Ultrasound Evaluation after EVAR: (Trying to) Let the CAT Scan Out of the Bag

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Disclosures

• None
Outline

• Background of Abdominal Aortic Aneurysm
• Epidemiology of Aortic Aneurysm Disease
• Pathophysiology of Aortic Aneurysms
• Screening for Abdominal Aortic Aneurysms
• Management of Aortic Aneurysms
• Surveillance after Repair of Aortic Aneurysms
• Complications after Aortic Aneurysm Repair
• Identification of Endoleaks
• Long-term Outcomes of Endoleaks
• Duplex Ultrasound vs Computed Tomography for Endoleaks
• Management of Endoleaks
• Conclusions
ABDOMINAL AORTIC ANEURYSM

DEFINITION

A LOCALIZED DILATATION

1. ABSOLUTE DIAMETER EXCEEDING 3.0 CM*

2. DIAMETER 1.5X ADJACENT NORMAL DIAMETER

*SVS GUIDELINES
ABDOMINAL AORTIC ANEURYSM
ABDOMINAL AORTIC ANEURYSM
ABDOMINAL AORTIC ANEURYSM

• KING GEORGE II*
• AUGUSTE RODIN
• ROY ROGERS
• SENATOR R. DOLE
• JOE DIMAGGIO
• RODNEY DANGERFIELD
• CANDIDO JACUZZI

• DUKE OF WINDSOR
• CHARLES DEGAULLE*
• GEORGE C SCOTT*
• LUCILLE BALL*
• ALBERT EINSTEIN*
• EMILE ZOLA
• CONWAY TWITTY*

* CAUSE OF DEATH
ABDOMINAL AORTIC ANEURYSM

PREVALENCE

MEN OVER 50 YEARS
4-8% (1.4% > 4cm)

WOMEN OVER 50 YEARS
1-1.3%

WITH FAMILY HISTORY 5-20%
<table>
<thead>
<tr>
<th>POPULATION</th>
<th>INCIDENCE (%)</th>
</tr>
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<tbody>
<tr>
<td>UNSELECTED, AUTOPSY</td>
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</tr>
<tr>
<td>UNSELECTED, U-S SCREENED</td>
<td>3.2-4.9</td>
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<td>MALE SMOKERS &gt; 65</td>
<td>6.0-7.0</td>
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<td>CAD, U-S SCREENED</td>
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<tr>
<td>PVD, U-S SCREENED</td>
<td>10.0</td>
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<tr>
<td>POP OR FEM ANEURYSM</td>
<td>40-53</td>
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</tbody>
</table>
ABDOMINAL AORTIC ANEURYSM

MAGNITUDE OF PROBLEM

1.7 MILLION PEOPLE HAVE AAA
190,000 NEW AAA DIAGNOSED ANNUALLY
50,000 AAA REPAIRS ANNUALLY
10,000-15,000 DEATHS / YEAR FROM RUPTURE
2ND-MOST FREQUENT CAUSE OF DEATH FROM ALL EMERGENCY SURGICAL CONDITIONS
AAA RUPTURE IS 13TH LEADING CAUSE OF DEATH IN MEN; 10TH IN MEN OVER 65
ABDOMINAL AORTIC ANEURYSM: RISK FACTORS

FACTORS ASSOCIATED WITH AN INCREASE:
- Older age
- Male gender
- Cigarette smoking
- Caucasian race
- Atherosclerosis
- Hypertension
- Family history of AAA
- Other large artery aneurysms (eg, iliac, ..)

FACTORS ASSOCIATED WITH A DECREASE:
- Female gender
- Non-Caucasian race
- Diabetes
CIGARETTE SMOKING AND AAA

LINEAR RELATIONSHIP WITH:

- DEVELOPMENT
- EXPANSION
- RUPTURE
US annual adult per capita cigarette consumption and US age-adjusted AAA mortality per 100,000 white men by year.

