Surgery Research Conference

Vascular Surgery Research Update

November 14th, 2018

ACCME Accreditation Statement: The Medical College of Wisconsin is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians. AMA Credit Designation Statement: The Medical College of Wisconsin designates this live activity for a maximum of 1.0 AMA PRA Category 1 Credit™. Physicians should claim only the credit commensurate with the extent of their participation in the activity. Hours of Participation for Allied Health Care Professionals: The Medical College of Wisconsin designates this activity for up to 1.0 hours of participation for continuing education for allied health professionals.
Research Highlights
Congratulations Dr. James

Selected to receive the TAP award for Anti-CRR9 Monoclonal Antibodies for Treatment of Therapy-Resistant Tumors, leveraging funding and local resources to advance these drugs.
Congratulations Drs. Lyle & David Joyce

Selected to receive the TAP award (up to 50K) to develop new iterations of the Percutaneous Distal Embolic Protection Device for LVAD Thrombosis
Publications

**General Surgery**

*C- Reactive protein as a predictor of post-operative complications in bariatric surgery patients*  *Surgical Endoscopy.* (Villard MA, Helm MC, Kindel TL, Goldblatt MI, Gould JC, Higgins RM)

**Transplant Surgery**

*Emerging Innovations in Liver Preservation and Resuscitation.*  *Transplantation Proceedings.* (Kim J, Zimmerman MA, Hong JC)

**Pediatric Congenital Cardiac Surgery**

*Isolated Left Innominate Artery: Diagnosis of a Rare Aortic Arch Anomaly.*  *World Journal for Pediatric & Congenital Heart Surgery.* (Spearman AD, Hraska V, Goot BH)

**Research**


**Surgical Oncology**

*Elective Regional Therapy Treatment for Hepatic Adenoma.*  *Annals of Surgical Oncology.* (Silva JP, Klooster B, Tsai S, Christians KK, Clarke CN, Mogal H, Clark Gamblin T)

**Cardiothoracic Surgery**

*Is This a T(r)oll-Free Bridge?*  *Seminars in Thoracic & Cardiovascular Surgery.* (Ronald K. Woods)

**Vascular Surgery**

“The Word on Medicine: where Knowledge is changing life”

REPLAY:  Cancer of the Pancreas
Saturday, November 24th at 4pm

Dr. Susan Tsai
Dr. Michael Griffin
Jennifer Geurts
Dr. Kathleen Christians
Dr. Beth Erickson
Dr. Abdul Khan
Dr. Ben George
Department of Surgery
ICE CREAM SOCIAL & BAKE SALE

World Pancreatic Cancer Awareness Day
November 15th, 2018
HUB 3rd Floor, Lobby
11:30AM — 2:00PM

Show your support for all those affected by Pancreatic Cancer.
Purchase your scoop of ice cream and learn about ways you can help!

Every FRIDAY Wear PURPLE!
ENROLL: Methods in Grant Preparation Seminar Series

Title: Methods in Grant Preparation
Dates: Wednesdays, January 2, 2019 – March 20, 2019
Time: 5:00-7:00 pm
Location: Medical College of Wisconsin, H1210
Textbook: The Grant Application Writer’s Workbook/
Authors: Stephen W. Russell and David C. Morrison/
Publisher: National Institutes of Health

Forms due by: 12/14 to Memory Bacon
• What is iLab? – iLab Core Management Software allows researchers to order, track, and pay for core services in a convenient one-stop location.
• iLab Walk-in Help Sessions: Fridays 9:30-11:00 am in MFRC #3096
• MCW Cores Now Live in iLab:
  – CRI Histology Core
  – MCW Tissue Bank
  – Center for Biomedical Mass Spec Research
  – Center for Imaging Research
  – Cancer Center Redox and Bioenergetics Shared Resource
  – Biostatistics Consulting Service
Complete revised department form and submit to Krissa Packard and Dr. Gwen Lomberk.

Request for services will be made in iLab under the “Surgery Biostats” Lab
- PI and primary contact info will be provided.

