORs), including 748 descending and 137 thoracoabdominal extent [Ex] I, 136 Ex II, 194 Ex III, 115 Ex IV, and 138 Ex V, and 964 endovascular repairs (EVRs). Of the 2435 patients, 1252 (51%) underwent preoperative magnetic resonance or computed tomography angiography to identify the AKA.

Results: The AKA was identified in 1096 of the 1252 patients who underwent preoperative imaging (87.6%). Hospital mortality was 9.2% (n = 136) in those who underwent OR and 6.4% (n = 62) in those who underwent EVR. The incidence of SCI was 7.3% in the OR group (descending, 4.2%; Ex I, 9.4%; Ex II, 14.0%; Ex III, 14.4%; Ex IV, 4.2 %; Ex V, 7.2%) and 2.9% in the EVR group. The risk factors for SCI in ORs were advanced age, extended repair, emergency, and occluded bilateral hypogastric arteries. In ORs of the aortic segment involving the AKA, having no AKA reconstruction was a significant risk factor for SCI (odds ratio, 2.79, 95% confidence interval, 1.14-6.79; $P = .024$).

Conclusions: In descending/thoracoabdominal aortic repairs, preoperative AKA identification with its adequate reconstruction or preservation, especially, in ORs of aortic pathologies involving the AKA, would be a useful adjunct for more secure spinal cord protection. (J Thorac Cardiovasc Surg 2016;151:122-8)

The Adamkiewicz artery, which arises from the intercostal artery in the aneurysm, is depicted.

Central Message

Identification of the Adamkiewicz artery would be an adjunct for spinal cord safety in descending/thoracoabdominal aortic repairs.

Perspective

For spinal cord safety, preoperative anatomic comprehension of spinal cord circulation would be beneficial as an adjunct in conjunction with appropriate subsequent strategies and surgical techniques, including other protective supports. Subsequently, the outcomes of aortic repairs would be improved, with lower mortality and morbidity rates.

See Editorial Commentary page 129.

Prevention of spinal cord ischemia: current Pitie-Salpetriere protocol

- Spinal cord blood supply imaging: arterio-CT-scan (except emergencies and most type IV TAAs)
- Reattachment of critical arteries
- CPB (with or without mild hypothermia or DHCA)
- Spinal fluid drainage
- Blood pressure monitoring / peroperatively and during ICU stay

Clinical Utility of Intraoperative Motor-Evoked Potential Monitoring to Prevent Postoperative Spinal Cord Injury in Thoracic and Thoracoabdominal Aneurysm Repair: An Audit of the Japanese Association of Spinal Cord Protection in Aortic Surgery Database

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BACKGROUND: Spinal cord ischemic injury is the most devastating sequela of descending and thoracoabdominal aortic surgery. Motor-evoked potentials (MEPs) have been used to intraoperatively assess motor tract function, but it remains unclear whether MEP monitoring can decrease the incidence of postoperative motor deficits. Therefore, we reviewed multicenter medical records of patients who had undergone descending and thoracoabdominal aortic repair (both open surgery and endovascular repair) to assess the association of MEP monitoring with postoperative motor deficits.

METHODS: Patients included in the study underwent descending or thoracoabdominal aortic repair at 12 hospitals belonging to the Japanese Association of Spinal Cord Protection in Aortic Surgery between 2000 and 2013. Using multivariable mixed-effects logistic regression analysis, we investigated whether intraoperative MEP monitoring was associated with postoperative motor deficits at discharge after open and endovascular aortic repair.

RESULTS: We reviewed data from 1214 patients (open surgery, 601 [49.5%]; endovascular repair, 613 [50.5%]). MEP monitoring was performed in 631 patients and not performed in the remaining 583 patients. Postoperative motor deficits were observed in 75 (6.2%) patients at discharge. Multivariable logistic regression analysis revealed that postoperative motor deficits at discharge did not have a significant association with MEP monitoring (adjusted odds ratio [OR], 1.13; 95% confidence interval [CI], 0.69–1.88; $P = .624$), but with other factors: history of neural deficits (adjusted OR, 6.08; 95% CI, 3.10–11.91; $P < .001$), spinal drainage (adjusted OR, 2.14; 95% CI, 1.32–3.47; $P = .002$), and endovascular procedure (adjusted OR, 0.45; 95% CI, 0.27–0.76; $P = .003$). The sensitivity and specificity of MEP <25% of control value for motor deficits at discharge were 37.8% (95% CI, 26.5%–49.5%) and 95.5% (95% CI, 94.7%–96.4%), respectively.

CONCLUSIONS: MEP monitoring was not significantly associated with motor deficits at discharge. (Anesth Analg XXX;XXX:00–00)

KEY POINTS

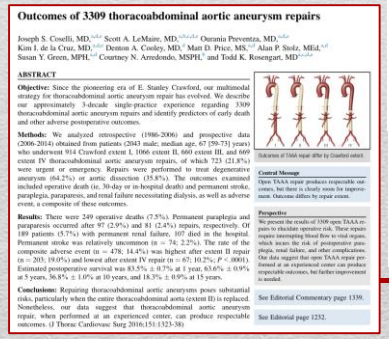
- **Questions:** Could motor-evoked potential (MEP) monitoring reduce the incidence of postoperative motor deficits in thoracic and thoracoabdominal aortic aneurysms repair?
- **Findings:** MEP monitoring was not associated with decreased postoperative motor deficits. Interventions to treat depressed MEP signal were no more effective than spontaneous recovery.
- **Meanings:** MEP monitoring did not reduce the postoperative motor deficits in thoracic and thoracoabdominal aortic aneurysms repair.

Anesth Analg 2017

TABLE 4. Results of consecutive elective cases (n = 2586)

Variable	All n = 2586	Extent I n = 700	Extent II n = 866	Extent III n = 504	Extent IV n = 516	*P* value
Adverse event	329 (12.7)	63 (9.0)	154 (17.8)	73 (14.5)	39 (7.6)	<.001
Operative mortality	161 (6.2)	32 (4.6)	72 (8.3)	41 (8.1)	16 (3.1)	<.001
Permanent paraplegia*	66 (2.6)	8 (1.1)	37 (4.3)	18 (3.6)	3 (0.6)	<.001
Permanent paraparesis*	57 (2.2)	14 (2.0)	25 (2.9)	10 (2.0)	8 (1.6)	.4
Permanent renal failure necessitating dialysis*	132 (5.1)	17 (2.4)	64 (7.4)	28 (5.6)	23 (4.5)	<.001
Permanent stroke*	60 (2.3)	17 (2.4)	31 (3.6)	5 (1.0)	7 (1.4)	.007
Survival with life-altering complication†	168 (6.5)	31 (4.4)	82 (9.5)	32 (6.3)	23 (4.5)	<.001

Values are n (%). Outcomes of interest (paraplegia, paraparesis, renal failure necessitating dialysis, and stroke) are permanent complications present at discharge or present in those patients with early death. *Excludes 5 patients who died during the operation. †Discharge with permanent paraplegia, paraparesis, renal failure, or stroke in 2425 early survivors of elective repair.



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Conclusions: Repairing thoracoabdominal aortic aneurysms poses substantial risks, particularly when the entire thoracoabdominal aorta (extent II) is replaced. Nonetheless, our data suggest that thoracoabdominal aortic aneurysm repair, when performed at an experienced center, can produce respectable outcomes. (J Thorac Cardiovasc Surg 2016;151:1323-38)

Outcomes of 3309 thoracoabdominal aortic aneurysm repairs differ by Crawford extent.

Central Message

Open TAAA repair produces respectable outcomes, but there is clearly room for improvement. Outcome differs by repair extent.