Frank A. Lederle Circulation. 2011;124:1097-1099
PATHOGENESIS OF AAA

• THINNING OF AORTIC WALL

• CHRONIC INFLAMMATION OF AORTIC WALL

• DECREASED MEDIAL SMC

• DEGRADATION OF STRUCTURAL PROTEINS

• INCREASED EXPRESSION OF MATRIX METALLOPROTEASE (MMP 2, 9)
PATHOGENESIS OF AAA

- INFLAMMATION
- TRAUMA
- SMOKING
- ATHEROSCLEROSIS

- MATRIX DEGRADATION
- DYSFUNCTIONAL REMODELING
- DECREASED TENSILE STRENGTH
SCREENING FOR AAA

USPSTF

ONE-TIME SCREENING

1. MEN 65-75 YEARS SMOKING HISTORY (>100 CIGS)
2. MEN OR WOMEN FAMILY HISTORY OF AAA
3. PART OF WELCOME TO MEDICARE PHYSICAL
1. One-time ultrasound screening for AAAs in men or women 65 to 75 years of age with a history of tobacco use

2. Ultrasound screening for AAA in first degree relatives of patients who present with an AAA.

3. One-time ultrasound screening for AAAs in men or women older than 75 years with a history of tobacco use
SCREENING FOR AAA

METHODS

- ULTRASOUND IDENTIFIES ANEURYSMS
  DETERMINES SIZE

- SERUM BIOMARKERS
  FIBRINOGEN, D-DIMER, IL-6, MMP-9, TIMP-1
  APOLIPOPROEIN-A, APO(a)
  MICRO RNAs
ULTRASOUND SCREENING

• DECREASE AAA RUPTURE
• DECREASE EMERGENCY SURGERY
• DECREASE AAA-RELATED MORTALITY 50%
• DECREASE ALL-CAUSE MORTALITY
• COST EFFECTIVE
• CONCERNS:
  – ONLY 40% ELIGIBLE ARE SCREENED
  – ONLY 65% FOLLOWUP OF POSITIVE SCANS
### NATURAL HISTORY OF AAA

<table>
<thead>
<tr>
<th>AAA Diameter (cm)</th>
<th>12-Month Rupture Risk (%)</th>
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<tr>
<td>3.0-3.9</td>
<td>0.3</td>
</tr>
<tr>
<td>4.0-4.9</td>
<td>0.5-1.5</td>
</tr>
<tr>
<td>5.0-5.9</td>
<td>1-11</td>
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<tr>
<td>6.0-6.9</td>
<td>11-22</td>
</tr>
<tr>
<td>&gt;7</td>
<td>&gt;30</td>
</tr>
</tbody>
</table>
1. **Patients with an AAA and Abdominal or Back Pain Attributed to the Aneurysm (Symptomatic)**

2. **Elective Repair for Patients with AAA Greater Than or Equal to 5.5 cm**

3. **Elective Repair for Patients with Saccular Aortic Aneurysm**

4. **Elective Repair in Women with AAA Diameter Between 5.0 cm and 5.4 cm**
MANAGEMENT OF AAA – OPEN SURGICAL REPAIR

Midline abdominal incision

Left flank or low thoracoabdominal incision
MANAGEMENT OF AAA – ENDOVASCULAR REPAIR

- Gore Excluder 2002
- Cook Zenith 2003
- Endologix Powerlink 2005
- Medtronic Endurant 2010
- TriVascular Ovation 2011
- Cook Zenith Fenestrated 2012
- Lombard Medical Aorfix 2013
COMPLICATIONS AFTER ENDOVASCULAR REPAIR (EVAR)

- Access site complications
- Endoleak
- Device Migration
- Separation of Device Components
- Limb Occlusion
- Endograft Infection

- Systemic Complications:
  - Cardiopulmonary Failure
  - Contrast-related Issues
  - Ischemic Complications
    - Renal
    - Intestinal
    - Extremity
    - Pelvic
    - Spinal
LONG-TERM COMPLICATIONS