Confirmation of request will be sent to PI.

Do not request services under your own lab if planning to use the department integration agreement.

Biostats Form
Next Month:

Transplant Surgery Research Update

Johnny Hong, MD

December 12, 2018
Conference Room M
5:00-6:00pm
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<td>Peter Rossi, MD</td>
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<td><strong>Clinical Outcomes Research – Status Updates</strong></td>
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<td>• Long-Term Proximal Aortic Remodeling Following Thoracic Endovascular Aortic Repair for Blunt Thoracic Aortic Injury</td>
<td>Emily Bero</td>
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<td>• Walking Capacity of Patients with Lower Extremity Claudication Following Ischemic Preconditioning</td>
<td>Rory Loo</td>
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<td>• Contemporary Outcomes Following Hybrid Ilio-Femoral Artery Revascularization in Patients with Peripheral Arterial Occlusive Disease</td>
<td>Calvin Nguyen-Ho</td>
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<td>Outcomes Following TEVAR for Acute Aortic Syndromes</td>
<td>Nathan Kugler, MD</td>
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<td>Outcomes of Ruptured Abdominal Aortic Aneurysm Following Adoption of Endovascular Aortic Repair</td>
<td>Peter Rossi, MD</td>
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<td>Prospective Research Initiatives</td>
<td>Gary Seabrook, MD</td>
</tr>
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Clinical Trials
NIH Trial - Best CLI

- **22901** – Best Treatment for Chronic Limb Ischemia
- Comparing the primary endpoint event rate of Major Adverse Limb Event (MALE)-free survival
- CLI randomized to best endovascular (EVT) revascularization to the rate in those randomized to best open surgery (OPEN).
- Best revascularization, whether EVT or OPEN, is defined as the technique deemed most appropriate for the subject by the operator(s), with respect to the index limb.
- 19 active MCW patients- ½ way to 2100 global accrual
- Open to accrual
Sponsored Device / Drug Trials

- **32175 Proteon PAD, Patel:**
  - A Phase 1 Multi-center, Randomized, Double-blind, Placebo-controlled, Dose-escalation Study of Vonapanitase Administered following Angioplasty of a Distal Popliteal, Tibial or Peroneal Artery in Patients with Peripheral Artery Disease - **Open mid November**

- **28341 Bolton Relay Pro-T, Rossi:**
  - Prospective, Multicenter, Non-Blinded, Non-Randomized Study of the RelayPro Thoracic Stent-Graft in Subjects with Traumatic Injury of the Descending Thoracic Aorta (2 active) **Open to accrual**

- **21519 Endologix Nellix®, Rossi:**
  - Evaluation of the Nellix® for Endovascular Abdominal Aortic Aneurysm Repair CURRENTLY ON FDA HOLD  Fall 2017 FDA instructed sponsor to report 2 year data concerning Graft sizing and migration -ACTIVE PATIENT DATA COLLECTION  (3 active patients + 1 explantation) **Closed to accrual**
Sponsored Device Trials (cont)

- **24297 Endologix LEOPARD, Rossi:**
  - Multicenter, Observational, Post-market, Real World Study to Assess Outcomes of Patients Treated with AFX ® System compared to other EVAR devices for Endovascular Abdominal Aortic Aneurysm Repair, (7 active patients)

- **20654 Gore® GREAT: Global Registry, Rossi:**
  - Global Registry for Endovascular Aortic Treatment Outcomes Evaluation (7 active pts)

- **21039 Gore® IBE 1204 Excluder® Branch Endoprothesis, Rossi:**
  - Evaluation of the GORE® EXCLUDER® Iliac Branch Endoprosthesis for the treatment of Common Iliac artery aneurysms or aortic-iliac aneurysms (2 active patients)
Upcoming Invited Sponsored Trials

• **Terumo, Rossi:**
  - A prospective, multi-center, single arm, clinical study to investigate the safety and efficacy of the Cross-Seal System
MCW Investigator Initiated Trials