Perspective

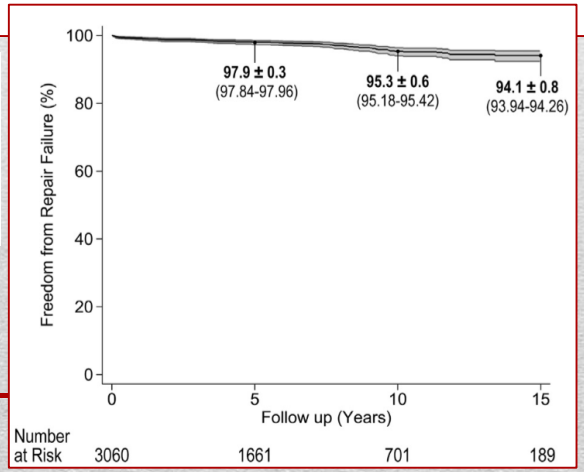
We present the results of 3309 open TAAA repairs to elucidate operative risk. These repairs require interrupting blood flow to vital organs, which incurs the risk of postoperative paraplegia, renal failure, and other complications. Our data suggest that open TAAA repair performed at an experienced center can produce respectable outcomes, but further improvement is needed.

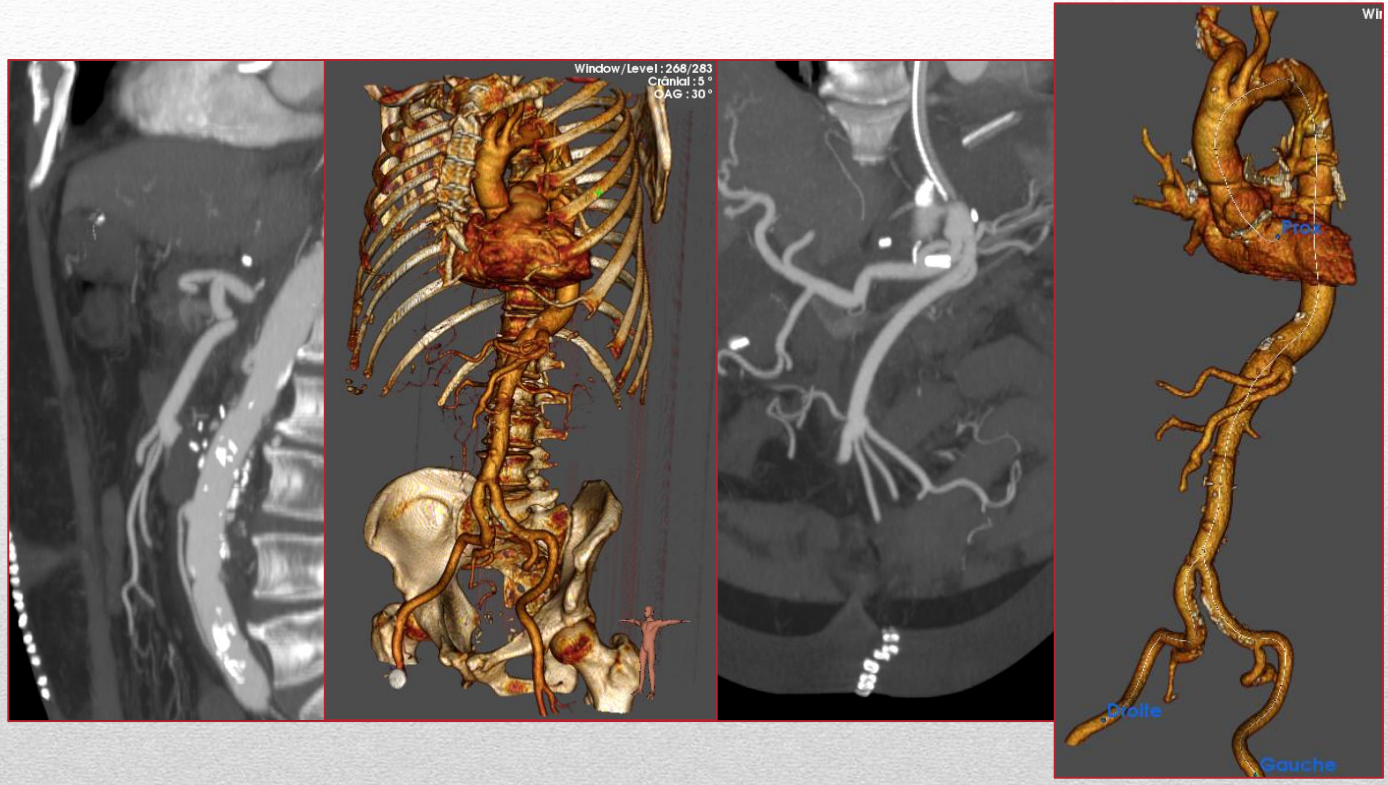
See Editorial Commentary page 1339.

See Editorial page 1232.

Open repair yields respectable results to which endo should now be compared with …/...