**ENDOLEAKS** = persistent flow of blood into the aneurysm sac after device placement

- **Type I** - incomplete seal at the proximal or distal attachment
- **Type II** - flow into and out of the aneurysm sac from one or more patent branch vessels (e.g. lumbar arteries, IMA)
- **Type III** - dissociation of modular components
- **Type IV** – flow into the aneurysm through porous graft material
- **Type V** - continued aneurysm sac expansion without a demonstrable endoleak (i.e. endotension)

Most Common Type Occurs in 10-20% of Cases
80% Resolve by 12 Months
SURVEILLANCE AFTER EVAR

GOAL OF POSTOPERATIVE SURVEILLANCE IS TO PREVENT LATE RUPTURE AND ANEURYSM-RELATED DEATH

Surveillance after EVAR is performed to identify sac growth, endoleak, device migration, or device failure

Significant incidence of postoperative endoleaks up to 7 years after EVAR
SURVEILLANCE AFTER EVAR

- CT imaging at 1 month, 6 months, and 12 months and yearly thereafter
  - 6-month CT scan can be eliminated if the 1-month scan shows no concerning endoleak or sac enlargement
- If no endoleak nor AAA sac enlargement seen at 1 year after EVAR, color duplex ultrasound or CT scans for annual surveillance
- If a type II endoleak present, but sac size is stable or decreasing, duplex ultrasound every 6-months for 24 months and annually thereafter
LONG-TERM SIGNIFICANCE OF ENDOLEAKS

- Type I & III Endoleaks = continuous pressurization of the aneurysm → persistent risk of rupture

- Type II Endoleaks
  - 80% resolve spontaneously within 6 to 12 months
  - Approximately 55% will have some aneurysm sac expansion
  - Benign natural history (i.e. very low rupture risk ~1%)

- Type IV Endoleaks – rarely seen with new grafts
IDENTIFICATION OF ENDOLEAKS
TECHNIQUE OF ULTRASOUND EVALUATION AFTER EVAR

• An adequate endoleak evaluation should include the following:
  1. A satisfactory B-mode image of the AAA sac and the stent graft
  2. Satisfactory color Doppler scan imaging without excessive overgain or undergain
  3. A color Doppler scan assessment of the entire AAA sac outside the graft in both the transverse and the longitudinal views
  4. Spectral Doppler scan waveform analysis outside the graft and within the AAA sac
Patients are studied after an overnight fast.

Examination starts in the supine position.

Low frequency (range, 2.25 to 5 MHz) transducer and pulsed Doppler scan transducers are used.

B-mode imaging of the graft, proximal and distal fixation, and the AAA sac size.

Optimize color Doppler scan to avoid undergain or overgain.

The color box should be adjusted to encompass the AAA sac but limit artifact.

The entire graft should be assessed in transverse and sagittal views.
Focus on potential leak sites:
- Cephalad and caudad attachment sites
- Anterior mid-AAA sac (inferior mesenteric artery)
- Posterior mid-AAA sac (lumbar arteries)

Power Doppler scan may be added to assist in the detection of perigraft flow

All suspected endoleaks are evaluated by spectral waveform analysis

Location, flow direction, and extent of AAA sac involvement are determined

Identify the origin and direction of the flow of endoleaks

Sampling of the AAA sac should be performed with spectral Doppler scan waveform signals
MANAGEMENT OF ENDOLEAKS

1. Endoleak present at surveillance endograft imaging*
2. Determine endoleak type
3. Refer to Box A
   - Type I, III, IV
   - Indeterminate
   - Type II
5. Sac enlargement >5 mm?
   - Yes
   - No
6. Advanced vascular imaging†
7. Is there an endovascular option for repair?
   - Yes
   - No
8. Endovascular repairΔ
   - Endoleak resolved
   - Endoleak persists
9. Assess risk for open surgery
   - Good-risk surgical candidate
   - High-risk patient
   - Open repair/ conversion
   - Expectant management
10. Endograft surveillance*
DUPLEX SURVEILLANCE AFTER EVAR

Review of postoperative CT and ultrasound for endovascular aneurysm repair using Talent stent graft: can we simplify the surveillance protocol and reduce the number of CT scans?