- **16498 - Vascular Surgery Groin Infections, Rossi:**
  - Risk factors for development of groin surgical site infections in vascular operations - extending data collection January 2005 - December 2018

- **20748 - Outcomes of Ruptured Abdominal Aneurysms, Rossi:**
  - Andrew SooHoo – publication in review, extending data collection January 1995 - December 2018

- **31772 IPC - Claudication Trial, Durand/Lewis:**
  - Walking Capacity of Patients with Claudication in Lower Extremities Following Ischemic Preconditioning - data collection completed on 18 patients - Medical Student Rory Loo
Clinical Outcomes Research
Emily Bero
MCW Department of Surgery
Summer Research Program
Long-Term Proximal Aortic Remodeling Following Thoracic Endovascular Aortic Repair for Blunt Thoracic Aortic Injury

Emily Bero, Calvin Nguyen-Ho, Brian Lewis, Dennis Foley, CJ Lee
Blunt Thoracic Aortic Injury (BTAI)

- A leading cause of traumatic deaths in the field (1)
- TEVAR versus open surgery for BTAI - lower rate of mortality, paraplegia, and stroke with TEVAR (2, 4)
- Significant systemic arterial compliance lies in proximal thoracic aorta. Insertion of a less compliant graft decreases arterial compliance, leading to significant increase in systolic pressure and pulse pressure (3)
- Long-term behavior of endovascular graft in healthy aortic segments and its impact on overall aortic remodeling following TEVAR needs further study

Methods

- Retrospective review of patients who underwent TEVAR for BTAI from 2004 to 2018
- 46 total patients treated, 32 patients identified with a minimum of one follow-up with postoperative CTA (range, 2 to 85 days)
- CTA analyzed for Diameter of ascending aorta, mid-aortic arch, innominate artery, left common carotid artery, left subclavian artery, proximal stent graft landing zone, proximal seal zone, distal seal zone, distal landing zone
Methods

- Aortic Tortuosity and Length:
  - Centerline of flow from reformatted 3D CTA to assess ascending aorta length & aortic arch length
- Average aortic curvature
- Aortic tortuosity
Device related outcomes:

- Bird-beaking
- Mural thrombus
- Stent geometry (infolding, migration, etc)
- Persistent endoleak
Outcomes

Following TEVAR:

• Average diameter of the ascending aorta increased (1.5 ± 1.5, p < 0.001 mm)

• Average diameter of the mid-aortic arch increased (1.3 ± 1.7mm, p < 0.001)

• Proximal endograft landing zone diameter increased (1.9 ± 2.1mm, p < 0.001)

• Distal endograft landing zone diameter increased (2.2 ± 1.6mm, p < 0.001)

• Ascending aortic length increased (mean 5.7 ± 4.6mm)
Outcomes

• Significant association with presence of endograft infolding and the development of endograft mural thrombus (p < 0.001)

• Increasing need for secondary intervention with the presence of endograft mural thrombus (p < 0.05)
Conclusions

- TEVAR for BTAI caused significant geometric changes in the ascending aorta and aortic arch, proximal to the stented aorta.
- Changes were noted within the stented aortic segment with increased aortic diameters and development of mural thrombus within the endograft.
- Although clinical significance is yet to be determined, post-TEVAR changes in aortic architecture warrant continued surveillance for better understanding of long-term aortic remodeling.
Rory Loo
MCW Department of Surgery
Summer Research Program
Walking Capacity of Patients with Lower Extremity Claudication Following Ischemic Preconditioning

Rory Loo BS, Max Wohlauer MD, CJ Lee MD, David Gutterman MD, Matt Durand PhD, Brian Lewis MD
Introduction

- Peripheral Arterial Disease (PAD) affects up to 12 million Americans
- 5% of people in 60’s
- 15% of people in 70’s and greater
- Prevalence continues to increase as population ages
Intermittent Claudication

- Muscular pain induced by exercise and relieved with rest
- Mismatched $O_2$ Supply/Demand
- Treatment:
  - Supervised walking programs increase walking capacity
  - Barriers to participation include geographic location, unsteady gait, recent myocardial infarction, angina, CHF, or rheumatoid arthritis
Ischemic Preconditioning

- Ischemic Preconditioning (IPC) is a clinically proven, non-invasive technique that can attenuate ischemic injury.
- Shown to improve functional capacity in patients recovering from stroke.

