Carotid Artery Stenting: Procedural Complications

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Disclosure Statement of Financial Interest

Within the past 12 months, I have had a financial interest/arrangement or affiliation with the organization(s) listed below.

<table>
<thead>
<tr>
<th>Affiliation/Financial Relationship</th>
<th>Company</th>
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<tr>
<td>Consulting Fees/Honoraria</td>
<td>Covidien</td>
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<td>Penumbra</td>
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Outline

• Pre- EPD

• Stent Deployment

• Post Stent Deployment
Embolic Stroke

- Catheterization
- Crossing the Lesion
- Angioplasty – pre or post
- Placement of Stent
- Retrieval of EPD
## Quantification of emboli

*Transcranial Doppler*

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<tr>
<th>Procedure</th>
<th>CEA</th>
<th>CAS</th>
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<tbody>
<tr>
<td>Number of hits</td>
<td>52±64</td>
<td>202±119</td>
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Stroke and death rate within 30 days = 1.8% with protection compared with 5.5% without protection ($P<0.001$).
- Mainly due to a decrease in occurrence of minor strokes (3.7% vs 0.5%; $P<0.001$) and major strokes (1.1% vs 0.3%; $P<0.05$), whereas death rates were almost identical (0.8%; 20.3, $P=0.6$).
Protection Device

Carotid Artery Stenting
*Impact of NeuroProtection – Global Registry*

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<thead>
<tr>
<th></th>
<th>Unprotected</th>
<th>Protected</th>
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<tbody>
<tr>
<td>Minor stroke</td>
<td>2.86</td>
<td>1.1</td>
</tr>
<tr>
<td>Major Stroke</td>
<td>1.61</td>
<td>0.72</td>
</tr>
<tr>
<td>Death</td>
<td>0.82</td>
<td>0.45</td>
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N = 6,688 cases                             4,005 cases
Protection Device Limitations

- Large profile
- Abrupt change in stiffness
- Capture efficiency
  - Pore size (>100uM)
  - Incomplete occlusion
  - Filter retrieval
- Dissection
Embolic Stroke - Management
Embolic Protection Device - Issues

Vessel Occlusion

- Embolic protection device can lead to slow flow, hypoperfusion injury, thrombosis
- 9% in a single center retrospective review.

Vasospasm

Navigating the vessels: Hemodynamically significant spasm in 3-5% of cases

Embolic Protection Device

Vasospasm - Management

- Removal of device and time
- IA Nitro 100 microgram aliquouts
- IA Verapamil 10 mg aliquouts
- IA Nicardipine

- Look for vessel injury/dissection, distal emboli
Stent Deployment Complications
Bradycardia and Hypotension

- Rates range from 10-42%
- Associated with: older age, female, MI, CAD, stenosis at carotid bulb
- Drug Intervention required in ~ 50% symptomatic patients

AJNR November 2008 29: 1942-1947
Managing Bradycardia Hypotension

- Arterial Line
- Communication with Anesthesia team
- Atropine/Glycopyrrolate at time of angioplasty
- Volume versus pressors at time of treatment
- Monitoring 6-12 hours following procedure
In stent thrombosis: 0.5-5% in early devices, 0.04-2% with modern anti-platelet regimen.
Stent Thrombosis

- Acute
  - IA IIb/IIIA inhibitors followed by IV drip
  - Mechanical thrombectomy with aspiration

- Delayed
  - ? Thrombosis vs restenosis
  - ? Platelet aggregation vs thrombus
    - IA treatments with IIb/IIIA or tPA or aspiration
    - IV heparin to stabilize the clot

Sabine Steiner-Böker et al. AJNR 2004;25:1411-1413
Other stent issues

- Vasospasm
  - Placement in tortuosity
  - Significant vessel size mismatch
    - Tx if needed with IA vasodilators
- Dissection
  - Can be treated medically in most instances
  - If flow limiting consider placement of additional stent
Post-Deployment: Hyperperfusion

Hyperperfusion syndrome and Hemorrhage
Rare (0.67%)

Post-Deployment: Hyperperfusion

- Increase in perfusion of 100% compared to baseline
- Clinical signs: Somnolence, Headache, Seizure, Signs of increased ICP, aphasia, weakness.
- Within 12 hours to days following procedure
- 10-24% of cases of syndrome
- 0.6-0.8% of cases with ICH
- Risks
  - Diabetes, Age, recent contralateral procedure, incomplete COW, high grade stenosis, post-op hypertension

Post Stent Deployment

- Inability to recapture EPD
  - Most instances related to inability to pass retrieval catheter through stent
    - Head rotation, extension, manual displacement of carotid with external force
    - Consider 4F or 5F catheter with angled tip to retrieve device. Angled tip allows for rotating around turns
Post Stent Deployment

Femoral Pseudoaneurysm: approximately 3% of patients

Delayed: Stent Fracture

- 11 of 312 at 1 year follow-up (3.4%)
- Associated with Calcification and vessel angulation
- Correlated with restenosis following stent

Conclusions

• Overall Safe Procedure

• Acute risks still less than that of open surgery

• Risks Decrease with increased use and Technology improvements
Thanks