Thomas Nyheim1, Lars Erik Staxrud1, L. Rosen1, Carl Erik Slagsvold2, Gunnar Sandbaek2 and Jorgen J. Gregersen1

1Oslo Vascular Centre, HX Department, Oslo University Hospital Aker, Oslo, 2Section of Vascular Investigations, Oslo Vascular Centre, St. Olavs Hospital, Trondheim, Norway.

Objectives: To simplify a CT surveillance protocol with ultrasound for patients undergoing EVAR with a Talent stent graft. To review the clinical need for early CT surveillance following the procedure. To evaluate an alternative ultrasound surveillance protocol.

Methods: Patients undergoing EVAR using a Talent stent graft were selected for this study. A surveillance protocol including early postoperative follow-up CT (day 1, 3 and 6 months) and late follow-up CT (1 year) was used in all patients. The surveillance protocol was reviewed and an alternative ultrasound surveillance protocol was proposed. The proposed surveillance protocol was evaluated by comparing early CT surveillance with ultrasound surveillance in a subset of patients.

Results: The proposed surveillance protocol was evaluated in 17 patients. CT surveillance was performed in 15 patients and ultrasound surveillance in 12 patients. The proposed surveillance protocol was found to be safe and feasible. The proposed surveillance protocol was found to be less invasive and less costly than the standard surveillance protocol. The proposed surveillance protocol was found to be equally effective in detecting endoleaks and aneurysm growth compared to the standard surveillance protocol.

Conclusion: The proposed surveillance protocol was found to be safe, feasible, and cost-effective. The proposed surveillance protocol was found to be equally effective in detecting endoleaks and aneurysm growth compared to the standard surveillance protocol. The proposed surveillance protocol was found to be a viable alternative to the standard surveillance protocol.

Keywords: Aneurysm, Endoleak, Ultrasound, CT, Surveillance, Talent stent graft

Submitted October 10, 2011; accepted for publication August 31, 2012

Endovascular aneurysm repair (EVAR) of abdominal aortic aneurysms (AAA) has the advantage of lower operative morbidity and mortality, as well as long-term follow-up and risk of reintervention (1). The detection of endoleak, endoleak growth, stent graft migration, structural damage, and graft-tube occlusion pose a considerable challenge and expense (2). Computed tomography angiography (CTA) is considered the gold standard for detection of endoleak and postoperative aneurysmal growth. The drawbacks include radiation exposure, the risk of contrast-induced nephropathy, allergic reactions, and the considerable expense (3, 4).

A considerable number of patients undergoing EVAR develop endoleaks. The identification and characterization of endoleaks is crucial for the management of these patients (5, 6). Ultrasound (US) has been used for surveillance of patients undergoing EVAR (7, 8). However, the role of US in detecting endoleaks is not fully established (9, 10). The aim of this study was to evaluate the role of US in detecting endoleaks in patients undergoing EVAR.

Methods: A total of 60 patients undergoing EVAR were prospectively enrolled in this study. All patients underwent postoperative CT at day 1, 3, and 6 months, and yearly thereafter. Ultrasound surveillance was performed at day 1, 3, and 6 months, and yearly thereafter. The presence and type of endoleaks were recorded and compared to the results of CT surveillance.

Results: During the study period, 60 patients underwent EVAR. Of these, 58 patients completed the study. Two patients were lost to follow-up. Of the 58 patients, 38 patients developed endoleaks. The most common type of endoleak was type II, which was identified in 34 patients. Type I endoleaks were identified in 4 patients. Type III endoleaks were identified in 1 patient. The sensitivity and specificity of US in detecting endoleaks were 92% and 100%, respectively. The positive and negative predictive values were 97% and 100%, respectively.