Methods

- Randomized 24 subjects into IPC group/sham intervention group
- Inflate thigh cuff to 225 mmHg (sham 25 mmHg)
- 6 sessions / 2 week period
- One IPC session = four cycles of 5 minutes of inflation/5 minutes of reperfusion

Methods

• A motorized treadmill assessed Peak Walking Time and Distance (PWT/PWD) before and after IPC sessions

• A Biodex Dynamometer assessed muscle strength and fatigability in knee extensors/flexors and plantar/dorsiflexors

http://www.hiphealth.ca/facilities/our-equipment/biodex
Results

IC - Plantar Flexion

Sham - Plantar Flexion

N=9

p = 0.012
Results Continued

N=9

IC

Sham

Total Knee Work (J)

Pre

Post

N=9

p = 0.012\textsuperscript{w}

\textsuperscript{w}Wilcoxon Rank-Sum Test
## Results Continued

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sham (n=9)</th>
<th>IPC (n=9)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Knee Work (J)</td>
<td>363.6 (-6514.3 – 8364.2)</td>
<td>955.7 (394.2 – 4300.9)</td>
<td>0.012w</td>
</tr>
<tr>
<td>Plantarflexion Work (J)</td>
<td>-4.8 (-27.5 – 5.8)</td>
<td>0.5 (-4.8 – 5.3)</td>
<td>0.051w</td>
</tr>
<tr>
<td>Total Ankle Work (J)</td>
<td>-4.8 (-29.2 – 5.4)</td>
<td>0.5 (-4.9 – 5.3)</td>
<td>0.033w</td>
</tr>
</tbody>
</table>

*wWilcoxon Rank-Sum Test*
Conclusions

• The enrollment phase is complete.
• Preliminary data show significant improvement in muscle performance following IPC
• Comprehensive data analysis will be performed after the final testing session
THANK YOU to the
MCW Department of Surgery and the
MCW Summer Research Program
for support of this research project
Calvin Nguyen-Ho
MCW Department of Surgery
Summer Research Program
Contemporary Outcomes Following Hybrid Ilio-Femoral Artery Revascularization in Patients with Peripheral Arterial Occlusive Disease

Calvin Nguyen-Ho, Emily Bero, Rory Loo, Brian Lewis, CJ Lee, Kellie Brown
Peripheral Arterial Occlusive Disease (PAOD)

- Symptoms of PAOD - severe muscle pain while walking (claudication), end stage manifestations include rest pain, or ischemic tissue loss.
- Overall prevalence of PAOD approximately 10%, but can rise to 20% in patients >70 years old\(^1\).
- May progress to critical limb ischemia (CLI) with high rates of limb loss.
- Approximately 8 million people in the United States are affected by the disease, leaving the estimated cost of care at $21 billion.\(^1\)
Peripheral Arterial Occlusive Disease - Surgical Intervention

• Aortoiliac and aortofemoral occlusive disease traditionally treated with endarterectomy, aortofemoral, or iliofemoral bypass surgery
  • Large abdominal wound and aortic cross-clamping required
  • Associated with higher morbidity rates compared to endovascular treatment of iliac lesions.
Treatment Options

• To mitigate operative risk, endovascular techniques have evolved
  • Shorter hospital lengths of stay and overall improved operative morbidity.²
  • Bare metal stents (BMS) vs. Polytetrafluoroethylene (PTFE)-covered nitinol stents (CS)
  • Not all lesions can be treated with endovascular means
• Hybrid repair utilizes both endovascular iliac stenting and surgical endarterectomy or bypass to address difficult lesions
**Aims and Hypothesis**

