Tips and tricks for “on-table imaging” to detect EVAR endoleak

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Disclosure

Speaker name:

Dittmar Böckler

I have the following potential conflicts of interest to report:

- Consulting
- Employment in industry
- Stockholder of a healthcare company
- Owner of a healthcare company
- Other(s)
- I do not have any potential conflict of interest
**Background**

**New Benchmarks for EVAR**

<table>
<thead>
<tr>
<th>Former criteria of Tx success</th>
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</thead>
<tbody>
<tr>
<td>Technical success</td>
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<td>Endoleak Type I &amp; III</td>
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<td>Migration, Material fatigue</td>
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<tr>
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<td>Reintervention</td>
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</table>
## Background

### New Benchmarks for EVAR

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<tr>
<th>Former criteria of Tx success</th>
<th>New key success criteria for EVAR</th>
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<tr>
<td>Technical success</td>
<td>Procedural time</td>
</tr>
<tr>
<td>Endoleak Type I &amp; III</td>
<td>Contrast (cc)</td>
</tr>
<tr>
<td>Migration, Material fatigue</td>
<td>Procedural Radiation Exposure</td>
</tr>
<tr>
<td>Limb occlusion</td>
<td>Case-specific Radiation</td>
</tr>
<tr>
<td>Conversion</td>
<td>Early Reintervention</td>
</tr>
<tr>
<td>Reintervention</td>
<td>No. of Devices used</td>
</tr>
<tr>
<td></td>
<td>Costs</td>
</tr>
</tbody>
</table>
On table Imaging
Fusion Imaging & Cone Beam CT

Routine and Standard in all EVAR, TEVAR, FEVAR and BEVAR Procedures
Objective

To demonstrate fusion imaging and Dyna CT as a standardized on table imaging modality in our service

To demonstrate present and future implications to detect endoleaks during EVAR
Principle of Fusion Imaging

Preoperative CTA

Intraoperative Fluoro

Registration
Perioperative EVAR Imaging

- **Preoperative**: Sizing
- **Procedure Guidance**: Fluoroscopy & DSA
- **Procedure Evaluation**: Completion DSA
- **Postoperative**: CTA

- **Preoperative**: Sizing / Segmentation
- **Procedure Guidance**: Fusion Imaging
- **Procedure Evaluation**: Cone Beam CT
- **Postoperative**: CEUS
EVAR Patients: n=98, prospective patient cohort

Intraoperative

Postoperative

DynaCT

DSA

DynaCT

CTA

Geisbüsch, Schulz, Böckler et al J Vasc Surg submitted for publication
## Dyna CT – Results (n=95)

<table>
<thead>
<tr>
<th></th>
<th>Dosis und Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DAP Dyna CT</strong></td>
<td>47,4 Gy cm² (23,3 - 59,2)</td>
</tr>
<tr>
<td></td>
<td>15% (4 - 28) / procedure</td>
</tr>
<tr>
<td><strong>Time Dyna CT</strong></td>
<td>3,0 min (2,0 - 20,0 min)</td>
</tr>
<tr>
<td></td>
<td>&lt; 10min (in 65%)</td>
</tr>
<tr>
<td><strong>Time Registration</strong></td>
<td>4,0 min (0,4 - 15,0 min)</td>
</tr>
<tr>
<td><strong>Registration type</strong></td>
<td></td>
</tr>
<tr>
<td>Automatic</td>
<td>29%</td>
</tr>
<tr>
<td>Semiautomatic</td>
<td>60%</td>
</tr>
<tr>
<td>Manual</td>
<td>11%</td>
</tr>
</tbody>
</table>
## Dyna-CT - Detection of Endoleaks

<table>
<thead>
<tr>
<th>Endoleak Type</th>
<th>DSA (n= / %)</th>
<th>DynaCT (n= / %)</th>
<th>CTA (n= / %)</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

**Sensitivity***

100%

**Specificity***

82.9%

*compared to the respective standard DSA / CTA
Workflow to reduce early reinterventions