…/... with no compromise regarding the long-term efficiency

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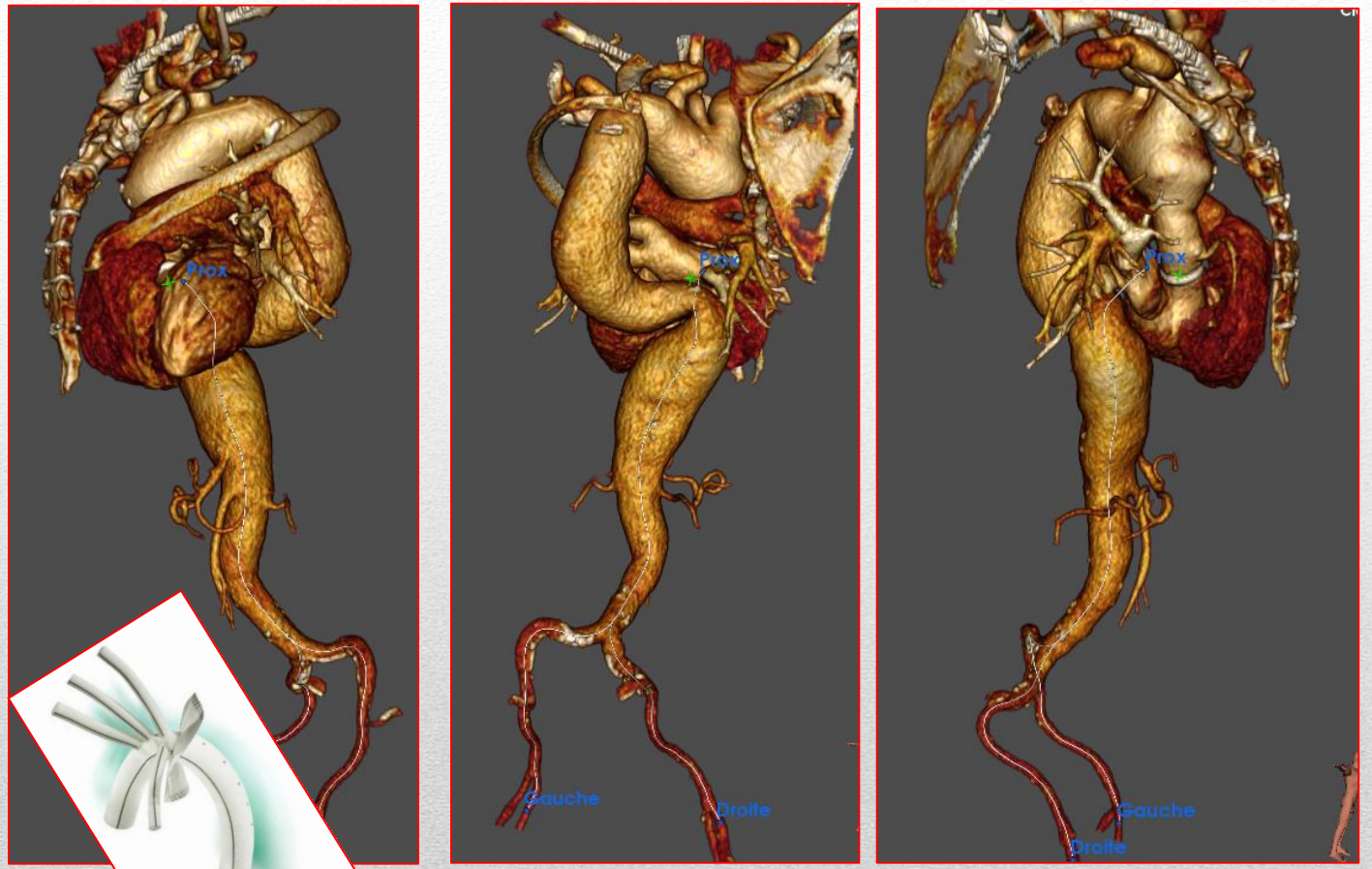
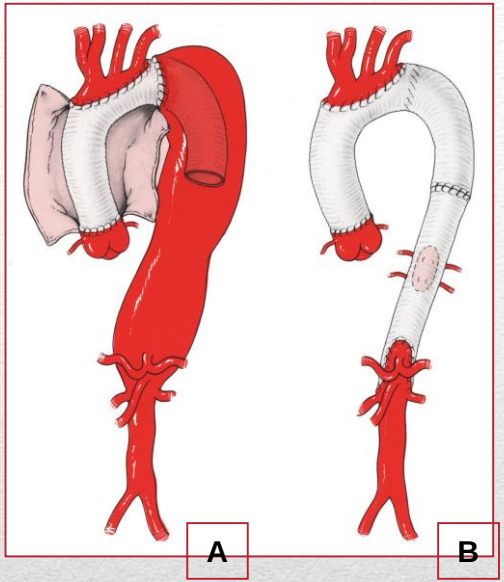
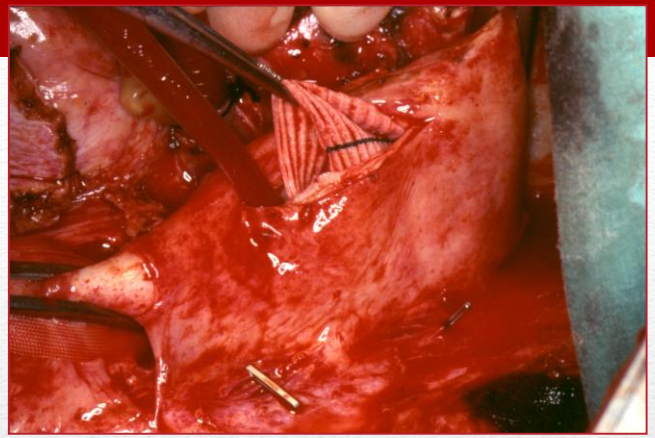
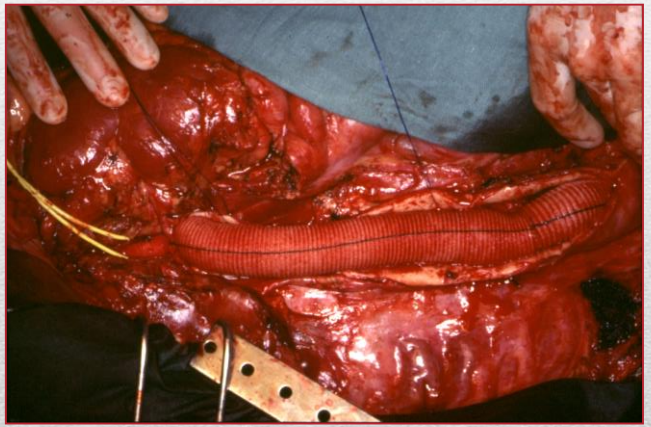
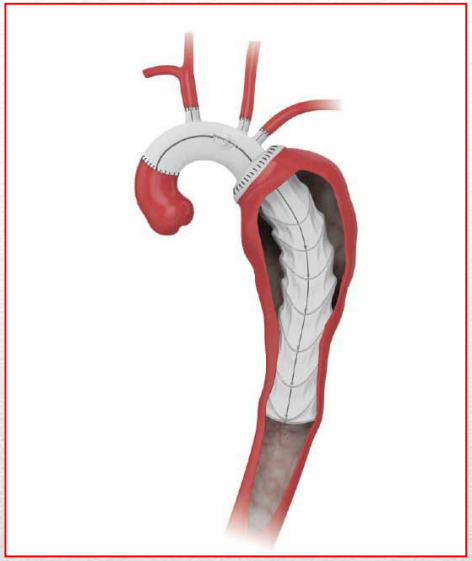


Use of the elephant trunk technique







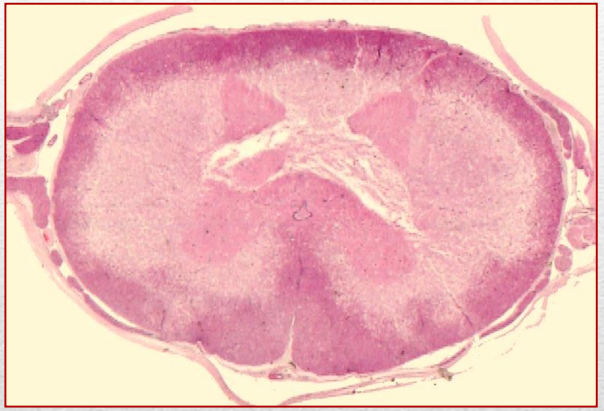


Use of the (frozen) elephant trunk technique

What to expect from new techniques for open repair?

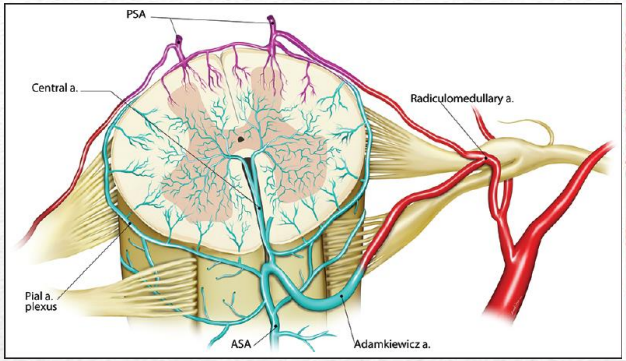
Prevention of spinal cord ischemia

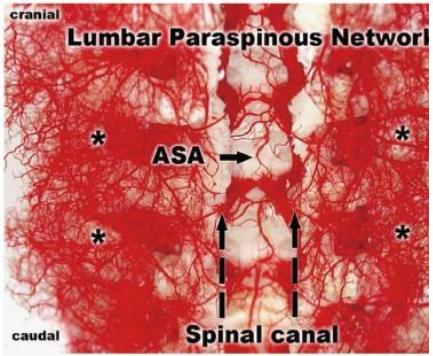
- There is still no definite prevention strategy for SCI, either for open or endo repair
- Improvement in CSF Drainage
- Better comprehension of spinal cord blood supply
- Preconditioning the collateral network
- Staged repair (even for open repair?)

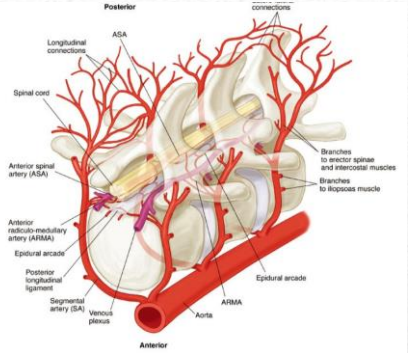


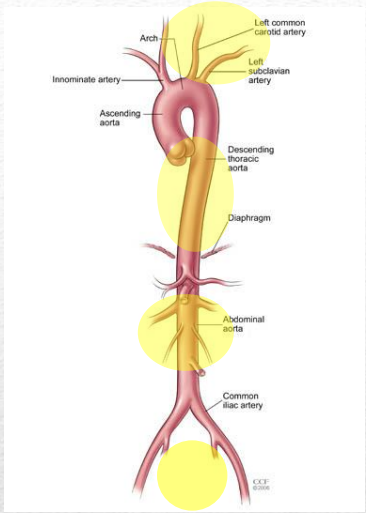
Etz CD et al. Spinal cord perfusion after extensive segmental artery sacrifice: can paraplegia be prevented? Eur J Cardiothorac Surg 2007;31(4):643-8

CSF Drainage / pressure and volume control









The AKA

T9-T12 75%

T8-L3 15%

L1-L2 10%

3 compartments

- Interspinal
- Paraspinal intramuscular
- Paraspinal extramuscular

4 independent contributors spinal blood flow

- Left subclavian artery
- Intercostal artery
- Lumbar artery
- Hypogastric artery

Better comprehension of spinal cord blood supply

Adamkiewicz A. Die Blutgefasse des Menschlichen Ruckenmarkes, Krakau, 1881

Gustavo S. Endovascular Aortic Repair: Current Techniques with Fenestrated, Branched and Parallel Stent-Grafts. Chapter 47 2017