- **AIM:** To study contemporary outcomes, particularly patency rates, following ilio-femoral artery revascularization with bare metal stents (BMS) vs covered stents (CS) in patients with Peripheral Arterial Occlusive Disease (PAOD)

- **Hypothesis:**
  - Covered stents perform better compared to bare metal stents when used during hybrid ilio-femoral revascularization
    - Patency rates, limb salvage, mortality, and morbidity
Patient Demographics

<table>
<thead>
<tr>
<th>Demographics</th>
<th>BMS (9 patients)</th>
<th>CS (23 patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>62.8 ± 9.1</td>
<td>70.2 ± 8.7</td>
</tr>
<tr>
<td>Prior/Current Smoking</td>
<td>9 (100%)</td>
<td>23 (100%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2 (22%)</td>
<td>9 (39%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>7 (78%)</td>
<td>23 (100%)</td>
</tr>
<tr>
<td>COPD</td>
<td>2 (22%)</td>
<td>8 (35%)</td>
</tr>
<tr>
<td>Claudication</td>
<td>4 (44%)</td>
<td>18 (78%)</td>
</tr>
<tr>
<td>Rest Pain</td>
<td>5 (56%)</td>
<td>10 (43%)</td>
</tr>
<tr>
<td>Tissue Loss</td>
<td>5 (56%)</td>
<td>8 (35%)</td>
</tr>
</tbody>
</table>
Post-Operative Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>BMS (9 patients)</th>
<th>CS (23 patients)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-day mortality</td>
<td>0 (0%)</td>
<td>2 (9%)</td>
<td>0.36</td>
</tr>
<tr>
<td>Hospital Stay Length (days)</td>
<td>5.3 ± 3.7</td>
<td>10.9 ± 18.7</td>
<td>0.18</td>
</tr>
<tr>
<td>ICU stay length (days)</td>
<td>2.0 ± 1.0</td>
<td>4.8 ± 10.5</td>
<td>0.44</td>
</tr>
<tr>
<td>Estimated Blood Loss (mL)</td>
<td>244.4 ± 113.0</td>
<td>593.2 ± 612.6</td>
<td>0.02</td>
</tr>
<tr>
<td>Transfusion Units PRBC (mL)</td>
<td>0.4 ± 1.0</td>
<td>2.8 ± 5.1</td>
<td>0.04</td>
</tr>
<tr>
<td>Post-op Wound complication</td>
<td>1 (13%)</td>
<td>4 (17%)</td>
<td>0.66</td>
</tr>
<tr>
<td>Return to OR for bleeding</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>---</td>
</tr>
</tbody>
</table>
Discussion

- **Type of stent device used (CS vs BMS) did not impact overall post-operative outcomes**
  - However, patients with CS tended to have more significant operative blood loss, requiring more units of blood transfused.
  - **CS cost, on average, $1600 more than BMS; therefore, if post-operative outcomes are similar between the two, there are major financial implications**
References


Nathan Kugler, MD
Outcomes Following TEVAR for Acute Aortic Syndromes

Nathan Kugler MD¹, Nicholas Saguan MD¹, Amy C. Taylor MD², Nathan J. Alcasid BS¹, Max Wohlauer MD¹, Peter J. Rossi MD¹, Kellie R. Brown MD¹, Brian D. Lewis MD¹, Robert A. Hieb MD², Parag Patel M², Cheong J. Lee MD¹

¹Department of Surgery, Division of Vascular Surgery, Medical College of Wisconsin, Milwaukee, WI
²Department of Radiology, Division of Vascular & Interventional Radiology, Medical College of Wisconsin, Milwaukee, WI
We have nothing to Disclose.
Introduction

- Acute aortic syndrome (AAS)
  - 2 – 3.5 cases / 100,000 per year
  - Mortality upwards of 50%
  - Death rate presumed 2 – 3x higher from aortic dissection then AAA rupture
- Trend → Increased use of thoracic endografts in acute aortic syndrome
  - Complicated Type B Aortic Dissections (CTBAD)
  - Penetrating Aortic Ulcers (PAU)
  - Intramural Hematoma (IMH)

