Radiation exposure of mobile C-Arm supported EVAR compared with new Siemens Artis pheno Hybrid System

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Disclosure

Speaker name: ..........................................................................................

I have the following potential conflicts of interest to report:

☑ Consulting  Siemens Healthineers
☐ Employment in industry
☐ Stockholder of a healthcare company
☐ Owner of a healthcare company
☐ Other(s)

☐ I do not have any potential conflict of interest
Impact of Hybrid Rooms with Image Fusion on Radiation Exposure during Endovascular Aortic Repair

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Table 2. Comparison of cases of endovascular aneurysm repair performed in the hybrid room (HR) versus a previous prospective cohort treated with a mobile C-arm.10

<table>
<thead>
<tr>
<th>Measure</th>
<th>C-arm (n = 301)</th>
<th>HR (n = 96)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAP (Gy.cm²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIF</td>
<td>30.0 (20.0—43.5)</td>
<td>12.2 (8.7—19.9)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>FEN</td>
<td>72.9 (52—109.2)</td>
<td>43.7 (24.7—57.5)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>BR</td>
<td>159.0 (101.8—222.4)</td>
<td>47.4 (37.2—108.2)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>THO</td>
<td>20.0 (11.4—30.0)</td>
<td>24.7 (22.0—28.7)</td>
<td>.63</td>
</tr>
<tr>
<td>Contrast medium volume (mL)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIF</td>
<td>80 (65—106)</td>
<td>59 (50—75)</td>
<td>.34</td>
</tr>
<tr>
<td>FEN</td>
<td>138 (100—160)</td>
<td>105 (70—136)</td>
<td>.03</td>
</tr>
<tr>
<td>BR</td>
<td>226 (150—278)</td>
<td>120 (100—170)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>THO</td>
<td>100 (78—140)</td>
<td>80 (50—100)</td>
<td>.07</td>
</tr>
<tr>
<td>Intervention time (min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIF</td>
<td>93 (75—120)</td>
<td>92.5 (75—120)</td>
<td>.97</td>
</tr>
<tr>
<td>FEN</td>
<td>150 (105—180)</td>
<td>150 (150—160)</td>
<td>.39</td>
</tr>
<tr>
<td>BR</td>
<td>210 (150—260)</td>
<td>205 (169—240)</td>
<td>.87</td>
</tr>
<tr>
<td>THO</td>
<td>117 (60—138)</td>
<td>80 (60—105)</td>
<td>.22</td>
</tr>
</tbody>
</table>
Radiation Dose Reduction During EVAR: Results from a Prospective Multicentre Study (The REVAR Study)

Adrien Hertault, Robert Rhee, George A. Antoniou, Donald Adam, Hisashi Tonda, Hervé Rousseau, Aurélie Bianchini, Stéphan Haulon

- 6 international centres «real world practice»
- EVAR with bifurcated grafts
- Fusion imaging guidance (GE Discovery+GE Healthcare)
- ALARA principle
- Feb-Nov 2016
- n=85 patients

Table 2. Results per centre of the main variables of interest.

<table>
<thead>
<tr>
<th>Centre</th>
<th>Number of patient enrolled</th>
<th>Median DAP (Gy·cm²)</th>
<th>Median CAK (mGy)</th>
<th>Median contrast medium used (g of iodine)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre 1</td>
<td>18</td>
<td>20.2 (7.1–38.9)</td>
<td>174 (67–303)</td>
<td>33.8 (21–39)</td>
</tr>
<tr>
<td>Centre 2</td>
<td>27</td>
<td>10.3 (8.2–14.7)</td>
<td>104 (88–185)</td>
<td>10.2 (4.0–16.0)</td>
</tr>
<tr>
<td>Centre 3</td>
<td>11</td>
<td>16.0 (11.9–22.5)</td>
<td>83 (71–139)</td>
<td>11.5 (8.8–13.1)</td>
</tr>
<tr>
<td>Centre 4</td>
<td>16</td>
<td>28.1 (13.6–43.9)</td>
<td>132 (51.5–203.5)</td>
<td>14.4 (10.5–17.0)</td>
</tr>
<tr>
<td>Centre 5</td>
<td>12</td>
<td>14.2 (11.0–24.8)</td>
<td>83 (62–117.1)</td>
<td>15 (9.6–18.8)</td>
</tr>
<tr>
<td>Centre 6</td>
<td>1</td>
<td>26.5</td>
<td>98</td>
<td>22.4</td>
</tr>
</tbody>
</table>

DAP = dose area product, in Gy·cm²; BMI = body mass index, in kg/m².
Radiation Dose Reduction During EVAR: Results from a Prospective Multicentre Study (The REVAR Study)

Adrien Hertault\textsuperscript{a}, Robert Rhee\textsuperscript{b}, George A. Antoniou\textsuperscript{c}, Donald Adam\textsuperscript{d}, Hisashi Tonda\textsuperscript{e}, Hervé Rousseau\textsuperscript{f}, Aurélia Bianchini\textsuperscript{g}, Stéphan Haulon\textsuperscript{h,*}

