“It's Not the Anesthesia, It's the Monitoring!”

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SCA 2012. Boston MA
Conflict of Interest

Baxter Pharmaceutical
Speakers’ Bureau, Consultant

Monitoring carotid procedures

• What is current morbidity/mortality?
• Heart vs head?
• Hematologic issues?
Our CEA review (1996)

Carotid Endarterectomy: Perioperative and Anesthetic Considerations
Hane J, Willke II, MD, John H. Ellis, MD, and James F. McKinsey, MD

Journal of Cardiotoracic and Vascular Anesthesia, Vol 10, No 7 (December), 1996 pp 928-949
http://goo.gl/2bhyO

Perioperative stroke and death rate for CEA in symptomatic patients

We're doing better!

Stroke 2011, 42:675-680
Erickson and Cole review (2010)


K. M. Erickson * and D. J. Cole
Mayo Clinic College of Medicine, Rochester, MN, USA
* Corresponding author. Email: erickson.kr@mayo.edu

NEUROSCIENCES AND NEUROANAESTHESIA

Carotid artery disease: stenting vs endarterectomy

K. M. Erickson * and D. J. Cole
Mayo Clinic College of Medicine, Rochester, MN, USA

What to monitor? HEART

- Ischemia
  - EKG
  - TEE?
  - Troponin
- Cardiac output
  - Non-invasive?
What to monitor? BRAIN

• Neurologic function
  o Awake patient
  o EEG
  o SSEP
• Cerebral emboli
  o TCD

• Perfusion
  o Stump pressure
  o Cerebral oximetry
  o TCD

What to monitor? BLOOD

• Heparin
  o ACT
• Antiplatelet Rx
  o ???
• Hematocrit
Causes of periop stroke?

- Postop Thrombosis: 15
- Cerebral Ischemia: 10
- Postop Embolus: 10
- Intracerebral bleed: 12
- Other surgery related: 8
- Unrelated to Op’d Art: 8
- Unknown: 3

Technical (65%)

Unrelated to Technique (35%)


What we learn from CREST

Stenting versus Endarterectomy for Treatment of Carotid-Artery Stenosis

Thomas G. Brott, M.D., Robert W. Hobson, II, M.D., George Howard, Dr.P.H., Gary S. Roubin, M.D., Ph.D., Wayne M. Clark, M.D., William Brooks, M.D., Ariane Mackey, M.D., Michael D. Hill, M.D., Pierre P. Leimgruber, M.D., Alice J. Sheffet, Ph.D., Virginia J. Howard, Ph.D., Wesley S. Moore, M.D., Jenifer H. Voecks, Ph.D., L. Nelson Hopkins, M.D., Donald E. Cutlip, M.D., David J. Cohen, M.D., Jeffrey J. Popma, M.D., Robert D. Ferguson, M.D., Stanley N. Cohen, M.D., Joseph L. Blackshear, M.D., Frank L. Silver, M.D., J.P. Mohr, M.D., Brajesh K. Lal, M.D., and James F. Meschia, M.D., for the CREST Investigators†
CREST (2010)

• ~ 2400 pts randomized CAS vs CEA
• For CEA:
  o 90% GA
  o 57% shunt
  o 92% aspirin preop
  o 91% antiplatelet Rx postop
  o 61% vasopressors intraop

n engl j med 363;1 nejm.org july 1, 2010

CREST (2010)

"During the periprocedural period, there was a higher risk of stroke with stenting and a higher risk of myocardial infarction with endarterectomy."

n engl j med 363;1 nejm.org july 1, 2010
CREST (2010)

<table>
<thead>
<tr>
<th>Myocardial infarction</th>
<th>CAS</th>
<th>CEA</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymptomatic (47%)</td>
<td>1.2%</td>
<td>2.2%</td>
<td>0.20</td>
</tr>
<tr>
<td>Symptomatic (53%)</td>
<td>1.0%</td>
<td>2.3%</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Periop MI increases death post CEA/CAS

Figure 2. Kaplan-Meier survival curves after randomized carotid revascularization in the Carotid Revascularization Endarterectomy

Monitoring troponins routinely?

Intense Cardiac Troponin Surveillance for Long-Term Benefits Is Cost-Effective in Patients Undergoing Open Abdominal Aortic Surgery: A Decision Analysis Model

Seinivas Mantha, MD
Joseph Foss, MD
John E. Ellis, MD
Michael F. Roizen, MD

http://goo.gl/0uZCC
 Would you rather have an MI or a stroke?