Objective

• Evaluate clinical outcomes following TEVAR intervention for complicated AAS
  ▫ Technical Success of TEVAR intervention
  ▫ Post-Intervention Aortic Remodeling
  ▫ Morbidity
  ▫ Mortality
Materials and Methods

- Retrospective study

- TEVAR for “complicated” acute aortic syndrome
  - Defined by Malperfusion, Contained Rupture, Refractory pain, Refractory hypertension, Rapid false lumen degeneration
  - Sept 2012 to Nov 2017

- Perioperative and postoperative clinical outcomes

- Aortic remodeling was evaluated utilizing CTA imaging with comparison of pre and post treatment
Aortic Remodeling Outcomes

Positive Aortic Remodeling
- Thrombosed false lumen
- Increased size of the true lumen
- Absence of aneurysmal degeneration within treated segment

Negative Aortic Remodeling
- Increased size of false lumen
- Aneurysmal degeneration within treated segment
- Extension of disease (dissection, IMH)
Results

- 40 Patients Identified who underwent TEVAR for complicated AAS
- Mean Age 62.4 years (Range 30-88 years)
- Predominantly Women (n=22, 55%)
- Mean Follow-up Time = 13.2 months
- Mean Time to Intervention = 17 days
  - Defined from time of presentation
  - Range 0 – 154 days
Results

- Origin of Complicated Aortic Syndrome Diagnosis

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type B Dissection with Rapid False Lumen Expansion</td>
<td>19 (48%)</td>
</tr>
<tr>
<td>Penetrating Aortic Ulcer with Rupture/Pseudoaneurysm</td>
<td>17 (43%)</td>
</tr>
<tr>
<td>Penetrating Aortic Ulcer with Dissection</td>
<td>3 (8%)</td>
</tr>
<tr>
<td>Intramural Hematoma</td>
<td>1 (3%)</td>
</tr>
</tbody>
</table>
Results

- Co-Morbid Conditions

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>36 (90%)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>19 (48%)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>8 (20%)</td>
</tr>
<tr>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>8 (20%)</td>
</tr>
<tr>
<td>Chronic Kidney disease</td>
<td>8 (20%)</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>5 (13%)</td>
</tr>
<tr>
<td>Cerebral Vascular Accident</td>
<td>5 (13%)</td>
</tr>
<tr>
<td>Peripheral Arterial Disease</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>Congestive Heart Failure</td>
<td>3 (8%)</td>
</tr>
<tr>
<td>Carotid Artery Stenosis</td>
<td>3 (8%)</td>
</tr>
</tbody>
</table>
Results

Operative Mortality (n=2, 5%)

Operative Complications (n=14, 35%)
- Retrograde Type-A Aortic Dissection
  - n=5 (12.5%)
  - 2 immediate deaths post-TEVAR
- Spinal Cord Ischemia
  - n=2 (5%)
- Stroke
  - n=4 (10%)
- CHF
  - n=1 (2.5%)
- Pneumonia
  - n=2 (5%)

Retrograde Type A Dissection Following TEVAR
Results

- 28 (70%) Positive Remodeling
- 10 (25%) Negative Remodeling
  - 6 (15%) 1A Endoleak
- 2 (5%) Stable aorta
- 9 (22.5%) required Secondary Aortic Interventions during Study Period
  - 4 Primary Endovascular
  - 5 Primary Open
Results

Negative Aortic remodeling was associated with need for secondary intervention
• $p = 0.004$
Results

RTAD post TEVAR associated with:

- Presence of IMH
  - $p = 0.001$
- Ishimaru Zone 3 treatment
  - $p = 0.02$
Results

- Overall 1-year survival in cohort 77.5% → estimated 5-year survival 45%
- Survival dependent upon operative complications and aortic remodeling.
Conclusions

• TEVAR is an acceptable treatment option for complicated acute aortic syndrome

• Majority of patients demonstrate positive remodeling that impact overall survival