Griep RB et al. Ann Thorac Surg 2007

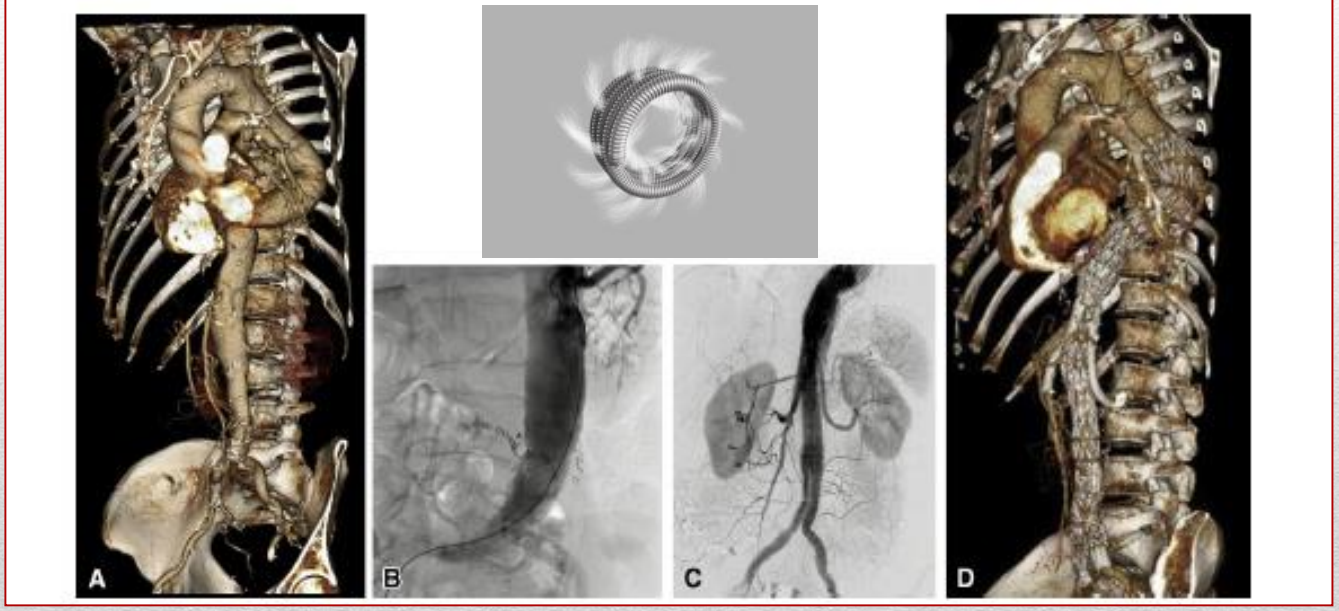
Czerny et al. J Endovasc Ther 2012

Gustavo S. Endovascular Aortic Repair: Current Techniques with Fenestrated, Branched and Parallel Stent-Grafts. Chapter 47 2017

Etz et al. Thorax Cardiovasc Surg 2012

First-in-man endovascular preconditioning of the paraspinal collateral network by segmental artery coil embolization to prevent ischemic spinal cord injury

Christian D. Etz, MD, PhD,[a] E. Sebastian Debus, MD, PhD,[b] Friedrich-Wilhelm Mohr, MD, PhD,[a] and Tilo Kölbel, MD, PhD[b]



Priming collateral regeneration

Ischaemic preconditioning of the spinal cord to prevent spinal cord ischaemia during endovascular repair of thoracoabdominal aortic aneurysm: first clinical experience

Published on 20 September 2018

Daniela Branzan[1]*, MD; Christian D. Etz[2], MD, PhD; Michael Moche[3], MD, PhD; Konstantin von Aspern[2], MD; Holger Staab[1], MD; Jochen Fuchs[3], MD; Florian Then Bergh[4], MD, PhD; Dierk Scheinert[5], MD, PhD; Andrej Schmidt[5], MD, PhD

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Aims: The purpose of our study was to report our experience with minimally invasive segmental artery coil embolisation (MISACE) to prevent spinal cord ischaemia (SCI) after endovascular repair (ER) of thoracoabdominal aortic aneurysm (TAAA).

Methods and results: A cohort of 57 patients with TAAAs was treated by MISACE followed by ER between October 2014 and December 2017. The TAAA Crawford classification was: type I, n=5; type II, n=12; type III, n=27; type IV, n=13. The average maximum aortic diameter was 62.7±8.8 mm. Patients had a median of 5 coiled SAs (range: 1-19). MISACE was completed in one (n=22), two (n=24), three (n=7), four (n=3) or five (n=1) sessions. The maximum number of coiled SAs per session was six. After completion of MISACE, 77.7% of direct segmental arterial flow was occluded. After a mean of 83±62 days, 55 of the patients received total ER of their TAAA. At 30 days after ER, no patient developed SCI and three patients had died.

KEYWORDS

- Embolisation technique
- Thoracic aorta aneurysm
- Thoracic aorta dissection

AUTHORS

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- Scheinert D
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J Thorac Cardiovasc Surg. 2014 January ; 147(1): 220–226. doi:10.1016/j.jtcvs.2013.09.022.

Endovascular Coil Embolization of Segmental Arteries Prevents Paraplegia After Subsequent TAAA Repair – An Experimental Model

S Geisbüsch, MD[1], A Stefanovic[1], JS Koruth, MD[2], HM Lin, ScD[3], S Morgello, MD[4], DJ Weisz, MD[5], RB Griepp, MD[1], and G Di Luozzo, MD[1]

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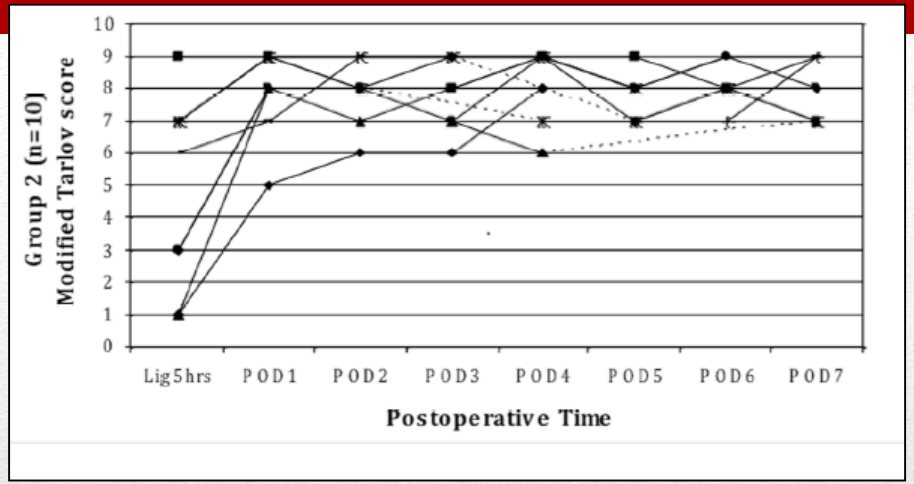
Abstract

Objective—To test a strategy for minimizing ischemic spinal cord injury (SCI) following extensive thoracoabdominal aneurysm (TAAA) repair, we occluded a small number of segmental arteries (SAs) endovascularly one week before simulated aneurysm repair in an experimental model.

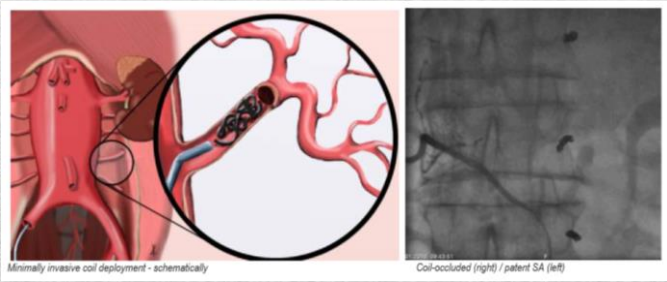
Methods—30 juvenile Yorkshire pigs (25.2±1.7kg) were randomized into three groups. All SAs —intercostal and lumbar—were sacrificed by a combination of surgical ligation of the lumbar SAs and occlusion of intercostal SAs with thoracic endovascular stent grafting (TEVAR). 7–10 days before this simulated TAAA replacement, SAs in the lower thoracic/upper lumbar region were occluded using embolization coils: 1.5±0.5 SAs in Group 1 (T13/L1), and 4.5±0.5 in Group 2 (T11-L3). No SAs were coiled in the controls. Hind limb function was evaluated blindly from daily videotapes using a modified Tarlov score: 0=paraplegia; 9=full recovery. After sacrifice, each segment of spinal cord was graded histologically using the 9-point Kleinman score: 0=normal, 8=complete necrosis.

