23RD INTERNATIONAL EXPERTS SYMPOSIUM

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Spinal drains and MEPs are a waste of time !

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www.critical-issues-congress.com

My remit from the course organisers…..

How do we achieve low paraplegia rates without spinal drains and MEPs?

What is our current spinal cord protocol?

Are spinal drains and MEPs ever useful?

Eur J Vasc Endovasc Surg (2017) 53, 4–52

Editor's Choice — Management of Descending Thoracic Aorta Diseases

Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS)

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Keywords: Clinical practice, Descending thoracic aorta, Descending thoracic aortic management, Guideline, Recommendations, Thoracic aorta abnormalities, Thoracic aorta diseases, Thoracic aorta disorders, Thoraco-abdominal aorta

2.4.3. Prevention of spinal cord ischaemia in thoracic endovascular repair. TEVAR has been associated with a reduced incidence of neurological complications compared with open DTAA repair, but the risk of paraplegia or paraparesis ranges from 2.5% up to 8% and remains a concern.[44–46] Prior abdominal aorta aneurysm (AAA) repair, prolonged hypotension, severe atherosclerosis of the thoracic aorta, occlusion of the left subclavian artery and/or hypogastric arteries, and extensive coverage of the thoracic aorta by the endograft are all associated with an increased incidence of SCI.[44–49] Therefore, spinal cord protection (including CSF drainage) should be considered in patients with previous AAA repair or in patients who require extensive aortic repairs, as the benefit of CSF drainage is greatest in patients at the highest risk for spinal cord injury.[45–47]

+ age, renal insufficiency, long procedures

Recommendation 10	Class	Level of evidence	References
Patients with planned extensive thoracic aorta coverage (>200 mm) or previous AAA repair have a high risk for spinal cord ischemia and prophylactic cerebrospinal fluid drainage should be considered in endovascular thoracic aorta repair.	IIa	C	45–47

Recommendation 5	Class	Level of evidence	References
During open thoracic or thoraco-abdominal aortic repair, peri-operative monitoring of motor and/or somatosensory evoked potentials may be considered to predict spinal cord ischaemia	IIb	C	30,33

Etz CD, Weigang E, Hartert M, Lonn L, Mestres CA, Di Bartolomeo R, *et al.* Contemporary spinal cord protection during thoracic and thoracoabdominal aortic surgery and endovascular aortic repair: a position paper of the vascular domain of the European Association for Cardio-Thoracic Surgery†. Eur J Cardio-Thoracic Surg 2015;47:943-57.

MEPs and CSF drainage (≥ 48hrs) should be considered in patients undergoing TEVAR at high risk of SCI
(extent II and III TAAA, previous aortic surgery, occluded LSA and/or IIA)

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Editor's Choice — Temporary Aneurysm Sac Perfusion as an Adjunct for Prevention of Spinal Cord Ischemia After Branched Endovascular Repair of Thoracoabdominal Aneurysms CME

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WHAT THIS PAPER ADDS
The purpose of this study is to describe the concept and experience of using temporary aneurysm sac perfusion with second stage side branch completion, as an adjunct to reduce the risk of severe spinal cord ischemia after branched endovascular repair of thoracoabdominal aortic aneurysms.

Objective: To report experience with the concept of temporary aneurysm sac perfusion (TASP) and second stage side branch completion to prevent severe spinal cord ischemia (SCI) after branched endovascular aortic repair (bEVAR) for thoracoabdominal aortic aneurysm (TAAA).
Methods: Patients were treated for TAAA with bEVAR between January 2009 and September 2012. TASP was performed by non-completion of side branches to one of the reno-visceral arteries, distal aortic or iliac extensions with secondary side branch completion. Primary endpoints of the study were overall technical success, side branch patency, perioperative mortality, and the rate of severe SCI.
Results: Eighty-three patients were treated for TAAA with branched aortic stent grafts with (n = 40) or without (n = 43) TASP. Overall technical success, including aneurysm exclusion, absence of persistent type I or III endoleak, TASP side branch patency, and secondary side branch completion was 35/40 (88%). Secondary TASP side branch completion was performed after a median of 48 days (range 1—370 days). The rate of early re-interventions for reno-visceral side branch complications was 8/283 (3%) and 6/83 (7%) for perioperative mortality, with three patients in both groups. Severe SCI or paraplegia was observed in 11/83 (13%) of the patients and reduced in the TASP group (2/40) compared with the non-TASP group (9/43; p = .03), especially in Crawford I—III aneurysms (1/29 vs. 7/24; p = .01). However, one TASP patient died 4 months after bEVAR during the TASP interval from suspected aorto-bronchial fistula.
Conclusion: The concept of TASP after bEVAR for TAAA is feasible and seems to reduce the risk of SCI. Early side TASP branch completion within 4 weeks is recommended to reduce the risk of rupture, although, according to the individual clinical presentation, a longer TASP interval might improve neurological rehabilitation from SCI.