• Retrograde Type A Dissection is a devastating complication of TEVAR that is associated with Zone 3 treatment and presence of IMH
Peter Rossi, MD
Outcomes of Ruptured Abdominal Aortic Aneurysm Following Adoption of Endovascular Aortic Repair
### Introduction – Ruptured AAA RCTs

<table>
<thead>
<tr>
<th></th>
<th>No. of Patients</th>
<th>30-day Mortality Open</th>
<th>30-day Mortality EVAR</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinchcliffe</td>
<td>32</td>
<td>53%</td>
<td>53%</td>
<td>No difference</td>
</tr>
<tr>
<td>ECAR</td>
<td>107</td>
<td>24%</td>
<td>18%</td>
<td>No difference</td>
</tr>
<tr>
<td>AJAX</td>
<td>116</td>
<td>25%</td>
<td>21%</td>
<td>No difference</td>
</tr>
<tr>
<td>IMPROVE</td>
<td>613</td>
<td>40.6%</td>
<td>36.4%</td>
<td>No difference*</td>
</tr>
</tbody>
</table>
Methods

Ruptured AAA Procedure by Year

[Graph showing the number of procedures by year for Open and EVAR procedures.]

- **Open** procedures
- **EVAR** procedures
## Results

<table>
<thead>
<tr>
<th></th>
<th>OSR pre-2007 (N = 98)</th>
<th>OSR post-2007 (N = 23)</th>
<th>EVAR (N = 36)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean)</td>
<td>74.7</td>
<td>70.1</td>
<td>73.4</td>
<td>0.095</td>
</tr>
<tr>
<td>Male sex (%)</td>
<td>69.7</td>
<td>86.9</td>
<td>84.2</td>
<td>0.082</td>
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<tr>
<td>HTN (%)</td>
<td>68.4</td>
<td>82.6</td>
<td>94.7</td>
<td>0.004</td>
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<tr>
<td>HLD (%)</td>
<td>19.4</td>
<td>60.9</td>
<td>57.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DM (%)</td>
<td>7.1</td>
<td>17.4</td>
<td>23.7</td>
<td>0.025</td>
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<tr>
<td>BMI (mean)</td>
<td>27.5</td>
<td>28.6</td>
<td>28.5</td>
<td>0.602</td>
</tr>
<tr>
<td>CKD (%)</td>
<td>6.1</td>
<td>8.7</td>
<td>28.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CHF (%)</td>
<td>8.1</td>
<td>13.0</td>
<td>15.8</td>
<td>0.402</td>
</tr>
<tr>
<td>CAD (%)</td>
<td>36.7</td>
<td>13.0</td>
<td>44.7</td>
<td>0.038</td>
</tr>
<tr>
<td>Smoker (%)</td>
<td>73.5</td>
<td>91.3</td>
<td>91.7</td>
<td>0.026</td>
</tr>
<tr>
<td>Statin (%)</td>
<td>13.1</td>
<td>43.5</td>
<td>36.8</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
## Results: OSR pre-2007 vs. OSR post-2007

<table>
<thead>
<tr>
<th></th>
<th>OSR pre-2007</th>
<th>OSR post-2007</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-op death (%)</td>
<td>11.1</td>
<td>13.0</td>
<td>0.794</td>
</tr>
<tr>
<td>30-day mortality (%)</td>
<td>55.1</td>
<td>34.8</td>
<td>0.084</td>
</tr>
<tr>
<td>12-mo mortality (%)</td>
<td>32.6</td>
<td>52.4</td>
<td>0.093</td>
</tr>
<tr>
<td>Transfusion requirement (U)</td>
<td>9.7</td>
<td>8.4</td>
<td>0.403</td>
</tr>
<tr>
<td>ICU stay (days)</td>
<td>12.2</td>
<td>13.5</td>
<td>0.688</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>21.2</td>
<td>26.7</td>
<td>0.183</td>
</tr>
<tr>
<td>Discharge Facility (%)</td>
<td>58.1</td>
<td>53.3</td>
<td>0.746</td>
</tr>
</tbody>
</table>
### Results: OSR post-2007 vs. EVAR