Results—Hind limb function remained normal after coil embolization. After simulated TAAA repair, paraplegia occurred in 6/10 control pigs, but only 2/10 pigs in Group 1: no pigs in Group 2 had SCI. Tarlov scores were significantly better in Group 2 (Control vs 1 p=0.06; Control vs 2 p=0.0002; 1 vs 2 p=0.05). A dramatic reduction in histologic damage—most prominently in the coiled region—was seen when SAs were embolized before simulated TAAA repair.

Conclusions—Endovascular coiling of 2–4 SAs prevents paraplegia in an experimental model of extensive hybrid TAAA repair, and helps protect the spinal cord from ischemic histopathological injury. A clinical trial in a selected patient population at high risk for postoperative SCI may be appropriate.



Zero paraplegia after coil embolization in a pig model

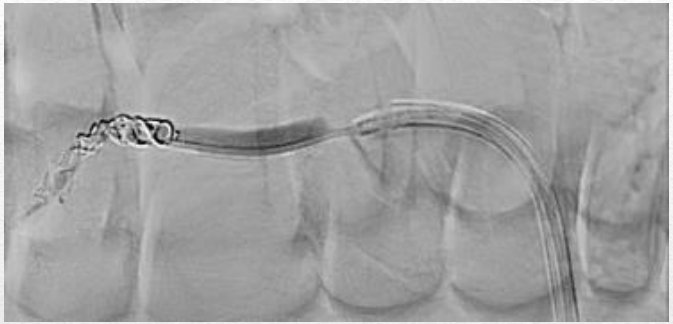


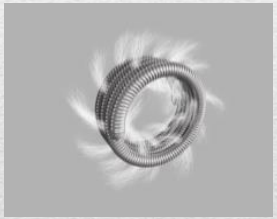
The MISACE (Minimally Invasive Segmental Artery Coil Embolisation) concept

Geisbusch et al. J Thorac Cardiovasc Surg 2014
Etz et al. J Thorac Cardiovasc Surg 2015

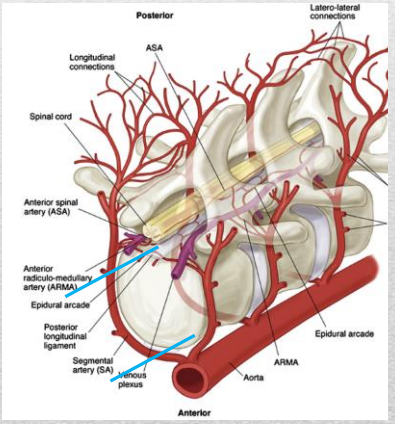
Coils-technique

Plug-technique



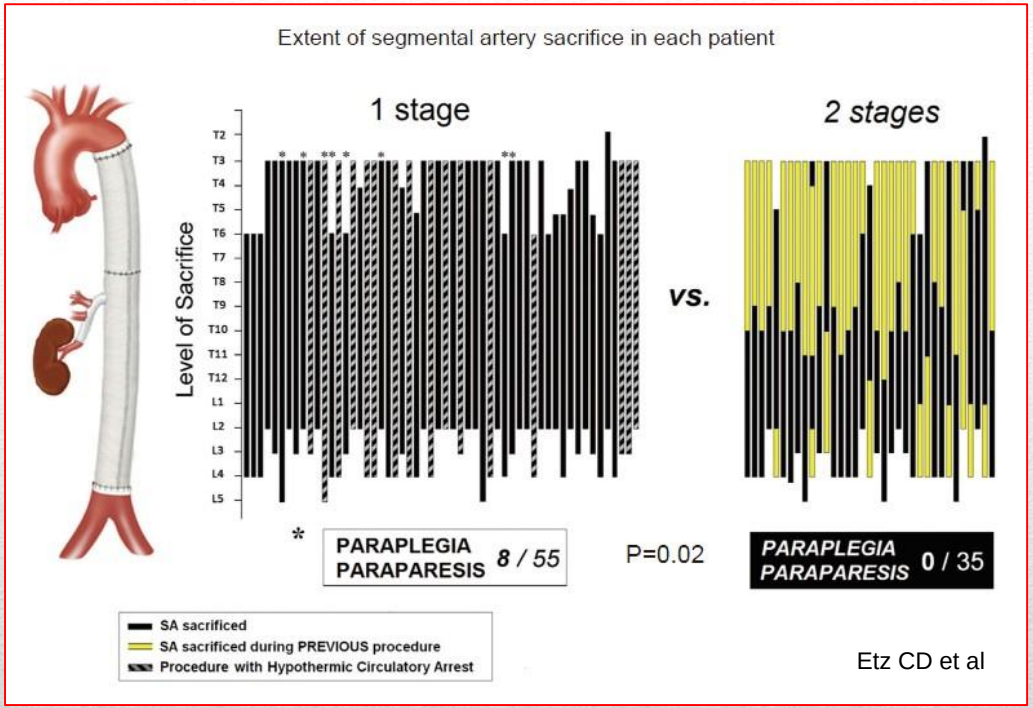


Require larger catheters - stable position



MISACE: technical aspects

Etz et al. *J Thorac Cardiovasc Surg* 2015



Open access Protocol

BMJ Open

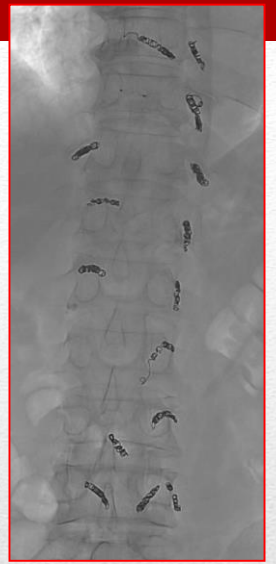
Paraplegia prevention in aortic aneurysm repair by thoracoabdominal staging with 'minimally invasive staged segmental artery coil embolisation' (MIS²ACE): trial protocol for a randomised controlled multicentre trial

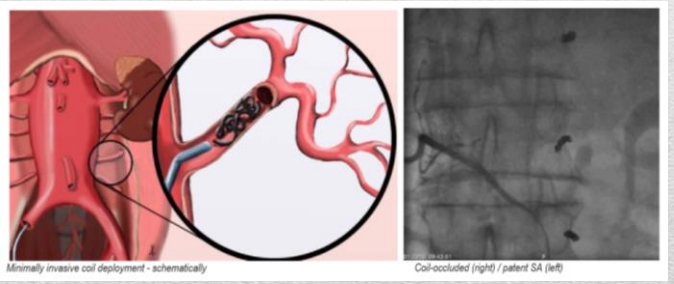
David Petroff,[1] Martin Czerny,[2,3] Tilo Kölbel,[4] Germano Melissano,[5] Lars Lonn,[6] Josephina Haunschild,[7] Konstantin von Aspern,[7] Petra Neuhaus,[1] Johann Pelz,[8] David Mark Epstein,[9] Nuria Romo-Avilés,[10] Katja Piotrowski,[1] Christian D Etz[7]