Article history: Received 6 March 2014, Accepted 21 May 2014, Available online 2 July 2014
Keywords: Aortic stent graft, Branched endovascular aortic repair, Spinal cord ischemia, TASP, Temporary aneurysm sac perfusion, Thoracoabdominal aneurysm

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Risk factors for spinal cord ischemia after endovascular repair of thoracoabdominal aortic aneurysms

Theodosios Bisdas, MD, PhD, Giuseppe Panuccio, MD, Masayuki Sugimoto, MD, Giovanni Torsello, MD, PhD, and Martin Austermann, MD, *Münster, Germany*

Objective: The introduction of fenestrated and multibranched endografting transformed the treatment paradigm of patients with thoracoabdominal aortic aneurysms (TAAAs). However, despite the minimally invasive character of the procedure, spinal cord ischemia (SCI) remains a devastating complication. The aim of this study was to address the SCI rates after endovascular TAAA repair and to analyze potential risk factors leading to this complication.

142 patients treated for extent II, III and IV TAAA
64 had prophylactic CSF drainage
23 (16%) developed SCI (10 immediate, 13 delayed)
3 (2%) had irreversible paraplegia at discharge

Prophylactic CSF drains did not reduce the SCI rate and were associated with a 6% adverse event rate

three patients (2%) showing irreversible paraplegia at discharge. There was no difference in the 30-day mortality between patients with and without SCI (no SCI, n = 3 [3%] vs SCI, n = 1 [4%]; $P = .511$). Prophylactic use of CSFD before the procedure was performed in 64 patients (45%), and among them, 4 patients (6%) developed a CSFD-associated complication. No clinical benefit for patients receiving prophylactic placement of CSFD was found ($P = .498$). The multivariate analysis revealed the percentage of thoracic aortic coverage as the only significant risk factor for SCI (odds ratio, 1.03; 95% confidence interval, 1.01-1.05; $P = .001$).

Conclusions: The SCI rate after endovascular repair of TAAA was 16%, with 8% of those patients suffering from paraplegia. Prophylactic use of CSFD could not reduce the SCI rate and was associated with 6% adverse events. The percentage of thoracic aortic coverage was the most powerful determinant of SCI in these series. (J Vasc Surg 2015;61:1408-16.)

Spinal Cord Protection Protocol

Stop anti-hypertensives pre-operatively

Preserve spinal cord collaterals (LSA, IIA)

Minimize embolisation, blood loss, lower limb/pelvic IRI

Staged procedures

HDU care for at least 36 hours post-operatively

Maintain MAP $\geq$ 80mmHg

Maintain patient lying at 30 degrees for 36 hrs

Maintain CVP $<$15mmHg

Maintain O_2 delivery (Hb >10, pO_2 >9, SaO_2 >95%)

Correct coagulopathy

Gradual mobilisation and restart anti-hypertensives

No prophylactic (only salvage) CSF drainage

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Elective Fenestrated and Branched Endovascular Thoraco-abdominal Aortic Repair with Supracoeliac Sealing Zones and without Prophylactic Cerebrospinal Fluid Drainage: Early and Medium-term Outcomes

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270 patients treated with SC coverage
6 (2.2%) non-ambulatory SCI

aortic repair with more complex endografts does not need to be at the expense of a higher risk of adverse events. To allow meaningful interpretation and comparison, patient outcomes should be reported according to

83 with < 40mm SC coverage
none staged, no prophylactic CSF drains = no SCI

(CSF) drainage on the incidence of spinal cord ischaemia (SCI).

187 with ≥ 40mm SC coverage
6 (3.3%) non-ambulatory SCI (3 immediate, 3 delayed)
Pre-SCPP: 4 of 20 (20%), none staged, 13 prophylactic CSF drains
Post-SCPP: 2 of 167 (1.2%), 89 staged, no prophylactic CSF drains

with ≥40 mm SC coverage, SCI occurred in 3.3% (pre-SCPP: 4/20 [20%; none staged, 13 prophylactic CSF drains] vs. post-SCPP: 2/167 [1.2%; 89 staged, no prophylactic CSF drains]; $p = .001$ [OR = 19.9]). Estimated survival (±SE) at one, two and three years was 92.6% ± 1.6%, 86.5% ± 2.4%, and 73.8% ± 3.5%, respectively, with no significant difference comparing extent of aneurysm or SC coverage. Forty-three (15.9%) patients required late re-intervention. Estimated freedom from re-intervention at one, two and three years was 91.9% ± 1.8%, 85.1% ± 2.5%, and 79.5% ± 3.2%, respectively.