Conclusion: Ultrasound surveillance is a safe and effective method for detecting endoleaks in patients undergoing EVAR. The sensitivity and specificity of US in detecting endoleaks are comparable to those of CT surveillance. Ultrasound surveillance is a feasible and cost-effective alternative to CT surveillance for detecting endoleaks in patients undergoing EVAR.
Comparison of the effects of open and endovascular aortic aneurysm repair on long-term renal function using chronic kidney disease staging based on glomerular filtration rate

Joseph L. Mills Sr, MD; Son T. Duong, MD; Luis R. Leon Jr, MD; Kaoru R. Goshima, MD; Daniel M. Ihnat, MD; Christopher S. Wendel, MS; and Angelika Greinacher, MS, PhD. *Abstract*

Objective: It has been suggested that endovascular aneurysm repair (EVAR) in conjunction with serial contrast-enhanced renal function may help assess the effects of EVAR on renal function. The primary objective was to assess the effects of EVAR on renal function.

Methods: A retrospective review was performed on 223 consecutive patients (103 EVAR, 120 OR) who underwent aneurysm repair. Patients were divided into a database, baseline, 30- and 90-day follow-up groups. Renal function was determined using Chronic Kidney Disease (CKD) staging and Kidney Disease (GFR) classification. EVAR and OR groups were compared. EVAR prevalence at baseline, 30, and 90 days was determined. EVAR and OR patients were compared. EVAR prevalence at baseline, 30, and 90 days was determined.

Results: The mean baseline difference in EVAR and OR cohorts was female gender (45 vs 12%, OR p < 0.02). Thirty-day a mean follow-up of 12.2 months, however, 18% of patients in the EVAR and OR groups developed significant renal function decline over time. Multivariate analysis of variance (ANOVA) was performed to determine if EVAR and OR patients were different. EVAR prevalence at baseline, 30, and 90 days was determined.

Conclusions: Compared with EVAR, OR patients were associated with a significant but transient fall in GFR at 30 days. The renal function decline was significantly greater by Kaplan-Meier analysis in EVAR than OR patients during long-term follow-up. More aggressive strategies to monitor and preserve renal function after AAA repair are warranted. (J Vasc Surg 2008;47:1141-9.)
DISTINCT ADVANTAGES:
– COST EFFECTIVE
– NON-INVASIVE
– NO NEPHROTOXIC CONTRAST ADMINISTRATION
– NO IONIZING RADIATION

DISADVANTAGES:
– OPERATOR-DEPENDANT
– INFLUENCED BY PATIENT FACTORS
Can Duplex Reliably Assess AAA Size?
Compared Tomography Versus Color Duplex Ultrasound for Surveillance of Abdominal Aortic Stent-Grafts

Ali F. AbuRahma, MD; Christine A. Welch, MS; Bandy B. Mullins, MD; and Benjamin Dyer, MD

Vascular Center of Excellence and Department of Surgery, Robert C. Byrd Health Sciences Center, West Virginia University, Charleston, West Virginia, USA.

- 174 consecutive patients over 4 years
- Overall (pre- and post-operative) diameters were similar between both modalities (<5mm difference)
- Post-operative variability in measurement of AAA sac diameter was similar between both modalities
Is Duplex Sensitive Enough to Detect Endoleaks?
Duplex ultrasound in aneurysm surveillance following endovascular aneurysm repair: a comparison with computed tomography aortography

Brian J. Manning, MD, FRCSI, Sean M. O’Neill, MCh, FRCSI, Syed N. Haider, FRCSI, Mary P. Colgan, MD, Prakash Madhavan, FRCS(Ed), and Dermot J Moore, MD, FRCSI, Dublin, Ireland

- 406 Paired US/CT Examinations
- Sensitivity for Duplex Scanning was 86%
- All clinically significant endoleaks identified on CT-A were also demonstrated on ultrasound!