Estimated impact of stroke, MI on the SF-36 scales at 1 year
Antiplatelet Rx in CREST

CAS
- Antiplatelet Rx pre CAS
  - 96.7%
- Antiplatelet Rx post CAS
  - 98.1%

CEA
- Aspirin 48 hrs pre CEA
  - 92.3%
- Antiplatelet Rx post CEA
  - 86%


Urgent CEA carries more risk

<table>
<thead>
<tr>
<th></th>
<th>Odds Ratio death/stroke</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–2 d</td>
<td>4.24</td>
<td>2.07–8.70</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>3–7 d</td>
<td>1.0</td>
<td></td>
<td>0.707</td>
</tr>
<tr>
<td>8–14 d</td>
<td>1.12</td>
<td>0.62–2.02</td>
<td></td>
</tr>
</tbody>
</table>

Stroke. 2012;43:00-00
What should BP be for cross-clamp?

Heart vs head

Do patients read anatomy texts?

K. M. Erickson * and D. J. Cole
Mayo Clinic College of Medicine, Rochester, MN, USA
Do patients read Miller's textbook?

Is phenylephrine the right drug?

- Norepinephrine vs. phenylephrine
- "light anesthesia" = norepinephrine?
- Would norepinephrine preserve cardiac function better?
Vasopressors vs "light" anesthesia

- Anesthetic randomized
  - Halothane (with nitrous oxide)
  - Isoflurane (with nitrous oxide)
- Concentration randomized
  - Low concentration alone (~1.0 MAC)


"Light" anesthesia to raise BP

Cerebral monitoring?

Neurological status in the awake patient and the EEG may be close to a ‘gold standard’.

Transcranial Doppler has the advantage of the ability to detect cerebral emboli.
General anaesthesia versus local anaesthesia for carotid surgery (GALA): a multicentre, randomised controlled trial

GALA Trial Collaborative Group

- 3526 patients
- Symptomatic or asymptomatic internal carotid stenosis for whom
- Open surgery with either local or general anaesthesia was advised
- 95 centres
- 24 countries

Recruitment ran from June, 1999 to October, 2007.

Lancet 2008; 372: 2132–42

Table 3 First events occurring up to 30 days in the GALA Trial

<table>
<thead>
<tr>
<th>Event</th>
<th>General anaesthesia</th>
<th>Local anaesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>70</td>
<td>66</td>
</tr>
<tr>
<td>Fatal</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>Non-fatal (including retinal infarction)</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Fatal</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Non-fatal</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Other death</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Stroke, myocardial infarction or death</td>
<td>84</td>
<td>80</td>
</tr>
</tbody>
</table>

British Journal of Surgery 2010; 97: 1218 – 1225
### EEG Changes during Awake Carotid Endarterectomy

Karl A. Illig, MD,1 Yaron Sterwisch, MD,1 Renyu Zhang,1 James Burchiel, PhD,2 Cynthia K. Shortell, MD,2 Jeffrey M. Rhodes, MD, Mark G. Davies, MD, PhD,2 Sean P. Lyden, MD,1 and Richard M. Green, MD,1 Rochester, New York

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### EEG during awake CEA

<table>
<thead>
<tr>
<th></th>
<th>CB ($n = 135$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensitivity 90%</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Specificity 90%</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EEG changes with clamping</th>
<th>CB ($n = 135$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ipsilateral</td>
<td>7.4</td>
</tr>
<tr>
<td>Global</td>
<td>0</td>
</tr>
<tr>
<td>Neurologic changes with clamping</td>
<td>7.4</td>
</tr>
<tr>
<td>Shunted$^b$</td>
<td>7.4</td>
</tr>
</tbody>
</table>

Illig KA Ann Vasc Surg, 2002
Less shunting in awake CEA

Table IV. EEG and neurologic changes with carotid artery clamping

<table>
<thead>
<tr>
<th></th>
<th>CB (n = 135) (%)</th>
<th>GA (n = 288)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEG changes with clamping</td>
<td>7.4</td>
<td>15.3</td>
<td>Overall p = 0.03</td>
</tr>
<tr>
<td>Ipsilateral</td>
<td>7.4</td>
<td>11.8</td>
<td>NS</td>
</tr>
<tr>
<td>Global</td>
<td>0</td>
<td>3.5</td>
<td>0.04</td>
</tr>
<tr>
<td>Neurologic changes with clamping</td>
<td>7.4</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Shunted(^b)</td>
<td>7.4</td>
<td>17.0</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Illig KA Ann Vasc Surg. 2002

REVIEW ARTICLES

Richard P. Cambria, MD, Section Editor

Shunting during carotid endarterectomy

Ali F. AbuRahma, MD, Albeir Y. Mousa, MD, and Patrick A. Stone, MD, Charleston, WV

"In conclusion, the use of routine shunting and selective shunting was associated with a low stroke rate. Both methods are acceptable, and the individual surgeon should select the method with which he or she is more comfortable."
Outcomes of carotid endarterectomy under general and regional anesthesia from the American College of Surgeons’ National Surgical Quality Improvement Program

Stefan W. Leichtle, MD, a Nicolas J. Mouawad, MD, b Kathleen Welch, MPH, b Richard Lampman, PhD, a Walter M. Whitehouse Jr, MD, a and Michael Heidenreich, MD, a Ann Arbor, Mich

Retrospective analysis of CEA cases from 2005 through 2009 in the ACS NSQIP database.

