Ischemic Complications During Fenestrated vs. Standard EVAR

Division of Vascular and Endovascular Surgery

DISCLOSURES

None relevant to this presentation

Background: Ischemic Complications During Aortic Repair

- Ischemia/embolization can affect multiple vascular beds including intestines, kidneys, extremities, spine, and cerebral vessels
- Can occur for both open and endovascular repairs; lower with standard EVAR than with open repair
- Patient risk factors: presentation with rupture, open repair, age, female gender, hypertension, heart failure, current smoking
- Procedural risk factors: occlusion of a hypogastric artery, operative time, blood loss

Background: Ischemic Complications During EVAR

- Rates of ischemic complications with EVAR may have decreased over time, possibly related to device improvements
- Early experience with FEVAR at the Cleveland Clinic demonstrated that acute kidney injury developed in 16% of patients without preoperative renal insufficiency and in 39% of those with chronic renal disease
- Post-FEVAR acute renal failure is as high as 29%, with a 14% decrease in eGFR and renal volume at 5 years postoperatively
- Midterm branch vessel patency rates range from 93% to 98% (at 3–5 years)

Ischemic complications and Fenestrated and Branched EVAR (F/BEVAR)

- Early experience with FEVAR at the Cleveland Clinic demonstrated that acute kidney injury developed in 16% of patients without preoperative renal insufficiency and in 39% of those with chronic renal disease
- Post-FEVAR acute renal failure is as high as 29%, with a 14% decrease in eGFR and renal volume at 5 years postoperatively
- Midterm branch vessel patency rates range from 93% to 98% (at 3–5 years)

The relative risk associated with fenestrated/branched endovascular repair remains poorly understood

Objective

To examine and compare ischemic complications between standard EVAR and fenestrated and branched repair of abdominal aortic aneurysms (F/BEVAR) in a prospectively collected database.
Group Definitions

- EVAR group: No visceral branches/fenestrations/stents
- F/BEVAR group: Any visceral branch/fenestration/stent

Exclusion from study: any arch branch; proximal aortic landing zone 0-4

Statistics

- Multivariate models created with significant univariate predictors
- Propensity score created for F/BEVAR

Methods

Retrospective review of the prospectively collected Vascular Quality Initiative database from 2013-2017

Group Demographics

<table>
<thead>
<tr>
<th></th>
<th>EVAR (N=35379)</th>
<th>F/BEVAR (N=2575)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>POST-OPERATIVE LENGTH OF STAY (DAYS)</td>
<td>3.0±10.6</td>
<td>6.1±19.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AGE (YEARS)</td>
<td>73.35±8.75</td>
<td>73.72±8.58</td>
<td>0.041</td>
</tr>
<tr>
<td>MALE</td>
<td>28,635 (80.9%)</td>
<td>1917 (74.4%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RACE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHITE</td>
<td>31,948 (90.5%)</td>
<td>2,261 (88.1%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BLACK OR AFRICAN AMERICAN</td>
<td>1,805 (5.1%)</td>
<td>156 (6.1%)</td>
<td></td>
</tr>
<tr>
<td>ASIAN</td>
<td>430 (1.2%)</td>
<td>31 (1.2%)</td>
<td></td>
</tr>
<tr>
<td>AMERICAN INDIAN OR ALASKAN NATIVE</td>
<td>70 (0.2%)</td>
<td>3 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>NATIVE HAWAIIAN OR PACIFIC ISLANDER</td>
<td>42 (0.1%)</td>
<td>2 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>MORE THAN 1 RACE</td>
<td>30 (0.1%)</td>
<td>1 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>UNKNOWN</td>
<td>981 (2.8%)</td>
<td>112 (4.4%)</td>
<td></td>
</tr>
</tbody>
</table>

