Reduced radiation and choice of intraoperative imaging modality for endoleak detection and correction

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Disclosure

Speaker name:

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☐ I have the following potential conflicts of interest to report:

✔ Receipt of grants/research support

☐ Receipt of honoraria and travel support

☐ Participation in a company sponsored speakers’ bureau

☐ Employment in industry

☐ Shareholder in a healthcare company

☐ Owner of a healthcare company

➢ I do not have any potential conflict of interest
Endoleaks are a major reason for revision after EVAR

- **Type I Endoleaks**:  
  Up to 6% with 80% reinterventions in immediate follow up (DREAM, EVAR1, ACE Trials)

- **Type II Endoleaks**:  
  14% endoleaks type II with a reintervention rate of 28%

- **Mortality**:  
  significantly higher aneurysm-related mortality rate in the EVAR group, mainly due to untreated endoleaks with secondary sac rupture (EVAR Trial)

Standard for Endoleak Detection

Advantages:
- Availability
- Flow Dynamics
- High resolution
- Good image quality
- “Gold Standard”
Reducing Radiation Dose

Presets
- Frame rate 15 fps
- DSA 7.5 fps
- Set dose level 3 mGy

Modifications to reduce radiation
- Frame rate 3 fps
- DSA 3 fps
- Set dose level 0.8 mGy

Surgeon’s skills
- Fusion imaging
- Collimation
- Shorter acquisitions
- Avoiding magnification
- Contrasted fluoroscopy
- Cone Beam CT

Modifications to reduce radiation include:
- Lowering the frame rate
- Reducing the dose level
- Adjusting the collimation technique
- Shortening the acquisition time
- Minimizing magnification
- Increasing the contrast in fluoroscopy images
Evolution of Dose for infrarenal EVAR

2012: 283,9 +/- 174,4 Gy cm²

2017: 66,6 +/- 62,7 Gy cm²
Workflow for Fusion imaging

- Preoperative CTA
- Fluoroscopy
- Fusion Imaging

Registration

DynaCT / Fluoroscopic image
Growing Body of Evidence for Fusion imaging
Reducing radiation dose with fusion imaging: Meta-analysis

7 studies showed significant reduction in contrast and radiation for FEVAR, BEVAR TEVAR CHEVAR AND EVAR

Figure 3. Forest plots of the pooled mean difference in the volume of contrast used for (A) endovascular aortic repairs and (B) complex endovascular aneurysm repair (EVAR) procedures [fenestrated EVAR (FEVAR), branched EVAR (BEVAR), and chimney EVAR]. Hertault refers to their FEVAR subanalysis and Hertault1 to their BEVAR subgroup. CI, confidence interval.
Contrasted-enhanced Cone Beam CT

Detector size
40x30cm

Rotational angiography
20x23.7cm

CT-like Reconstruction
Increasing Evidence for cone beam CT

Intraoperative CT in EVAR is also helpful in ruptured cases

P Geisbusch, CH Schulz, M Schmitt and D Röckler

Introduction

Over the last years, huge improvements regarding intraoperative imaging for endoaneurysm procedures have been made. These include the increasing utilization of dedicated vascular hybrid operating rooms, which offer the capability of intraoperative 3D imaging using flat-panel detectors that allow acquisitions of an intraoperative cone beam computed tomography (CBCT). This technology can be used for various applications: (1) basic imaging for anatomic navigation by performing 3D registration of the intraoperative cone beam CT with a preoperative CT angiography. (2) Intraoperative 3D imaging using a contrast-related cone beam CT that allows visualization of aneurysm necks and evaluation of the aneurysm wall. The following chapter aims to gain an overview of technical aspects, potential advantages and contraindications of intraoperative 3D imaging using a contrast-enhanced cone beam CT for intraoperative quality assurance and management of patients with ruptured infrarenal aortic aneurysms.
Contrasted-enhanced Cone Beam CT

Protocol: 5 sec, 270 ° rotation 248 projections, 7 sec injection, 2 sec delay
On-table Conebeam CT

Dyna CT axial view

Dyna CT sagittal view
Intraluminal Thrombus
Limb stenoses
<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>
<tbody>
<tr>
<td>Schulz et al. (2016)</td>
<td>n=98</td>
<td>5s, 200°248f³ 40 x 30 cm³</td>
<td>43.7 ± 10.8 Gycm²</td>
<td>X</td>
<td>7/98 (7.1%)</td>
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<td>2/98 (2.0%)</td>
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<td>Hertault et al. (2015)</td>
<td>n=54</td>
<td>8s, 200°150f 30 x 30 cm³</td>
<td>7 Gycm² (5.25 - 8)</td>
<td>-</td>
<td>17/54 (31.5%)</td>
<td>CEUS</td>
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Perioperative assessment of EVAR/FEVAR/BEVAR
New Workflow

- **Intervention with completion DSA**
- **Secondary Reintervention**
- **CTA**
- **Standard Follow-Up**

- **Intervention with completion DSA**
- **Immediate Revision**
- **DynaCT**
- **CEUS**
- **Standard Follow-Up**
Outlook: 4D ceCBCT
Outlook: Colour-coded 2D DSA (syngo iFlow)

*syngo* iFlow Supports Endoleak Categorization

Completion Angio

Colour-coded 2D DSA
Conclusions

- Fusion imaging reduces radiation
- Reliable detection of
  - Endograft-associated complications
  - Endoleaks (sensitivity 100%)
  - Additional intraoperative corrections in 7%
- Cone beam CT scan reduced case specific overall radiation per hospital stay
- And reduced reintervention rate due to on table assessment
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