How to manage the left subclavian and left vertebral artery during TEVAR

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Disclosure

No Disclosures
Pathologies involving aortic segment 2, 3 and 4
Introduction

- Up 40% of patients undergoing TEVAR have pathology that extends near the left subclavian artery (LSA) \(^1\)
- dominant left vertebral artery (60% of patients)
- previous left internal mammary coronary artery bypass graft
- distal right vertebral segment is absent

- Prospective randomized trials directly comparing a selective strategy of LSA revascularization and routine LSA revascularization as well as other techniques of neuroprotection are unavailable and are needed.

\(^1\)Freezor et al., J Endovasc Ther 2007;14:568-73.
Neurologic injury with TEVAR

Multifactorial

**Stroke** may be caused by

1. Systemic factors such as hypotension, hypertension, and anticoagulation
2. Intracranial changes related to edema, cerebrospinal fluid drainage, or contrast/drug infusion
3. Embolization of air, atheroma, or thrombus from the device or manipulation of devices within the aortic arch
4. Interruption of forward blood flow from injury or coverage of arch vessels.
Imaging Assessment before TEVAR with intended coverage of the LSA

✓ CTA or MRA of thoracoabdominal aorta
✓ MRA of supraaortic and intracranial vessels
✓ Completeness of the Willisii circle
✓ US of supraaortic vessels
Ultrasound studies

After complete overstenting
- Complete reversed flow in ipsilateral vertebral artery in 70% of pts.
- Alternating flow profile in 25% of pts.
- Systolic deceleration: only few pts.

After partial overstenting
- No pathologic changes detected

E. Weigang, Mainz, VISAR 2007
10 studies
2594 patients
pooled prevalence for stroke 4.1% (95% CI 2.9e5.5)
LSA uncovered
pooled stroke incidence 3.2% (95% CI 1.0e6.5)
19 patients

TEVAR, 8 with coverage of LSA

In 63% new foci of restricted diffusion

Overstenting of the left subclavian artery not associated with lateralization of lesions to one side

Expected symptoms after LSA coverage

Neurologic symptoms
• Vertebrobasilar insufficiency
  Subclavian steal syndrome
dizziness
Left arm hypoperfusion
• Ischemia
• Rest pain
• Claudication
Reported symptoms after LSA coverage

Neurological signs

✓ Vertebrobasilar insufficiency (24%)  
  ✓ Subclavian steal syndrome
  ✓ Posterior cerebral strokes
  ✓ Cerebellar infarction
  ✓ Impaired binocular vision
  ✓ TIA with speech disorders

✓ Paraplegia/paraparesis

Left arm hypoperfusion

✓ Ischemia
✓ Rest pain
✓ Claudiaction

The effect of left subclavian artery coverage on morbidity and mortality in patients undergoing endovascular thoracic aortic interventions: a systematic review and meta-analysis.

- 6% arm ischemia
- 4% spinal cord ischemia
- 2% vertebrobasilar ischemia
- 5% anterior circulation stroke
- 6% death

Risk of coverage
- increase in the risk of paraplegia (odds ratio [OR], 2.69; 95% confidence interval [CI] 0.75-9.68)
- anterior circulation stroke (OR, 2.58; 95% CI, 0.82-8.09)
- Arm ischemia (OR, 47.7; 95% CI, 9.9-229.3)
- Vertebrobasilar ischemia (OR, 10.8; 95% CI, 3.17-36.7)

Risk of revascularisation
- Incidence of phrenic nerve injury as a complication of primary revascularization was 4.40% (95% CI, 1.60%- 12.20%)
- no association with death, myocardial infarction, or transient ischemic attack.
Prior revascularization appears to protect against posterior circulation territory stroke

✓ MOTHER Registry
✓ 1002 patients
✓ Overall Stroke 2.2%
✓ Coverage without revasc independently associated with stroke (odds ratio 3.5; 95% confidence interval [CI], 1.7-7.1)
✓ specifically in the posterior territory (OR, 11.7; 95% CI, 2.5-54.6)
✓ And previous cerebrovascular accident (OR, 7.1; 95% CI, 2.2-23.1)
✓ But not SCI
10 studies
2594 patients
pooled prevalence for stroke 4.1% (95% CI 2.9 - 5.5)

LSA uncovered
pooled stroke incidence 3.2% (95% CI 1.0 - 6.5)

LSA covered with revascularization
pooled stroke incidence 5.3% (95% CI 2.6 - 8.6)

LSA covered without revascularization
pooled stroke incidence 8.0% (95% CI 4.1 - 2.9)

Conclusion
Stroke incidence is an important morbidity after TEVAR, and probably increases if the LSA is covered during the procedure, particularly in those without revascularisation.
Left subclavian artery revascularization in zone 2 thoracic endovascular aortic repair is associated with lower stroke risk across all aortic diseases.