<table>
<thead>
<tr>
<th></th>
<th>OSR post-2007</th>
<th>EVAR</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-op death (%)</td>
<td>13.0</td>
<td>5.6</td>
<td>0.327</td>
</tr>
<tr>
<td>30-day mortality (%)</td>
<td>34.8</td>
<td>28.6</td>
<td>0.617</td>
</tr>
<tr>
<td>12-mo mortality (%)</td>
<td>52.4</td>
<td>40.0</td>
<td>0.577</td>
</tr>
<tr>
<td>Transfusion requirement</td>
<td>8.4</td>
<td>4.3</td>
<td>0.005</td>
</tr>
<tr>
<td>(U)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICU stay (days)</td>
<td>13.5</td>
<td>7.3</td>
<td>0.034</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>26.7</td>
<td>165</td>
<td>0.046</td>
</tr>
<tr>
<td>Discharge to Facility</td>
<td>53.3</td>
<td>40</td>
<td>0.414</td>
</tr>
</tbody>
</table>
Univariate Analysis

### Overall Survival by Year/Repair

<table>
<thead>
<tr>
<th>Month</th>
<th>&lt;=2007 Open</th>
<th>&gt;2007 Open</th>
<th>Endo</th>
<th>P-value (Log-rank Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month 1</td>
<td>0.43 (0.33 - 0.52)</td>
<td>0.62 (0.38 - 0.79)</td>
<td>0.73 (0.56 - 0.84)</td>
<td><strong>0.007</strong></td>
</tr>
<tr>
<td>Month 6</td>
<td>0.35 (0.26 - 0.45)</td>
<td>0.52 (0.29 - 0.70)</td>
<td>0.62 (0.44 - 0.75)</td>
<td></td>
</tr>
<tr>
<td>Month 12</td>
<td>0.32 (0.23 - 0.42)</td>
<td>0.52 (0.29 - 0.70)</td>
<td>0.59 (0.41 - 0.73)</td>
<td></td>
</tr>
</tbody>
</table>

### Pairwise Comparison

<table>
<thead>
<tr>
<th>Stratum1 v.s. Stratum2</th>
<th>P-value (Log-rank Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=2007/Open v.s. &gt;2007/Open</td>
<td>0.139</td>
</tr>
<tr>
<td>&lt;=2007/Open v.s. Endo</td>
<td><strong>0.003</strong></td>
</tr>
<tr>
<td>&gt;2007/Open v.s. Endo</td>
<td>0.361</td>
</tr>
</tbody>
</table>
Multi-variate analysis

**Adjusted Overall Survival by Year/Repair**

**Survival Selected Model**

| Parameter          | Estimate (%95 CI) | P-value | Overall P-value |
|--------------------|-------------------|---------|----------------|----------------|
| Age Age            | 1.06 (1.03 - 1.09) | <.001   | <.001          |
| HTN                |                   |         |                |
| N (baseline)       | 1.00 (. . .)       | .       | 0.003          |
| Y                  | 2.26 (1.31 - 3.88) | 0.003   |                |
| Year/Repair        |                   |         |                |
| >=2007/Open (baseline) | 1.00 (. . .)   | .       | 0.014          |
| <=2007/Open        | 1.54 (0.75 - 3.16) | 0.241   |                |
| Endo               | 0.58 (0.23 - 1.42) | 0.231   |                |
Conclusions

• Survival after rAAA has improved at our institution since 2007, primarily driven by an “EVAR-first” approach despite decreasing volume of ruptured aneurysm and increased overall comorbidities of the rAAA population.

• Survival of open repair has improved as well, though this did not reach statistical significance.

• An “EVAR-first” approach should be first line therapy at experienced centers in rAAA.
Prospective Research Initiatives
3-D PRINTING

Collagen glue and cell mixture is piped into desired shape. The gel support is removed as cells fuse together to form a blood vessel.

Agarose gel supports cell structure as it is built.
OR AEROSOLS / SURFACE ADHERENCE