Group Comorbidities

<table>
<thead>
<tr>
<th></th>
<th>EVAR (N=35379)</th>
<th>F/BEVAR (N=2575)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREOP SMOKING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRIOR</td>
<td>18,869 (53.5%)</td>
<td>1,386 (53.9%)</td>
<td>0.063</td>
</tr>
<tr>
<td>CURRENT</td>
<td>11,352 (32.2%)</td>
<td>859 (33.4%)</td>
<td></td>
</tr>
<tr>
<td>PRIOR CORONARY DISEASE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- HISTORY OF MI BUT NO SYMPTOMS</td>
<td>7,650 (21.7%)</td>
<td>619 (24%)</td>
<td>0.006</td>
</tr>
<tr>
<td>- STABLE ANGINA</td>
<td>2,146 (6.1%)</td>
<td>173 (6.7%)</td>
<td></td>
</tr>
<tr>
<td>- UNSTABLE ANGINA OR MI &lt;6MO</td>
<td>489 (1.4%)</td>
<td>43 (1.7%)</td>
<td></td>
</tr>
<tr>
<td>PRIOR CONGESTIVE HEART FAILURE</td>
<td>2,496 (7.1%)</td>
<td>234 (9.1%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>- HISTORY OF CHF, ASYMPTOMATIC</td>
<td>1,096 (3.1%)</td>
<td>107 (4.2%)</td>
<td></td>
</tr>
<tr>
<td>- MILD</td>
<td>425 (1.2%)</td>
<td>47 (1.8%)</td>
<td></td>
</tr>
<tr>
<td>- MODERATE</td>
<td>160 (0.5%)</td>
<td>11 (0.4%)</td>
<td></td>
</tr>
<tr>
<td>- SEVERE</td>
<td>234 (9.1%)</td>
<td>112 (4.4%)</td>
<td></td>
</tr>
<tr>
<td>HYPERTENSION</td>
<td>29,254 (83%)</td>
<td>2,267 (88%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DIABETES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- DIET CONTROLLED</td>
<td>1,586 (4.5%)</td>
<td>112 (4.4%)</td>
<td>0.287</td>
</tr>
<tr>
<td>- NON-INSULIN MEDICATIONS</td>
<td>4,229 (12%)</td>
<td>291 (11.3%)</td>
<td></td>
</tr>
<tr>
<td>- INSULIN</td>
<td>1,297 (3.7%)</td>
<td>80 (3.1%)</td>
<td></td>
</tr>
<tr>
<td>COPD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- UNTREATED</td>
<td>3,445 (9.8%)</td>
<td>267 (10.4%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>- ON MEDICATIONS</td>
<td>6,325 (17.9%)</td>
<td>561 (21.8%)</td>
<td></td>
</tr>
<tr>
<td>- ON HOME OXYGEN</td>
<td>1,777 (5%)</td>
<td>149 (5.8%)</td>
<td></td>
</tr>
<tr>
<td>RENAL FAILURE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- FUNCTIONING KIDNEY TRANSPLANT</td>
<td>106 (0.3%)</td>
<td>8 (0.3%)</td>
<td>0.766</td>
</tr>
<tr>
<td>- ON DIALYSIS</td>
<td>397 (1.1%)</td>
<td>33 (1.3%)</td>
<td></td>
</tr>
<tr>
<td>PRE-OPERATIVE CREATININE</td>
<td>1.13±0.56</td>
<td>1.20±0.61</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PRIOR ANEURYSM REPAIR</td>
<td>733 (2.1%)</td>
<td>348 (13.7%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PRE-OPERATIVE ANTICOAGULATION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- YES</td>
<td>3,547 (11.7%)</td>
<td>293 (12.1%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>- NO, FOR MEDICAL REASON</td>
<td>453 (1.5%)</td>
<td>114 (4.7%)</td>
<td></td>
</tr>
<tr>
<td>- NON-COMPLIANT</td>
<td>20 (0.1%)</td>
<td>1 (0.0%)</td>
<td></td>
</tr>
</tbody>
</table>