Rhiannon J. Bradshaw, BA, S. Sadie Ahanchi, MD, Obie Powell, MD, Sebastian Larion, MD, Colin Brandt, MD, Michael C. Soult, MD, and Jean M. Panneton, MD, Norfolk, Va

✓ 96 Patients
✓ 54 with revascularization (laser fenestration 33, bypass 11, trsp 10)
✓ 30d stroke rate overall 7.3%, SCI 2.1%
✓ 30d stroke for LSA coverage without revasc 14.3% vs 1.9% (p=.02)
✓ 30d SCI without revasc 4.8% vs 0% (p=.11)

Our study suggests that coverage of the LSA without revascularization increases the risk of stroke and possibly SCI.

J Vasc Surg 2017;65:1270-9
Opinion leaders: LSA revascularization before TEVAR

I do it in every patient!
Carotid-subclavian bypass and subclavian-carotid transposition in the thoracic endovascular aortic repair era

Carotid-Subclavian Bypass or Subclavian-Carotid Trsp in patients with TEVAR or without (isolated reconstruction)

✓ 30-day postoperative cerebrovascular accident (CVA) or death (CVA/D)
✓ Overall stroke, mortality, and combined CVA/D rates were for all 3.5% (n [31), 3.3% (n [29), and 5.8% (n [51), respectively
✓ Surgical approach did not affect outcome
✓ **CVA/D rate was 10.2% (n [9) for revascularization in conjunction with TEVAR and 5.3% (n [42) for isolated reconstruction (P [ .06).**
Intentional left subclavian artery coverage during thoracic endovascular aortic repair for traumatic aortic injury

Cameron L. McBride, BS, Joseph J. Dubose, MD, Charles C. Miller III, PhD, Alexa P. Perlick, Kristofer M. Charlton-Ouw, MD, Anthony L. Estrera, MD, Hazim J. Safi, MD, and Ali Azizzadeh, MD, Houston, Tex

82 Patients
32 LSA covered

Fig 3. Incidence of left upper extremity symptoms in the postoperative period. LSAC, Left subclavian artery covered; LSAU, left subclavian artery uncovered.
Meta-analysis of Left Subclavian Artery Coverage With and Without Revascularization in Thoracic Endovascular Aortic Repair

Shahin Hajibandeh, MBChB¹, Shahab Hajibandeh, MBChB¹, Stavros A. Antoniou, MD, PhD, FEBS², Francesco Torella, MD, FRCS³, and George A. Antoniou, MD, PhD, MSc, FEBS³

- 5 studies
- 1161 patients with LSA coverage
- 444 revascularization, 717 without
- Stroke rate, SCI rate and death rate not significantly different

JEVT 2016, Vol. 23(4) 634–641
LSA repair techniques

✓ Carotid-subclavian Bypass
✓ Subclavian-carotid transposition
  • lateral approach
  • medial approach
Technique for subclavian to carotid transposition, tips, and tricks  Mark D. Morasch, MD, Chicago, Ill
Ligation and division of thoracic duct

Ligation and division of the vertebral vein.

Subclavian stump and transposition suture line.

Mobilization of the subclavian artery and its proximal branches, inf. Thyroid art
Completed transposition.

Carotid to subclavian bypass

Results - subclavian transposition

n = 24

in-hospital mortality 0%

neurologic injury 0%

Results- double transposition

n = 40

in-hospital mortality 2.5%

neurologic injury 0%

Results - total arch rerouting

n = 17

in-hospital mortality 17%

neurologic injury 5.8%

retrograde type A aortic dissection!!

Coverage of vertebral artery originating from the arch and LSA

Completed transposition.

Surgical solution

Vertebral to carotid artery transposition by same exposure as for subcalvian to carotid artery transposition
Recommendation 1:
• In patients who need elective TEVAR where achievement of a proximal seal necessitates coverage of the left subclavian artery, we suggest routine preoperative revascularization, despite the very low-quality evidence (GRADE 2, level C).

Recommendation 2:
• In selected patients who have an anatomy that compromises perfusion to critical organs, routine preoperative LSA revascularization is strongly recommended, despite the very low-quality evidence (GRADE 1, level C).