Completion DSA

Secondary Reintervention

Completion DynaCT

Immediate Revision

Duplex / CEUS

Standard Follow-Up

Standard Follow-Up
# Literature on Cone Beam CT

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Patients</th>
<th>Protocol</th>
<th>Radiation Dose</th>
<th>Intra-operative cDSA</th>
<th>Intervention DynaCT (n= / %)</th>
<th>Postoperative Control Method</th>
<th>Reinterventions after CTA / CEUS</th>
</tr>
</thead>
</table>
| Heidelberg¹                 | n=98     | 5s, 200°  
248f³  
40 x 30 cm⁴  
43.7 ± 10.8 Gycm²  
X  
7/98 (7.1%)  
CTA  
2/98 (2.0%) |
| Hertault et al. (2015) Lille| n=54     | 8s, 200°  
150f  
30 x 30 cm  
7 Gycm²  
(5.25 - 8)  
-  
17/54 (31.5%)  
CEUS  
2/54 (3.7%) |
| Törnvist et al. (2015) Malmö| n=51     | 8s, 200°  
397f  
40 x 30 cm  
70.6 Gycm²  
(34.9 – 126.5)  
X  
4/59 (6.7%)  
CTA  
3/51 (5.9%) |
| Dijkstra et al. (2011) Cleveland| n=19   | 8s  
397f  
-  
0.55 ± 0.036 Gy  
-  
6/19 (31.5%)  
CTA  
n.a. |
| Biasi et al. (2009) St. George’s London| n=65  | 8s 200°  
248f  
40 x 30 cm  
-  
X  
5/65 (7.7%)  
CTA  
0/65 |

¹Geisbüsch, Schulz, Böckler et al J Vasc Surg submitted for publication, ²rotation, ³f=frames, ⁴detector size
Reduction of „in hospital use of contrast“

<table>
<thead>
<tr>
<th></th>
<th>DSA &amp; CTA</th>
<th>DSA &amp; DynaCT &amp; CEUS</th>
<th>DynaCT &amp; CEUS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volume</strong></td>
<td>192.5 ± 38.5 mL</td>
<td>145.5 ± 38.8 mL</td>
<td>118.6 ± 38.6 mL</td>
</tr>
<tr>
<td><strong>Reduction</strong></td>
<td></td>
<td><strong>-24.4%</strong></td>
<td><strong>-38.8%</strong></td>
</tr>
</tbody>
</table>
Heidelberg Hybrid OR- Equipment

Artis Zeego (Siemens) 1\textsuperscript{st} generation 2009
Siemens floating table
Prototype Workstation
Cone Beam (Dyna) CT - Protocoll

Contrast volume 70 cc (2:1 contrast:saline)
Flow 10 cc/sec, Injection time 7 sec, delay 2 sec
Aquisation: 90 LAO - 110 RAO in 5 sec
1 image per 0.8°
Recorded Case Demonstration
EVAR Procedure on 3rd April 2017

- 71 yrs, male
- asymptomatic, sacciforme AAA
- max. diameter 62 mm
- CT Scan:
  - complex neck morphology
  - kinked iliacs
  - patent lumbars and IMA
- Planned procedure: pEVAR with suprarenal fixation
Preop. CT Scan
Image Postprocessing on workstation
Fluoroscopy a.p. and lateral

a.p.   lateral
Predeployment Angio
Manuel Correction of Distorsion

<table>
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<tr>
<th>Craniocaudal Deviation (%)</th>
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<tbody>
<tr>
<td>&lt;1mm</td>
<td>23%</td>
</tr>
<tr>
<td>1-3mm</td>
<td>23%</td>
</tr>
<tr>
<td>4-5mm</td>
<td>22%</td>
</tr>
<tr>
<td>&gt;5mm</td>
<td>32%</td>
</tr>
<tr>
<td>Median</td>
<td>3 mm (0 - 15)</td>
</tr>
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Fusion Imaging guided SG Deployment
Intraoperative Completion Angiography
On-table Conebeam CT
On-table Conebeam CT

Dyna CT axial view

Dyna CT sagittal view
3 D VRT Conebeam CT
Color-coded 2D DSA (syngo iFlow)

syngo iFlow Supports Endoleak Categorization

Completion Angio

Colour-coded 2D DSA

3.37

3.67

5.33
Color-coded 2D DSA (syngo iFlow)

syngo iFlow Supports Endoleak Categorization

Completion Angio

Color-coded 2D DSA
Color-coded 2D DSA (syngo iFlow) supports endoleak categorization
The future: Dynamic 3-D Imaging?
Summary & Conclusions

- Fusion maging (FI) is feasible & easily integrated into daily workflow
- FI reduces radiation and contrast per patient
- FI is accurate but impact on clinical results needs to be proven
- Dyna-CT detects stent graft related complications e.g. endoleaks
- Reintervention rate can be reduced by on table quality control
- On table 3D assessment reduces in-hospital contrast use and case-specific overall radiation exposure (new benchmarks)
- Hybrid OR technology reduces procedural time and costs
- Color coded 2D and 3D imaging for iop. Endoleak categorization is under evaluation
- Intraoperative 3D assessment is already standard in our institution
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