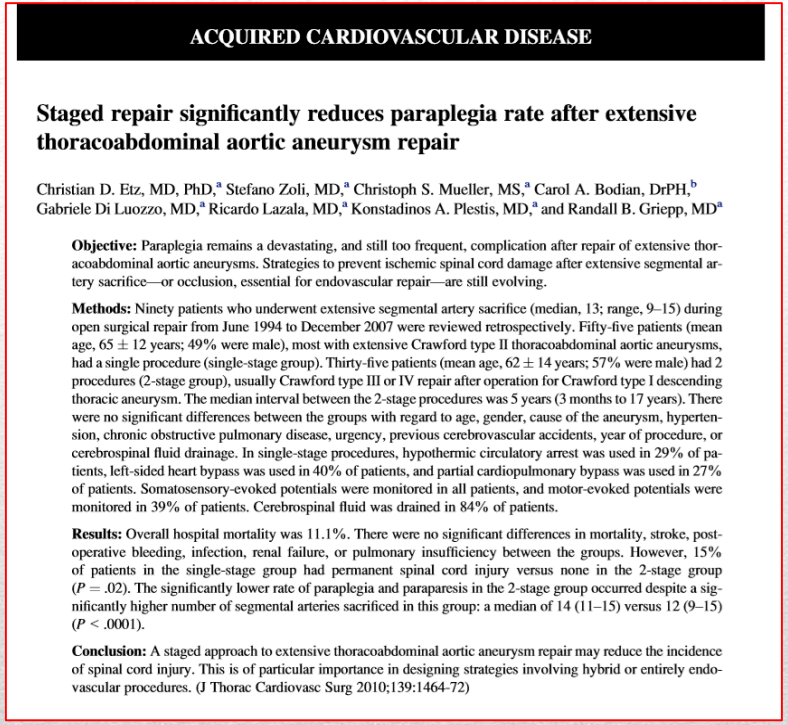
MIS²ACE Procedure: concept and clinical application

MIS²ACE Procedure: technical aspects

- Selected, elective high SCI risk
- Under local anesthesia
- Percutaneous trans-femoral access
- No CSF-drainage
- Clinical monitoring of the patients neurologic function for 72h
- After 1-3 MIS²ACE sessions → proceed to open- or endovascular TAAA repair







ACQUIRED CARDIOVASCULAR DISEASE

Staged repair significantly reduces paraplegia rate after extensive thoracoabdominal aortic aneurysm repair

Christian D. Etz, MD, PhD,[a] Stefano Zoli, MD,[a] Christoph S. Mueller, MS,[a] Carol A. Bodian, DrPH,[b] Gabriele Di Luozzo, MD,[a] Ricardo Lazala, MD,[a] Konstadinos A. Plestis, MD,[a] and Randall B. Griepp, MD[a]

Objective: Paraplegia remains a devastating, and still too frequent, complication after repair of extensive thoracoabdominal aortic aneurysms. Strategies to prevent ischemic spinal cord damage after extensive segmental artery sacrifice—or occlusion, essential for endovascular repair—are still evolving.

Methods: Ninety patients who underwent extensive segmental artery sacrifice (median, 13; range, 9–15) during open surgical repair from June 1994 to December 2007 were reviewed retrospectively. Fifty-five patients (mean age, 65 ± 12 years; 49% were male), most with extensive Crawford type II thoracoabdominal aortic aneurysms, had a single procedure (single-stage group). Thirty-five patients (mean age, 62 ± 14 years; 57% were male) had 2 procedures (2-stage group), usually Crawford type III or IV repair after operation for Crawford type I descending thoracic aneurysm. The median interval between the 2-stage procedures was 5 years (3 months to 17 years). There were no significant differences between the groups with regard to age, gender, cause of the aneurysm, hypertension, chronic obstructive pulmonary disease, urgency, previous cerebrovascular accidents, year of procedure, or cerebrospinal fluid drainage. In single-stage procedures, hypothermic circulatory arrest was used in 29% of patients, left-sided heart bypass was used in 40% of patients, and partial cardiopulmonary bypass was used in 27% of patients. Somatosensory-evoked potentials were monitored in all patients, and motor-evoked potentials were monitored in 39% of patients. Cerebrospinal fluid was drained in 84% of patients.

Results: Overall hospital mortality was 11.1%. There were no significant differences in mortality, stroke, postoperative bleeding, infection, renal failure, or pulmonary insufficiency between the groups. However, 15% of patients in the single-stage group had permanent spinal cord injury versus none in the 2-stage group ($P = .02$). The significantly lower rate of paraplegia and paraparesis in the 2-stage group occurred despite a significantly higher number of segmental arteries sacrificed in this group: a median of 14 (11–15) versus 12 (9–15) ($P < .0001$).

Conclusion: A staged approach to extensive thoracoabdominal aortic aneurysm repair may reduce the incidence of spinal cord injury. This is of particular importance in designing strategies involving hybrid or entirely endovascular procedures. (J Thorac Cardiovasc Surg 2010;139:1464-72)

90 patients

% SCI: Single stage: 15%

Staged: 0%

Staged repair (for open ?)

Eur J Vasc Endovasc Surg (2019) 57, 340–348

Editor's Choice — Outcomes After One Stage Versus Two Stage Open Repair of Type II Thoraco-abdominal Aortic Aneurysms

Alexander Gombert [a], **Linda Kirner** [a], **Shirley Ketting** [b], **Marcia V. Rückbeil** [c], **Barend Mees** [b], **Mohammad E. Barbati** [a], **Paula R. Keschenau** [a], **Johannes Kalder** [a], **Geert W. Schurink** [b], **Drosos Kotelis** [a,d], **Michael J. Jacobs** [a,b,*,d]

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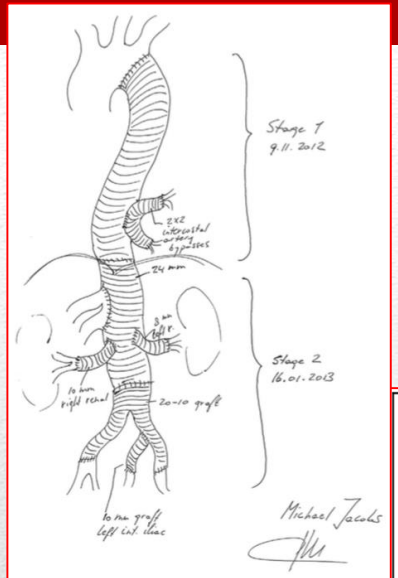
[c] Department of Medical Statistics, University Hospital Aachen, RWTH Aachen University, Aachen, Germany

WHAT THIS PAPER ADDS
This study confirms that staged open and hybrid surgery of type II thoraco-abdominal aortic aneurysm (TAAA) may be related to favourable results in terms of decreased mortality rates versus one stage type II TAAA open repair.

Objective: This study compared the outcomes of open one stage with open two stage repair of type II thoraco-abdominal aortic aneurysms (TAAA).
Methods: This retrospective study included 94 patients (68 men) with a mean ± SD age of 54.5 ± 14 years who underwent open type II TAAA repair from March 2006 to January 2016. The mean aneurysm diameter was 65 ± 14.4 mm. The median follow up was 42 months (range 12–96). Seventy-six patients received one stage open repair and 18 patients were treated in two steps: 12 received two open procedures (thoracic and abdominal) and six received hybrid repair (one open and one endovascular procedure). This study focused on the comparison of open one stage and open two stage TAAA repair. The median time between the two steps was 31.5 days (range 1–169).
Results: In hospital mortality after open one stage repair versus open two stage type II repair was 22.4% versus 0% (odds ratio 7.352, 95% confidence interval [CI] 0.884–959.1]; $p = .19$). The one year survival rate after one stage repair versus open two stage repair was 74.7% (95% CI 62.7–83.3) versus 90.9% (95% CI 50.8–98.7 [$p = .225$]). The five year survival rate after one stage repair versus open two stage repair was 53.0% (95% CI 37.2–66.5) versus 90.9% (95% CI 50.8–98.7 [$p = .141$]). The hazard ratio for survival after one stage repair and after open two stage repair was 4.563 (95% CI 96.9–81.4 [$p = .137$]). Paraplegia was observed after open one stage repair versus open two stage in 10.5% vs. 8% ($p = 1$). Acute kidney injury requiring permanent dialysis and myocardial infarction were assessed for after open one stage repair and open two stage and were seen in 3.9% vs. 0% ($p = 1$) and in 5.3% vs. 0% ($p = 1$), respectively.
Conclusion: Open two stage repair may be recommended as a treatment option for type II TAAAs if anatomically feasible, as it has a lower mortality and similar complication rates to one stage repair.