Recommendation 3:
• In patients who need urgent TEVAR for life-threatening acute aortic syndromes where achievement of a proximal seal necessitates coverage of the left subclavian artery, we suggest that revascularization should be individualized and addressed expectantly on the basis of anatomy, urgency, and availability of surgical expertise (GRADE 2, level C).
# ESVS descending aorta clinical practice guidelines

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

<table>
<thead>
<tr>
<th>Recommendation 11</th>
<th>Class</th>
<th>Level of evidence</th>
<th>References</th>
</tr>
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<tr>
<td>In elective thoracic endografting cases when it is planned to intentionally cover the left subclavian artery, in patients at risk of neurological complications, preventive left subclavian artery revascularisation should be considered</td>
<td>Iia</td>
<td>C</td>
<td>44</td>
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<tr>
<th>Recommendation 24</th>
<th>Class</th>
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<td>In emergency ruptured descending thoracic aortic aneurysm in patients with a patent left mammary to coronary bypass or with a dominant or single left vertebral artery, left subclavian artery revascularisation should be performed prior to left subclavian artery coverage</td>
<td>I</td>
<td>C</td>
<td>49</td>
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LSA revascularization strongly recommended

- presence of a **patent left internal mammary artery** to coronary artery bypass graft
- termination of the left vertebral artery at the posterior inferior cerebellar artery or other discontinuity of the vertebrobasilar collaterals
- absent or diminutive or occluded right vertebral artery
- functioning arteriovenous **shunt** in the left arm
- prior infrarenal aortic repair with ligation of lumbar and middle sacral arteries
- planned long-segment (>20 cm) coverage of the descending thoracic aorta where critical intercostal arteries originate
- hypogastric artery occlusion
- presence of early aneurysmal changes that may require subsequent therapy involving the distal thoracic aorta.
- Left-handed professionals (e.g. piano player)
LSA revascularization not recommended

- Emergency TEVAR (no sufficient time)
  - Type B aortic dissections with malperfusion
  - Traumatic aortic transsection
- Anatomic variations precluded revascularization
  - Congenital anomalies such as aberrant arch anatomy
  - Abnormalities of the LSA or vertebral
- Post radiation therapy
- Expertise is not available
Management of the vertebral artery during thoracic endovascular aortic repair with coverage of the left subclavian artery

Jian Zhu*, Er-Ping Xi*, Shui-Bo Zhu, Gui-Lin Yin, Rong-Ping Wang, Yu Zhang

- 160 patients underwent LSA closure or partial coverage
- 94 patients with partial LSA coverage during TEVAR, no treatment was provided
- 66 patients with full LSA coverage during TEVAR, right carotid artery-left common carotid artery bypass surgery was performed before TEVAR
- 10 patients, without any treatment for the vertebral artery, showing reverse blood flow of the left vertebral artery after surgery.
- 4 patients: Left common carotid artery-LSA bypass surgery was performed before TEVAR
- 3 patients: right common carotid artery-left common carotid artery-LSA bypass
- 6 out of these 7 patients underwent proximal LSA ligation
- In 160 patients, postoperative recurrent laryngeal nerve injury occurred in one patient
- No death

J Thorac Dis 2017;9(5):1273-1280
Neurological complications after left subclavian artery coverage during thoracic endovascular aortic repair: A systematic review and meta-analysis

David G. Cooper, MS, FRCS, Stewart R. Walsh, MSc, MRCSEd, Umar Sadat, MRCS, Ayesha Noorani, MRCS, Paul D. Hayes, MD, FRCS, and Jonathan R. Boyle, MD, FRCS, Cambridge, United Kingdom

Pooled odds ratios (POR) postoperative CVA and SCI.

- CVA without LSA coverage without revasc vs non-coverage (4.7% vs 2.7%; POR, 2.28; 95% confidence interval [CI], 1.28-4.09; P < .005)
- CVA in LSA coverage after revascularization vs non-coverage (4.1% vs 2.6%; POR, 3.18; 95% CI, 1.17-8.65; P < .02).
- The risk of SCI with LSA coverage without revasc vs non-coverage (2.8% vs 2.3%; POR, 2.39; 95% CI, 1.30-4.39; P < .005)
- SCI in LSA coverage after revascularization vs non-coverage (0.8% vs 2.7%; POR, 1.69; 95% CI, 0.56-5.15; P < .35).