Conclusion: Elective endovascular thoraco-abdominal aortic repair with SC sealing zones can be performed with low peri-operative risk and good medium-term outcomes. Selective staging without prophylactic CSF drainage contributed to a significant reduction in the incidence of SCI.

Keywords: Complex endovascular repair, Supracoeliac seal zone, Spinal cord ischaemia
Article history: Received 8 June 2018, Accepted 10 December 2018, Available online 17 April 2019

Table 3. Adjunctive open and endovascular procedures to fenestrated or branched EVAR in 270 patients presenting with juxtarenal or thoraco-abdominal aortic aneurysm

Adjunctive procedure	Number of patients (%)
Proximal arterial access	129 (47.8)
Infraclavicular axillary artery approach (left/right)	58 (21.5)/57(21.1)
Proximal brachial artery approach (left/right)	13 (4.8)/1 (0.4)
Open procedures	
Left carotid-subclavian bypass	15 (5.6)
Unilateral common iliac to external iliac/femoral bypass	10 (3.7)
Temporary common iliac artery conduit	4 (1.5)
Femoro-femoral cross over bypass	4 (1.5)
Common femoral artery interposition graft	3 (1.1)
Bilateral revision of iliac limbs of open aorto-bi-iliac repair	2 (0.7)
Unilateral external iliac to internal iliac artery bypass	2 (0.7)
Common iliac artery exposure for direct endograft delivery	1 (0.4)
Temporary axillo-femoral bypass	1 (0.4)
Endovascular procedures	
Unilateral iliac branch device	13 (4.8)
Arch fenestrated device	4 (1.5)[a]
Left subclavian artery chimney endograft	1 (0.4)
Occluder plug to endograft sidebranch or fenestration	7 (2.6)
Iliac angioplasty	4 (1.5)
Iliac endografting/endoconduit	3 (1.1)
Axillo-femoral wire access	1 (0.4)

Table 2. Baseline comorbidity information on 270 aneurysm patients undergoing fenestrated or branched EVAR without prophylactic cerebrospinal fluid drainage

Comorbidity	Number of patients (%)
Prior aortic reconstruction	76 (28.1)
Ascending aortic repair ± aortic valve replacement	3 (1.1)
Ascending and aortic arch repair with floating elephant trunk	9 (3.3)
Ascending and aortic arch repair with frozen elephant trunk	9 (3.3)
Open descending thoracic aortic aneurysm repair	6 (2.2)
Open thoraco-abdominal aortic aneurysm repair	5 (1.9)
Endovascular thoracic aortic aneurysm repair	10 (3.7)
Endovascular infrarenal aortic aneurysm repair (bifurcated/aorto-uni-iliac)	12 (4.4)/3 (1.1)
Fenestrated endovascular aortic aneurysm repair	1 (0.4)
Open infrarenal/juxtarenal aortic aneurysm repair	27 (10)
ASA grade	
II	49 (18.1)
III	218 (80.7)
IV	3 (1.1)
Hypertension	199 (73.7)
COPD	95 (35.2)
CKD stage 3A–5	94 (34.8)[a]
CAD	88 (32.6)
Current or ex-smokers	98 (36.3)

COPD = chronic obstructive pulmonary disease; CAD = coronary artery disease; CKD = chronic kidney disease (stage 3A–5 = estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2); EVAR = endovascular aneurysm repair.
[a] 13 patients had a pre-operative eGFR <30 mL/min/1.73 m^2.

Tabl… or thoraco-abdominal aortic aneurysm in 92 patients

Stag…	Stage 3	Number of patients (%)
Arch		3 (1.1)
TEVA…		38 (14.1)
TEVA…	Limb	6 (2.2)
TEVA…	Distal body + limb	1 (0.4)
TEVA…	IBD	1 (0.4)
TEVA…	CA fenestration	2 (0.7)
TEVA…	FEVAR	1 (0.4)
BEVA…		11 (4.1)
BEVA…		4 (3/1) (1.5)
BEVA…		20 (18/1/1) (7.4)
BEVA…		2 (1/1) (0.7)
BE…	Limb	1 (0.4)
BE…		1 (0.4)
FE…		1 (0.4)

FEVAR … vascular aortic repair; IBD = iliac branched device; CA = coeliac axis; SMA … implantation of distal bifurcated body endograft extension; Limb = impl… of single branch vessel endograft. All approaches were second or third st… of temporary aneurysm sac perfusion.