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>n</th>
<th>Follow-up (months)</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>PPV %</th>
<th>NPV %</th>
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<td>Sato⁶</td>
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<td>74</td>
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<td>Zannetti⁴</td>
<td>2000</td>
<td>103</td>
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<td>78.6</td>
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<td>Wolf⁵</td>
<td>2000</td>
<td>100</td>
<td>9</td>
<td>81</td>
<td>95</td>
<td>94</td>
<td>90</td>
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<tr>
<td>D’Audiffret⁹</td>
<td>2001</td>
<td>89</td>
<td>18</td>
<td>96</td>
<td>94</td>
<td>89</td>
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</tbody>
</table>

*Author et al.*
3D Contrast Enhanced Ultrasound for Detecting Endoleak Following Endovascular Aneurysm Repair (EVAR)

A. Abbas a, V. Hansrani a, N. Sedgwick b, J. Ghosh c, C.N. McCollum a,*

a Institute of Cardiovascular Sciences, University Hospital of South Manchester, Manchester, UK
b Independent Vascular Services, South Manchester University Hospital Trust, Manchester, UK
c Vascular Surgery Department, University Hospital of South Manchester, Manchester, UK
Prospective, pilot study of 23 consecutive patients who underwent EVAR with suspicion on endoleak over 1 year time period

<table>
<thead>
<tr>
<th>Endoleak (yes)</th>
<th>2D CEUS</th>
<th>CTA</th>
<th>Endoleak (yes)</th>
<th>Endoleak (no)</th>
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<tbody>
<tr>
<td>17</td>
<td>1</td>
<td>Positive predictive value (94%)</td>
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</table>

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<th>CTA</th>
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</thead>
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<td>1</td>
<td>Positive Predictive Value (94%)</td>
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</table>

<table>
<thead>
<tr>
<th>Type of endoleak</th>
<th>CTA</th>
<th>2D CEUS</th>
<th>3D CEUS</th>
</tr>
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<tbody>
<tr>
<td>All endoleaks</td>
<td>17</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Type 1</td>
<td>1²</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Type 2</td>
<td>12</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Type 3</td>
<td>4²</td>
<td>2²</td>
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</tr>
<tr>
<td>Type 4</td>
<td>None</td>
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</tr>
<tr>
<td>Type 5</td>
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<td>None</td>
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</tbody>
</table>
Can Duplex Provide Characterization of Endoleaks?
The incidence and natural history of type I and II endoleak: A 5-year follow-up assessment with color duplex ultrasound scan

F. Noel Parent, MD, RVT, George H. Meier, MD, RVT, Vasso Godziachvili, MD, PhD, Christopher J. LeSar, MD, Frank M. Parker, DO, RVT, Kathleen A. Carter, BSN, RVT, Robert G. Gayle, MD, RVT, Richard J. DeMasi, MD, RVT, Michael J. Marcinczyk, MD, RVT, and Roger T. Gregory, MD, RVT, Norfolk, Va

- Retrospective review of 83 consecutive patients who underwent EVAR
- 41 patients developed an endoleak over the followup period (4 years)
- Duplex identified the source vessel in 100% of cases
- CT scan identified the source vessel in 19% of cases

Table I. Comparison of type II endoleak source vessel identification with color duplex ultrasound scan versus computed tomographic scan

<table>
<thead>
<tr>
<th></th>
<th>Lumbar</th>
<th>IMA</th>
<th>Lumbar and IMA</th>
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<td><strong>T2EL (n = 36)</strong></td>
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<td>CDU (n = 36)</td>
<td>22</td>
<td>8</td>
<td>6</td>
<td>0</td>
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<tr>
<td>CT (n = 18)</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>11</td>
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</tbody>
</table>

*T2EL, Type II endoleak; IMA, inferior mesenteric artery; CDU, color duplex ultrasound scan; CT, computed tomography.*
• Retrospective review of 123 consecutive patients who underwent EVAR over 2 year period

• CEUS was more sensitive/specific than CDUS, more accurate than CTA and similar accuracy to MRA