Leichtle SW et al J Vasc Surg. 2012 Apr 3

GA associated with more MI

Table II. Unadjusted and adjusted ORs for stroke, MI, and death after CEA under GA versus RA for the entire study population

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Before propensity score adjustment</th>
<th>After propensity score adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Stroke</td>
<td>1.13</td>
<td>0.86-1.49</td>
</tr>
<tr>
<td>MI</td>
<td>2.21</td>
<td>1.19-4.09</td>
</tr>
<tr>
<td>Death</td>
<td>1.04</td>
<td>0.69-1.57</td>
</tr>
</tbody>
</table>

CEA, Carotid endarterectomy; CI, confidence interval; GA, general anesthesia; MI, myocardial infarction; OR, odds ratio; RA, regional anesthesia.
*Denotes statistical significance with P < .05.

...particularly in the subgroup of patients with preoperative neurologic symptoms

Leichtle SW et al J Vasc Surg. 2012 Apr 3
Limitations of NSQIP database

• No data on use of:
  o antiplatelet agents
  o perioperative beta-blockers.
• No specifics about the anesthesia:
  o beyond GA or RA
• No operative details:
  o monitoring
  o shunting

Leichtle SW et al J Vasc Surg. 2012 Apr 3

Wake up test
ESCVS article - Carotid and imaging
Preserved consciousness in general anesthesia during carotid endarterectomy: a six-year experience


*Unit of Vascular and Endovascular Surgery, San Paolo Hospital, Cittàdella, Rome, Italy
*Unit of Anesthesia and Intensive Care, San Paolo Hospital, Cittàdella, Rome, Italy
*Unit of Anesthesia and Intensive Care, European Hospital, Rome, Italy

Received 15 June 2011; received in revised form 8 August 2011; accepted 11 August 2011

A: Lyon, France; B: Florence, Italy; C: Modena, Italy; D: Bolzano, Italy
Wake-Up Test Decrease Shunts Insertion During Carotid Endarterectomy Under General Anesthesia

Luigi Vetrugeo, MD, Elena Di Luca, MD, Daniela Drigo, MD, Valsiero Fregonese, MD, Nevio Genano, MD, and Francesco Giordano, MD

Figure 1. Of 343 patients, 20 (5.8%) were shunted based on a positive wake-up test (WUT) after cross-clamping in comparison to 45 patients (12.8%) based on stump pressure (SP) < 40 mm Hg.

The Role of Cerebral Oximetry in Combination with Awake Testing in Patients Undergoing Carotid Endarterectomy under Local Anaesthesia

J.C. Ritter, D. Green, H. Slim, A. Tiwari, J. Brown, H. Rashid
TCD limitations

- In 25% of the patients, no appropriate temporal bone window was identified for intra-operative TCD monitoring.
  - 2 patients required shunting due to deterioration of consciousness
- Sensitivity = 58%
- Specificity = 100%
- Positive predictive value = 100%
- Negative predictive value = 92%
A potential dilemma represents the question whether data obtained in this study is applicable to GA.
Neuromonitoring in Carotid Surgery: Are the Results Obtained in Awake Patients Transferable to Patients Under Sevoflurane/Fentanyl Anesthesia?

Stefan Moritz, MD,* Christoph Schmidt, MD,* Michael Bucher, MD,* Christoph Wiesmack, MD,† Markus Zimmermann, MD,‡ Karl-Michael Schebesch, MD,§ Piotr Kasprzak, MD,† and Christoph Metz, MD¶

* J Neurosurg Anesthesiol Volume 22, Number 4, October 2010

** J Neurosurg Anesthesiol Volume 22, Number 4, October 2010
Case report

Does bilateral bispectral index monitoring (BIS) detect the discrepancy of cerebral reperfusion during carotid endarterectomy?

Mitsuhiro Kodaka MD (Associate Professor)*, Yuki Nishikawa MD (Senior Resident), Toshinari Suzuki MD (Instructor), Kazumi Asano MD (Instructor), Akihiko Maeyama MD (Instructor), Hideki Miyao MD (Professor, Chairperson)

Department of Anesthesiology, Saitama Medical Center/University, Saitama 350-8550, Japan

Received 7 November 2007; revised 23 September 2008; accepted 7 October 2008
Cerebral monitoring?

Neurological status in the **awake patient** and the **EEG** may be close to a ‘gold standard’.

**Transcranial Doppler** has the advantage of the ability to detect cerebral emboli

*British Journal of Anaesthesia 105 (S1): i34–i49 (2010) doi:10.1093/bja/aeq319*
Polls for CEA management

- Do you routinely monitor ACT?
- Do you measure antiplatelet Rx?
- Do you use an A-Line routinely?
Polls for CEA management

- Which 1st choice monitor:
  - Awake pt
  - EEG
  - TCD
  - Cerebral oximetry
  - Stump pressure
  - Shunt everyone