Spinal cord ischemia after endovascular repair of thoracoabdominal aortic aneurysms with fenestrated and branched stent grafts

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Objective: The aim of this study was to report the incidence and associated risk factors of perioperative spinal cord ischemia (SCI) after endovascular repair of thoracoabdominal aortic aneurysms (TAAAs) with fenestrated and branched stent grafts.

Methods: The study included consecutive patients with TAAA treated with fenestrated and branched stent grafts within the period January 2004 to December 2014. Suprarenal abdominal aortic aneurysms treated with fenestrated and

201 survivors of extent I-V TAAA repair
144 (72%) had prophylactic CSF drains
21 (10%) developed SCI (5 immediate, 16 delayed)
8 (4%) had disabling SCI at 30-days

Prolonged procedure > 300 mins, eGFR < 30 - independent predictors of SCI

operation. Multivariate analysis using logistic regression identified operation time >300 minutes (odds ratio [OR], 7.4; 95% confidence interval [CI], 2.6-21.1; $P < .001$), peripheral arterial disease (OR, 6.6; 95% CI, 2-21.9; $P = .002$), and baseline renal insufficiency (glomerular filtration rate <30 mL/min; OR, 4.1; 95% CI, 1.1-16.1; $P = .04$) as independent risk factors for SCI.

Conclusions: In our experience, most SCI events after endovascular TAAA repair are transient, with persistent paraplegia being rare. Patients with prolonged procedure duration, peripheral arterial disease, and baseline renal insufficiency appear to be at higher risk for development of SCI after endovascular TAAA repair. (J Vasc Surg 2015;62:1450-6.)

INVITED COMMENTARY

Commentary on "Elective Fenestrated and Branched Endovascular Thoraco-abdominal Aortic Repair With Supracoeliac Sealing Zones and Without Prophylactic Cerebrospinal Fluid Drainage: Early and Medium-term Outcomes"

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In this issue, Juszczak et al.[1] report outcomes of fenestrated and branched endografting (F/BEVAR) according to the extent of proximal aortic coverage above the coeliac trunk (CT) (<40 mm vs. ≥ 40 mm). Their report is relevant, as more extended aortic coverage is a risk factor for peri-operative complications and especially spinal cord ischaemia (SCI).[2] Reporting outcomes of F/BEVAR on the basis of the extent of aortic coverage also seems more accurate than on the basis of the anatomical extent of the aneurysm, as the chosen sealing zone level in similar extent aneurysms may vary significantly.

A threshold of a 40 mm sealing zone above the CT as chosen by the authors is of clinical relevance, as most four fenestration grafts for juxtarenal (JAAA) and type IV thoraco-abdominal aneurysms (TAAA) are designed with a supracoeliac sealing zone up to 40 mm. Juszczak et al. show that among patients with a coverage up to 40 mm above the CT, none developed SCI. Thirty day mortality was also low with 1.2%.[1] This suggests that we can safely lengthen the sealing zone up to 40 mm above the CT and that a four FEVAR should be preferred over a two or three FEVAR when needed in order to achieve a more durable proximal sealing zone.

The most important finding of the study is undoubtedly the significant reduction in the incidence of disabling SCI in patients with ≥40 mm coverage above the CT, after the introduction of a spinal cord protection protocol (SCPP) (pre-SCPP 4/20 [20%] vs. post-SCPP 2/167 [1.2%]; $p = .001$ [OR = 19.9]). The authors should be congratulated for this improvement. They attribute the significant reduction in SCI mainly to the following two measures: (1) the use of selective staging, and (2) the avoidance of prophylactic cerebrospinal fluid (CSF) drainage. This deserves an explanation.

On the one hand, adopting a strategy of selective staging seems reasonable in view of accumulating evidence. Selection criteria and the optimal method of staging (e.g. thoracic stent grafting as a first stage procedure, temporary aneurysm sac perfusion via an open branch, or segmental artery coil embolisation) are still open to discussion.