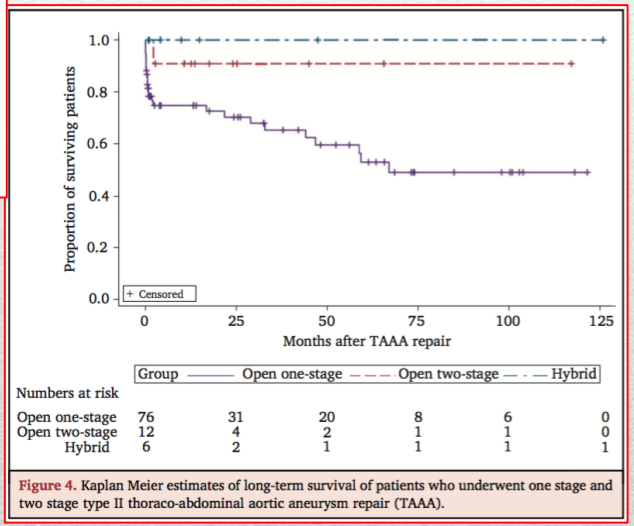
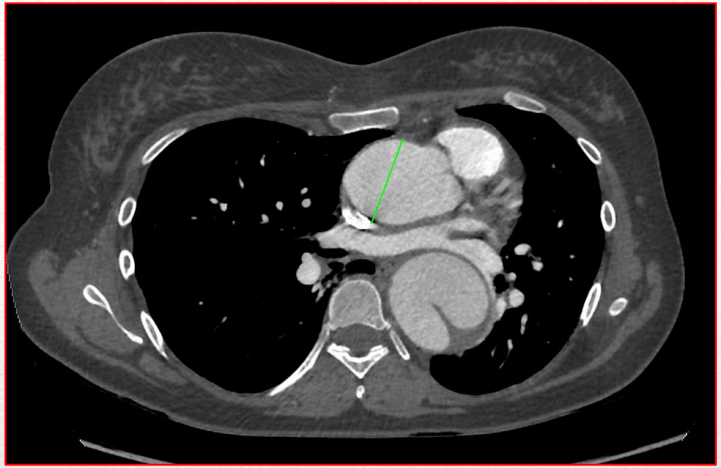
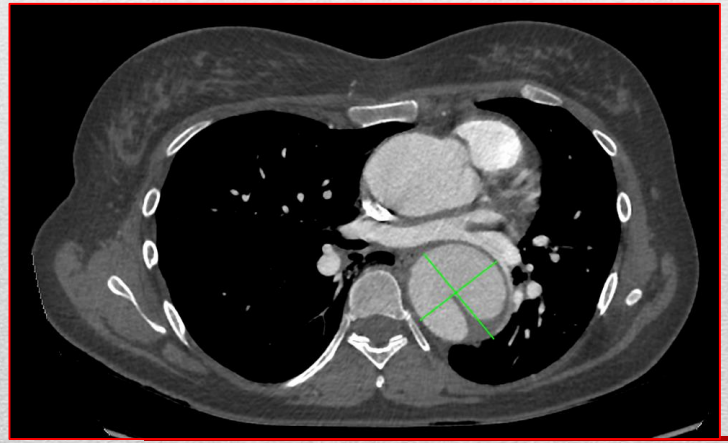
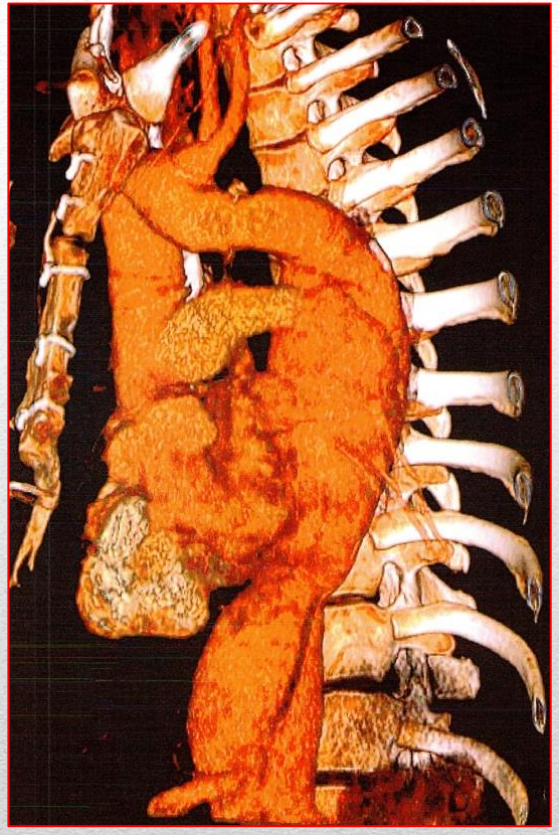


Figure 4. Kaplan Meier estimates of long-term survival of patients who underwent one stage and two stage type II thoraco-abdominal aortic aneurysm repair (TAAA).