• CEUS allowed better classification of endoleaks

<table>
<thead>
<tr>
<th>Imaging modality</th>
<th>True positives</th>
<th>False positives</th>
<th>False negatives</th>
<th>True negatives</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>Negative predictive value</th>
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</thead>
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<td>6</td>
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<td>78</td>
<td>58%</td>
<td>93%</td>
<td>85%</td>
<td>89%</td>
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<tr>
<td>CEUS</td>
<td>23</td>
<td>0</td>
<td>1</td>
<td>84</td>
<td>96%</td>
<td>100%</td>
<td>99%</td>
<td>99%</td>
</tr>
<tr>
<td>CTA</td>
<td>20</td>
<td>0</td>
<td>4</td>
<td>84</td>
<td>83%</td>
<td>100%</td>
<td>96%</td>
<td>95%</td>
</tr>
<tr>
<td>MRA</td>
<td>23</td>
<td>0</td>
<td>1</td>
<td>84</td>
<td>96%</td>
<td>100%</td>
<td>99%</td>
<td>99%</td>
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</table>

CDUS: Colour-Doppler ultrasound; CEUS: contrast-enhanced ultrasound; CTA: computed tomography angiography; MRA: magnetic resonance angiography.
• Prospective, pilot study of 23 consecutive patients who underwent EVAR with suspicion on endoleak over 1 year time period

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<td>18</td>
</tr>
<tr>
<td>Type 1</td>
<td>1?(^a)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Type 2</td>
<td>12</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>Type 3</td>
<td>4?(^a)</td>
<td>2(^a)</td>
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</tr>
<tr>
<td>Type 4</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Type 5</td>
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</table>
Can Duplex Assess Potential Outcomes of Endoleaks?
Biphasic/Monophasic waveforms were most commonly found in those endoleaks that persisted without intervention (14/19 patients).

To/Fro pattern waveforms were most often found in patients whose endoleaks spontaneously resolved (7/10 patients).
Intrasac flow velocities predict sealing of type II endoleaks after endovascular abdominal aortic aneurysm repair

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- Retrospective review of 30 patients with Type II endoleaks over a 6-year period
- Two Groups:
  - Group 1 (14 patients) sealed endoleak (< 6 months) without intervention
  - Group 2 (16 patients) persistent endoleak without resolution
- Spectral Doppler flow velocities were recorded from endoleaks within the aneurysm sac
- Intr sac flow Doppler velocities can be used to predict whether type II endoleaks will spontaneously resolve
- Patients with low-velocity endoleaks (<80 cm/s) are likely to endoleaks resolve without treatment
- Patients with high-velocity endoleaks (>100 cm/s) are related to preoperative large branch vessel diameter and number and are unlikely to resolve
- Spectral intrasac AAA Doppler flow velocities

<table>
<thead>
<tr>
<th></th>
<th>Sealed endoleaks (n = 14)</th>
<th>Persistent endoleaks (n = 16)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrasac AAA Doppler flow velocities (cm/s)</td>
<td>75.5 ± 78.8</td>
<td>138.2 ± 36.2</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>IMA patent</td>
<td>43%</td>
<td>81%</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>IMA diameter (mm)</td>
<td>5.6 ± 1.8</td>
<td>7.2 ± 1.3</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Paired lumbar arteries</td>
<td>1.3 ± 0.8</td>
<td>2.4 ± 0.6</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
Is It Really Cost Effective?
Retrospective review of 250 patients who underwent EVAR over 10-year period (1998-2008)

Switched over to exclusive color duplex follow-up in 2004

- Group 2 = 2004 to 2008)

- Decreased charges of $1595 per patient per year in Group 2

- Hospital system charges for surveillance studies in group 1 were $1,851,216

- Hospital system charges for surveillance studies for group 2 patients were $967,008
Conclusions

• Abdominal aortic aneurysms are a common finding in vascular patients undergoing imaging
• Screening for AAA is highly impactful
• Management of AAA should be done to prevent aortic-specific morbidity/mortality
• Complications after AAA repair warrant on-going follow-up and surveillance
• Ultrasound after EVAR is a cost-effective, reliable method of surveillance
• Ultrasound can identify and characterize endoleaks
• Ultrasound can provide information about the prognosis of endoleaks