On the other hand, a "no prophylactic CSF drainage" standard policy, as adopted by some centres,[3] is disputable. The lower SCI occurrence with 1.2% is a weak argument. In their series, the authors experienced one fatal spinal drain related complication, which led them to stop prophylactic CSF drainage.[1] Other centres, like ours, continue to use a spinal drain, but only in the higher risk type I and II TAAA. In the absence of more elaborated evidence, we would advise balancing the pros and cons of a spinal drain. In their series, the significant reduction of SCI noted after introduction of the SCPP seems to be the result of all additional measures adopted by the authors (preservation of antegrade perfusion of the left subclavian artery and at least one hypogastric artery, minimisation of lower limb ischaemia reperfusion injury and intra-operative blood loss, maintenance of a MAP > 80 mmHg, and adequate oxygen delivery [Hb > 10, $pO_2 > 9$, $SaO_2 > 95\%$ etc.]), rather than only the result of avoiding CSF drainage. Similar measures and prophylactic CSF drainage in higher risk TAAAs, as applied in our centre, also resulted in an equally low occurrence of SCI.[2]

REFERENCES

1 Juszczak M, Murray A, Koutsoumpelis A, Vezzosi M, Mascaro J, Claridge M, et al. Elective fenestrated and branched endovascular thoracoabdominal aortic repair with supracoeliac sealing zones and without prophylactic cerebrospinal fluid drainage: early and medium-term outcomes. *Eur J Vasc Endovasc Surg* 2018 [IN THIS ISSUE].

2 Katsargyris A, Oikonomou K, Kouvelos G, Renner H, Ritter W, Verhoeven EL. Spinal cord ischemia after endovascular repair of thoracoabdominal aortic aneurysms with fenestrated and branched stent grafts. *J Vasc Surg* 2015;62:1450–6.

3 Bisdas T, Panuccio G, Sugimoto M, Torsello G, Austermann M. Risk factors for spinal cord ischemia after endovascular repair of thoracoabdominal aortic aneurysms. *J Vasc Surg* 2015;61:1408–16.

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Q.E.D.

Endovascular repair of thoracoabdominal aortic aneurysms using fenestrated and branched endografts

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ABSTRACT

Purpose: The study purpose was to review the outcomes of patients treated for thoracoabdominal aortic aneurysms using endovascular repair with fenestrated

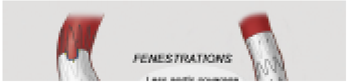

TABLE 2. Procedural details in 185 patients treated for thoracoabdominal aortic aneurysms with fenestrated-branched stent-grafts

Variable	Extent I-III (N = 73)		Extent IV (N = 112)		P value	Overall (N = 185)	
General anesthesia	72	99%	112	100%		184	99%
Cerebrospinal fluid drainage	72	99%	75	67%	<.001	147	79%
SSP/motor-evoked potentials	50	68%	60	54%	.043	110	59%

Results: A total of 112 patients (60%) were treated for extent IV thoracoabdomi-

185 patients treated for extent I-IV TAAA
9 (5%) developed SCI - 3 paraparesis, 6 paraplegia (4 immediate, 5 delayed)
4 of 6 paraplegia were extent I-III TAAA

dominal aortic aneurysms ($P = .12$) and 15.6% to 2.4% for extent I to III thoracoabdominal aortic aneurysms ($P = .04$). Early major adverse events occurred in 36 patients (32%) with extent IV thoracoabdominal aortic aneurysms and 26 patients (36%) with extent I to III thoracoabdominal aortic aneurysms, including spinal cord injury in 2 patients (1.8%) and 4 patients (3.2%), respectively. Mean follow-up was 21 ± 20 months. At 5 years, patient survival (56% and 59%, $P = .37$) and freedom from any reintervention (50% and 53%, $P = .26$) were similar in those with extent IV and extent I to III thoracoabdominal aortic aneurysms. Primary patency was 93% at 5 years.

Conclusions: Endovascular repair of thoracoabdominal aortic aneurysms can be performed with high technical success and low mortality and morbidity. However, the need for secondary reinterventions and continued graft surveillance represents major limitations compared with results of conventional open surgical repair. Long-term follow-up is needed before the widespread use of these techniques in younger or lower-risk patients. (J Thorac Cardiovasc Surg 2017;153:S32-41)

Perspective

Fenestrated and branched endografts have been used to treat TAAAs in elderly and higher-risk patients. This study shows low mortality (4%), SCI (3%), and dialysis rate (1%), which compares favorably to historical results of conventional open repair in large centers. Rate of reinterventions was high because of endoleak of branch vessel stenosis.

See Editorial Commentary page S42.

Low paraplegia rates without CSF drains and MEPs

Patient selection

Preserve spinal cord collaterals (LSA, IIA)

Minimize embolisation and lower limb/pelvic IRI

Staged (quicker) procedures

Maintain MAP $\geq$ 80mmHg and optimise O_2 delivery

CSF drains useful

for salvage if no/poor response to elevated MAP > 100mmHg

MEPs may be useful if they can

- predict immediate and delayed SCI
- identify the 20% of patients who should benefit from staging