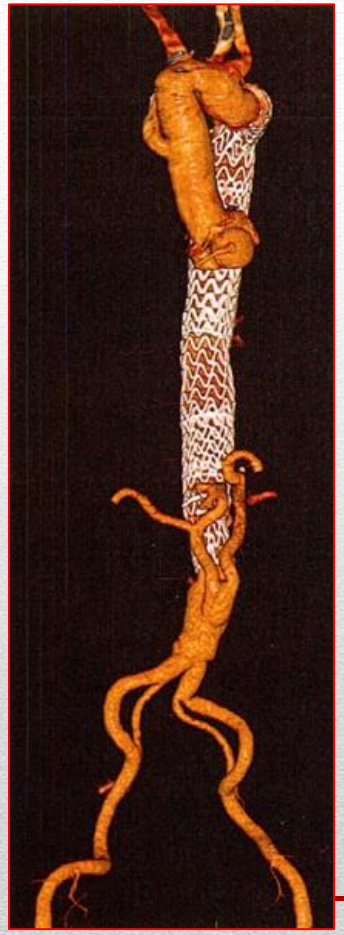
Staged open repair

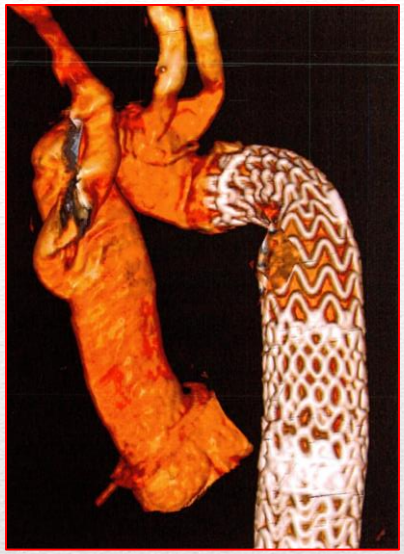


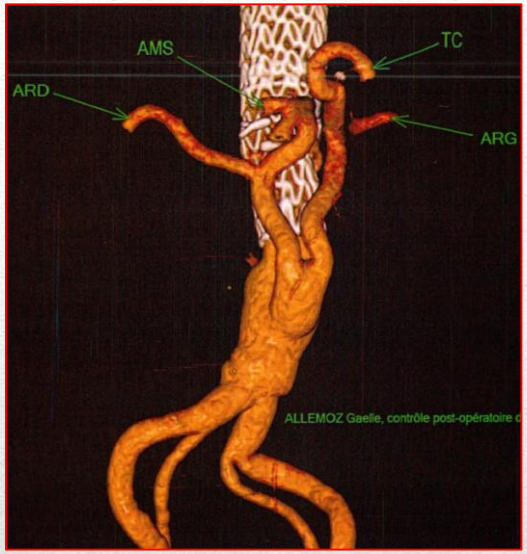




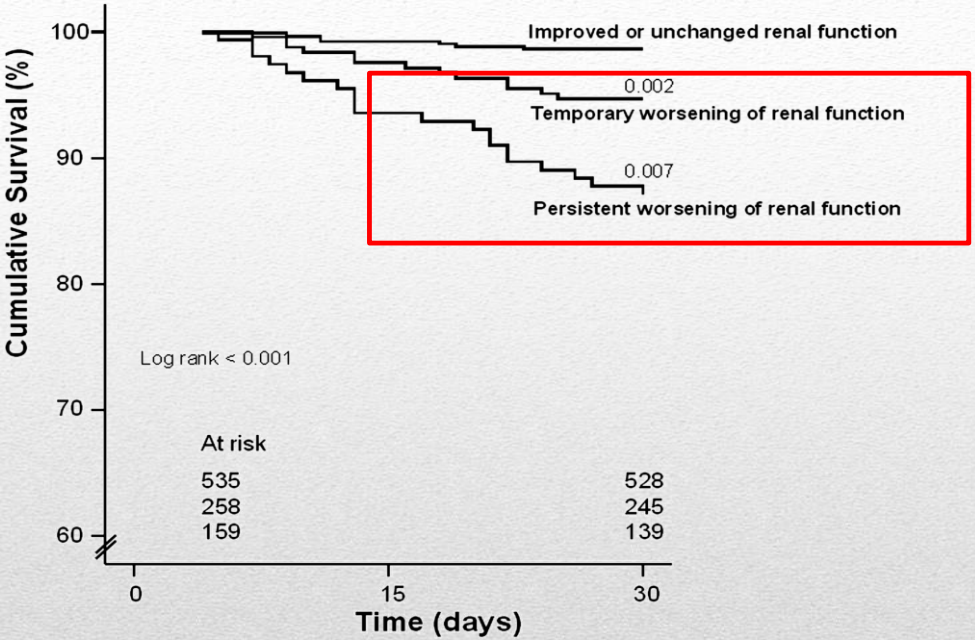
Staged hybrid repair







Staged hybrid repair



. Direct or bypass reattachment of all renal arteries
. Kidney perfusion during ATA repair to assure cooling +/- buffering?
. Blood / Crystalloid / Custodiol ?

Renal dysfunction is linked with mortality…

Welten et al. Am J Kidney Dis 2007

RINGER GROUP (54 pts)

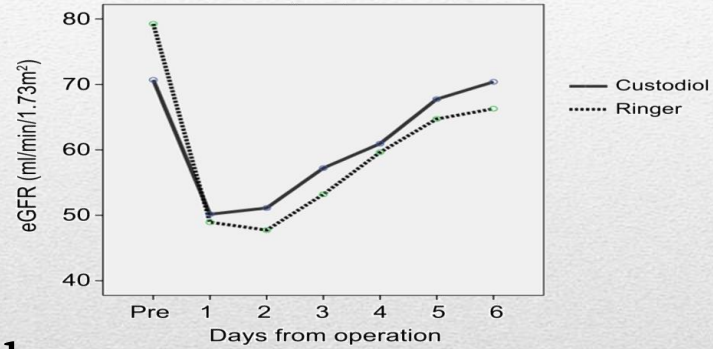
(April 2008 – August 2009)

The last consecutive TAAA with Ringer

CUSTODIOL GROUP (50 pts)

(September 2009 – December 2011)

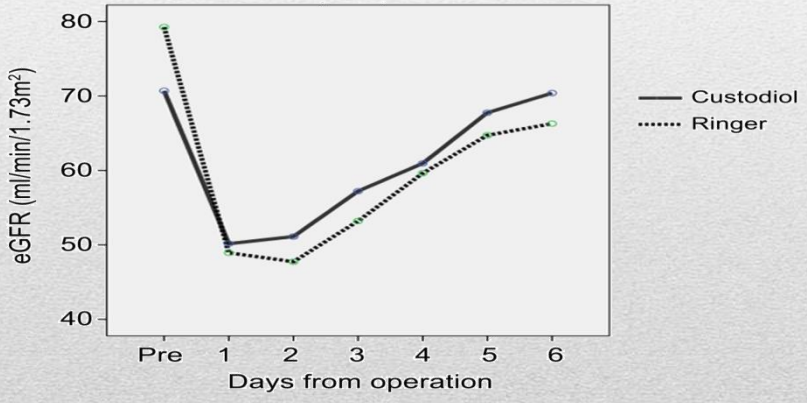
The first consecutive TAAA with Custodiol



Renal protection: 104 pts

Tshomba, […] & Chiesa. J Vasc Surg 2014

	Total (n = 84)	Ringer group (n = 42)	Custodiol group (n = 42)	p value
Acute Kidney Injury (AKI)	64 (76.2%)	38 (90.5%)	26 (61.9%)	0.002
Total renal ischemic time, min, mean ± SD	47.9 ± 16.61	43.6 ± 15.99	51.5 ± 16.48	0.053

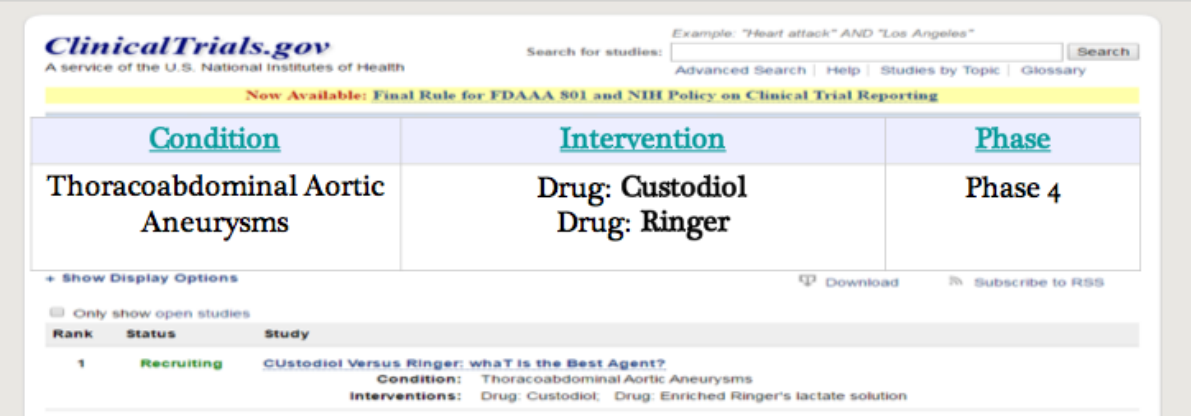


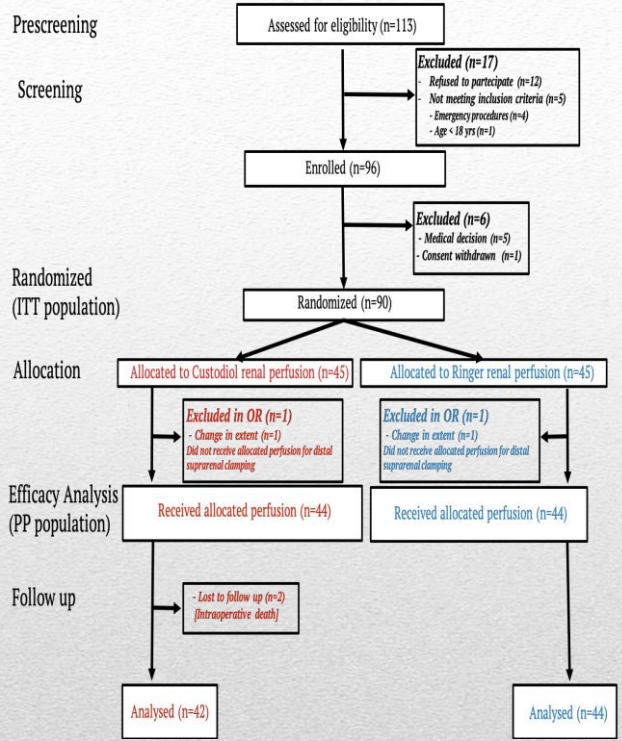
Renal protection: Short-term outcomes

Tshomba, […] & Chiesa. J Vasc Surg 2014

CURITIBA TRIAL

Prospective, Randomized & Double-blinded Non-Inferiority Trial (Off-label Use)





ClinicalTrials.gov Identifier: NCT 02327611

CURITIBA TRIAL (adapted from Tshomba Y.)

Conclusions

- TAAA surgery probably remains « the most complex » among cardiovascular surgery
- Improving results of open TAAA surgery implies to improve both surgical and anesthesiological levels
- New insights regarding SCI protection, especially developed for endo procedures, should also be considered for open repair
- Better prevention of renal dysfunction is still assessed by ongoing studies
- Selecting patients for a tailored technique (open, endo, hybrid, staged, …) implies that patients should be refered in large volume centers which include specialists dedicated to each techniques