Other measures of operative risk

<table>
<thead>
<tr>
<th></th>
<th>EVAR (N=35379)</th>
<th>F/BEVAR (N=2575)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUNCTIONAL STATUS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FULL</td>
<td>13,160 (68.9%)</td>
<td>1,293 (65.1%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LIGHT WORK</td>
<td>3,221 (16.9%)</td>
<td>398 (20.1%)</td>
<td></td>
</tr>
<tr>
<td>SELF CARE</td>
<td>2,147 (11.2%)</td>
<td>249 (12.5%)</td>
<td></td>
</tr>
<tr>
<td>ASSISTED CARE</td>
<td>542 (2.8%)</td>
<td>39 (2.0%)</td>
<td></td>
</tr>
<tr>
<td>BED BOUND</td>
<td>35 (0.2%)</td>
<td>6 (0.3%)</td>
<td></td>
</tr>
<tr>
<td>UNFIT FOR OPEN ANEURYSM REPAIR</td>
<td>5,761 (16.5%)</td>
<td>187 (30.1%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>UNFIT FOR GENERAL ANESTHESIA</td>
<td></td>
<td></td>
<td>0.216</td>
</tr>
<tr>
<td>ELECTIVE</td>
<td>30,212 (85.9%)</td>
<td>773 (86.5%)</td>
<td></td>
</tr>
<tr>
<td>SYMPTOMATIC/URGENT</td>
<td>3,000 (8.5%)</td>
<td>106 (11.9%)</td>
<td></td>
</tr>
<tr>
<td>RUPTURED/EMERGENT</td>
<td>1,976 (5.6%)</td>
<td>15 (1.7%)</td>
<td></td>
</tr>
</tbody>
</table>

F/BEVAR Procedures Are More Complicated

- All comparisons significant at p<0.001 after Bonferroni correction
Ischemic complications of F/BEVAR vs. EVAR

F/BEVAR Patients Have More Ischemic Complications

*All comparisons significant at p<0.001 after Bonferroni correction

Multivariate regression models - Significant relative risks

- Any ischemia:
  - Ruptured/emergent: 10.8
  - Symptomatic/urgent: 2.8
  - Female: 2.3
  - Current smoking: 2.2
  - Hypertension: 1.8
  - Age (per year): 1.02

- Leg embolization:
  - Ruptured/emergent: 3.8
  - Symptomatic/urgent: 2.5
  - Female: 2.2
  - Current smoking: 1.8
  - Hypertension: 1.7
  - Age (per year): 1.02

- Intestinal ischemia:
  - Ruptured/emergent: 13.3
  - Symptomatic/urgent: 3.79
  - Female: 1.87
  - Cr: 1.39
  - Age (per year): 1.03

Propensity analysis confirms significant effect of F/BEVAR

- Relative risks from F/BEVAR vs. EVAR after propensity adjustment
  - Any ischemia: 3.7 [3.0, 4.6]
  - Intestinal ischemia: 4.5 [3.1, 6.4]
  - Leg embolization: 2.5 [1.8, 3.7]
  - New HD: 4.3 [3.2, 5.8]
  - Cr rise >1: 3.6 [3.0, 4.3]
  - Stroke: 3.4 [2.6, 5.9]

EVAR outcomes over time

FEVAR outcomes over time
Why do F/BEVAR patients have more ischemic complications?

- Larger sheath sizes
- Increased wire/catheter manipulation causing disruption of plaque/thrombus
- Wire/catheter/sheath placement in visceral arteries
- Longer procedure times
- Higher contrast doses

Conclusions

Can we reduce ischemic risk?

- Continued technology development: smaller sheaths, improved imaging, possibly embolic protection
- Increased wire/catheter skill/experience
- Patient selection: risk stratification
- Operative strategies: staging repair

Conclusions

- Patients who require F/BEVAR have more comorbidities and have more complex disease
- Even after adjustment for comorbidities, they have higher in-hospital rates of intestinal, extremity, renal, and cerebrovascular ischemic events
- Particularly high risk when combined with other risk factors such as presentation with rupture, female gender, increased age, or current smoking.

Thank You