

Shunt Intention During Eversion Carotid Endarterectomy and Perioperative Stroke Risk

Scott R Levin MD MSc, Alik Farber MD, Philip Goodney MD MS, Virendra Patel MD MPH, Rebecca Hasley MD, Nkiruka Arinze MD, Thomas Cheng MD, Denis Rybin PhD, Jeffrey J Siracuse, MD MBA
Boston Medical Center, Boston University School of Medicine, Boston, MA

OBJECTIVES

- Eversion carotid endarterectomy (eCEA) is a safe and effective alternative to conventional CEA for treating symptomatic and selected asymptomatic carotid stenosis
- eCEA entails oblique division of the internal carotid artery (ICA) at the carotid bulb, endarterectomy via ICA eversion, and ICA reimplantation into the bulb
- Carotid cross-clamping during CEA has been associated with low flow-induced cerebral ischemia and perioperative neurologic injury
- Shunting to maintain continuous ipsilateral cerebral blood flow has been postulated to prevent further ischemia in patients undergoing CEA
- Shunting is typically either planned in advance or performed only based on intraoperative monitoring
 - Planning to shunt in theory minimizes technical complications that may arise with urgent shunting in response to neurophysiologic changes.
 - In contrast, reports of shunt-related thromboembolism and impaired visualization, even in the setting of planned shunting, have supported a more selective approach
 - Shunting during eCEA may be technically challenging
- Whether shunting practice patterns modify perioperative stroke risk after eCEA is unclear
- Study Aims:**
 - Primary: Compare eCEA outcomes based on whether surgeons prospectively planned or planned not to shunt.
 - Secondary: Compare outcomes based on shunting indication

METHODS

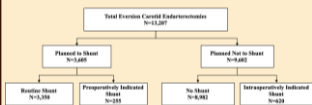
- Study Design:**
• Retrospective cohort study
- Database:**
• Vascular Quality Initiative (VQI) 2011-2019
• eCEA data from >600 academic/non-academic medical centers



METHODS

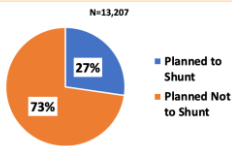
- Patient Selection:**
• All patients undergoing eCEA at VQI centers
- Exposures:**
• Whether surgeons planned versus planned not to shunt
• Whether shunting was routine practice, preoperatively indicated, intraoperatively indicated, or not performed

Figure. Shunting Patterns during eCEA in the VQI (2011-19)



- Outcome:**
• Operative duration, 30-day stroke, 30-day mortality
- Outcome:**
• Demographics, medical history, procedural details
- Statistical Analysis:**
• Univariable and multivariable analyses

RESULTS: ANALYSIS BY SURGEON PLAN TO SHUNT



RESULTS

Demographics, Medical History, Procedural Details by Planning to Shunt

| Characteristic | Overall (N=13207) | Planned to Shunt (N=3605) | Not Planned to Shunt (N=9602) | P-value |
|-------------------------------|-------------------|---------------------------|-------------------------------|---------|
| Age (year), mean ± SD | 71.4±9.1 | 71.1±9.2 | 71.5±9.0 | 0.054 |
| Male gender | 7840 (59.4%) | 2161 (59.9%) | 5679 (59.1%) | 0.404 |
| White race | 11770 (89.2%) | 3268 (90.4%) | 8502 (88.7%) | 0.005 |
| Obese | 4509 (34.1%) | 1228 (34.1%) | 3281 (34.2%) | 0.960 |
| Current Smoking | 3234 (24.5%) | 937 (26.0%) | 2297 (23.9%) | 0.034 |
| Primary Payer | | | | <0.001 |
| Medicare | 8152 (61.8%) | 2310 (64.1%) | 5842 (60.9%) | |
| Medicaid | 510 (3.9%) | 137 (3.8%) | 373 (3.9%) | |
| Commercial | 4251 (32.2%) | 1045 (29.0%) | 3206 (33.4%) | |
| Other | 284 (2.2%) | 109 (3.0%) | 175 (1.8%) | |
| Hypertension | 11677 (88.4%) | 3128 (86.8%) | 8549 (89.3%) | <0.001 |
| Diabetes | 4676 (35.4%) | 1378 (38.2%) | 3298 (34.4%) | <0.001 |
| Hemoglobin >10 g/dl | 12363 (94.3%) | 3357 (93.5%) | 9006 (94.6%) | 0.014 |
| Pre-op Statin | 10700 (81.0%) | 2879 (79.9%) | 7821 (81.5%) | 0.037 |
| Pre-op P2Y12 | 4406 (33.4%) | 1327 (36.8%) | 3079 (32.1%) | <0.001 |
| Ipsilateral Symptoms < 6 mo | | | | <0.001 |
| No/contralateral symptoms | 9915 (75.2%) | 2692 (74.8%) | 7223 (75.3%) | |
| Ipsilateral TIA | 1607 (12.2%) | 394 (11.0%) | 1213 (12.7%) | |
| Ipsilateral stroke | 1662 (12.6%) | 512 (14.2%) | 1150 (12.0%) | |
| Modified Rankin | | | | <0.001 |
| None/Non-significant | 10809 (89.2%) | 2766 (87.0%) | 8043 (90.0%) | |
| Slight/moderate | 1029 (8.5%) | 323 (10.2%) | 706 (7.9%) | |
| Moderately severe/severe | 279 (2.3%) | 92 (2.9%) | 187 (2.1%) | |
| Severe contralateral stenosis | 845 (6.6%) | 293 (11.6%) | 552 (7.5%) | <0.001 |
| Anesthesia | | | | <0.001 |
| Local | 334 (2.5%) | 35 (1.0%) | 299 (3.1%) | |
| Regional | 1947 (14.7%) | 121 (3.4%) | 1826 (19.0%) | |
| General | 10925 (82.7%) | 3448 (95.7%) | 7476 (77.9%) | |
| EEG | 4077 (30.9%) | 362 (10.1%) | 3715 (38.7%) | <0.001 |
| Stump Pressure | 1939 (14.7%) | 378 (10.5%) | 1561 (16.3%) | <0.001 |

No significant difference in preadmission living location, ESRD, CAD, CHF, COPD, CABG/PCI, preop ASA, preop anticoagulation, anatomic high neck, previous radiation, degree of ipsilateral stenosis, preop statin, preop P2Y12.

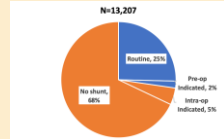
Outcomes by Planning to Shunt

| | Overall (N=13207) | Planned to Shunt (N=3605) | Not Planned to Shunt (N=9602) | P-value |
|--------------------------------|-------------------|---------------------------|-------------------------------|---------|
| Operative time (min) Mean ± SD | 109.8±46.1 | 116.8±49.4 | 107.1±44.6 | <0.001 |
| Post-op Ipsilateral Stroke | 99 (0.7%) | 24 (0.7%) | 75 (0.8%) | 0.5 |
| Mortality | 83 (0.6%) | 21 (0.6%) | 62 (0.6%) | 0.7 |

Multivariable Analysis of Outcomes by Planning to Shunt vs. Planning Not to Shunt

| | Adj. OR | 95% CI | P-value |
|----------------------------|---------|---------------|---------|
| Operative time | 1.155 | 1.136 - 1.175 | <0.001 |
| Post-op Ipsilateral Stroke | 0.863 | 0.531 - 1.404 | 0.553 |
| Mortality | 0.817 | 0.491 - 1.361 | 0.437 |

RESULTS: ANALYSIS BY SHUNT INDICATION



Outcomes by Shunt Indication

| Outcome | Overall (N=13207) | Routine (N=3350) | Pre-op Indicated (N=255) | Intra-op Indicated (N=620) | No Shunt (N=8982) | P-value |
|--------------------------------|-------------------|------------------|--------------------------|----------------------------|-------------------|---------|
| Procedure time (min) mean ± SD | 109.8±46.1 | 117.2±49.9 | 111.8±41.8 | 118.6±41.5 | 106.3±44.7 | <0.001 |
| Post-op ipsilateral stroke | 99 (0.7%) | 21 (0.6%) | 3 (1.2%) | 12 (1.9%) | 63 (0.7%) | 0.004 |
| Post-op mortality | 83 (0.6%) | 20 (0.6%) | 1 (0.4%) | 8 (1.3%) | 54 (0.6%) | 0.192 |

Multivariable Analysis of Outcomes by Shunt Indication

| Outcome | Exposure | Adj. OR | 95% CI | P-value |
|------------------|---|---------|-------------|---------|
| Operative time | Routine vs. no shunt | 1.174 | 1.154-1.194 | <0.001 |
| | Preoperatively indicated vs. no shunt | 1.094 | 1.043-1.147 | <0.001 |
| | Intraoperatively indicated vs. no shunt | 1.122 | 1.088-1.158 | <0.001 |
| 30-day stroke | Routine vs. no shunt | 0.913 | 0.540-1.544 | 0.735 |
| | Preoperatively indicated vs. no shunt | 1.530 | 0.469-4.986 | 0.481 |
| | Intraoperatively indicated vs. no shunt | 2.738 | 1.414-5.3 | 0.003 |
| 30-day mortality | Routine vs. no shunt | 0.894 | 0.529-1.515 | 0.678 |
| | Preoperatively indicated vs. no shunt | 0.533 | 0.073-3.908 | 0.536 |
| | Intraoperatively indicated vs. no shunt | 1.758 | 0.792-3.902 | 0.165 |

Multivariable Subanalysis of Intraoperatively Indicated Shunting

| | Adj. OR | 95% CI | P-value |
|---|---------|---------------|---------|
| Previous Radiation | 1.954 | 1.083 - 3.525 | 0.026 |
| Wheelchair/Bedridden vs. Ambulatory | 1.936 | 1.040 - 3.602 | 0.037 |
| Rankin: Slight/Moderate vs. None | 1.606 | 1.211 - 2.131 | 0.001 |
| Pre-op P2Y12 | 1.357 | 1.135 - 1.622 | 0.001 |
| Non-White vs. White | 1.34 | 1.048 - 1.713 | 0.02 |
| CAD | 1.281 | 1.060 - 1.548 | 0.01 |
| Pre-op Creatinine 1.8+ mg/dl | 1.309 | 0.913 - 1.876 | 0.143 |
| Ipsilateral stroke vs. Asymptomatic | 1.213 | 0.934 - 1.575 | 0.147 |
| Ambulatory with Assistance vs. Ambulatory | 1.133 | 0.846 - 1.517 | 0.404 |
| Rankin: Moderately severe/Severe vs. None | 1.037 | 0.578 - 1.862 | 0.903 |
| Ipsilateral TIA vs. Asymptomatic | 0.877 | 0.663 - 1.160 | 0.358 |
| Obesity | 0.842 | 0.699 - 1.014 | 0.069 |

CONCLUSIONS

- In eCEAs, there is no difference in perioperative stroke risk when surgeons prospectively plan or plan not to shunt
- When shunting is performed, shunting planned in advance is associated with lower stroke risk