Table 3. Univariable analysis: impact of main variables known or suspected to influence DAP$^a$ (linear regression).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Regression coefficient</th>
<th>95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>−0.013</td>
<td>−0.034−0.007</td>
<td>0.208</td>
</tr>
<tr>
<td>BMI, kg/m$^2$</td>
<td>0.079</td>
<td>0.050−0.108</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fluoroscopy time, min</td>
<td>0.060</td>
<td>0.042−0.077</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Percentage of DAP with gantry in extreme angulations (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;35%</td>
<td>0.010</td>
<td>0.002−0.019</td>
<td>0.021</td>
</tr>
<tr>
<td>≥35%</td>
<td>0.425</td>
<td>0.078−0.773</td>
<td>0.017</td>
</tr>
<tr>
<td>Percentage of field of view collimation (%)</td>
<td>−0.022</td>
<td>−0.032 to −0.013</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Use of magnification</td>
<td>0.411</td>
<td>−0.232−1.054</td>
<td>0.207</td>
</tr>
<tr>
<td>Procedure time (min)</td>
<td>0.013</td>
<td>0.009−0.018</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>General anaesthesia</td>
<td>−0.327</td>
<td>−0.703−0.040</td>
<td>0.088</td>
</tr>
</tbody>
</table>

DAP increased: Fluoroscopy time
BMI
>30% lateral view
>15% AP angulation

DAP reduction: Collimation
Lucerne Cantonal Hospital (LUKS):  
Cantonal Hospital of central switzerland  
Academic Hospital with 700 beds  
Service for 750,000 inhabitants

Vascular Surgery Unit:  
- 100 aortic procedures  
- 60 Endovascular Aortic Procedures/Year  
  EVAR/TEVAR/FEVAR, Iliac branches and branched Devices  
Team: 4 board certified vascular surgeons  
Service: 24/7
Lucerne goes Hybrid

Nov 2017 Siemens Pheno-System in Lucerne
90 qm Hybrid OR
facilities for multi/interdisciplinary use
(vascular surgery/cardiac surgery/cardiology/trauma)
Comparism uncomplicated/standard EVAR in «real world»

Artis pheno:

- new detector technology (CMOS)
- Fusion imaging
- EVAR Guidance Workflow

Mobile C-arm: historic cohort (Flat panel detector)

Inclusion criteria: all standard EVAR (no complex cases/ruptures/AUI etc.)

Study endpoints:

- ✓ DAP
- ✓ CAK
- ✓ Fluoro time
- ✓ Procedure time
EVAR-Workflow mobile C-arm (6/2013-11/2017)

- Orientation/Overview DSA
- Introduction Device
- Control of infrarenal position after partly released Device DSA
- Release Main Body until contralateral leg opens
- Contralateral cannulation
- Contralateral retrograde localisation of hypogastric artery DSA
- Complete release main body
- Ipsilateral retrograde DSA for hypogastric artery DSA
- Ballooning
- Final control DSA
Protocol includes 5 series of DSA during standard EVAR

ALARA principle
Fluoro: 3 pulses/sec
DSA: 6 frames/sec

Angulation as much as needed
max. Collimation
no magnification
Historic group – mobile C-arm

Endovascular aortic sealing with Nellix reduces intraoperative radiation dose when compared to endovascular aortic repair

Stefan Ockert, MD, PhD, Mirjam Heinrich, Thomas Kaufmann, MD, Thomas Syburra, MD, Ruben Lopez, MD, and Robert Seelos, MD, Luceme, Switzerland

<table>
<thead>
<tr>
<th>Author</th>
<th>DAP (Gy*cm²)</th>
<th>Fluoro time (min)</th>
<th>mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geijer 2005</td>
<td>60.1</td>
<td>28.4</td>
<td>low dose</td>
</tr>
<tr>
<td>Weiss 2008</td>
<td>151.7</td>
<td>20.6</td>
<td></td>
</tr>
<tr>
<td>Kalef-Ezra 2009</td>
<td>37.4</td>
<td>22.6</td>
<td>low dose</td>
</tr>
<tr>
<td>Maurel 2012</td>
<td>30.5</td>
<td>11.2</td>
<td>low dose pulsed</td>
</tr>
<tr>
<td>Ockert 2018</td>
<td>22.6</td>
<td>19</td>
<td>low dose pulsed</td>
</tr>
</tbody>
</table>
Workflow Artis pheno

Preparation of CT scan
Registration for fusion imaging
With EVAR Guidance automated workflow
3D Guidance during Stent deployment
Optional: 3d assessment of result
Lucerne-Workflow Artis pheno

Registration CT dataset
AP+lateral Fluoro
Fusion imaging (bone orientation)
manual correction/repositioning
Confirmation
Implantation
no routine assessment via Dyna-CT
Workflow Artis pheno

Fluoro 2 pulses/sec; DSA 2.5 frames/sec

- Implantation of device
- 3 D Guidance
- Proof of markers via DSA

- Re-Positioning
- Main Body Release

- Leg placement
- Final DSA

2 DSA series during Standard EVAR
Reduction of 2-3 DSA runs vs mobile C-arm
**Pheno group I:**
Jan 2018-Jan 2019  n=40  standard EVAR (learning curve group)
EVAR Guidance imaging+ zen40HDR Detector
Fluoro: 2 pulses/sec  DSA: 2.5 frames/sec

**Pheno group II:**
Jan 2018-Jan 2020  n=40  standard EVAR (advanced group)
EVAR Guidance+zen40HDR Detector
*optimized adopted workflow+dose Protocol*

**Mobile C-arm Group III:**
June 2013-Nov 2017  n=60  standard EVAR (historic group)
mobile C-arm reference group
Fluoro 3 pulses/sec
DAS 6 frames/sec
Pheno group I:  
Jan 2018-Dez 2018 n=25 Standard EVAR (learning curve group)  
Fusion imaging/3D EVAR Guidance/zen40HDR Detector  
Fluoro: 2 pulses/sec DAS: 2.5 frames/sec

Historic Group III:  n=60  
mobile C-arm reference group  
Fluoro 3 pulses/sec  
DAS 6 frames/sec

Early results (n= 25 Artis pheno):  
Fluoro time less  
Procedure time higher
Risk of increased Radiation exposure using high dose Hybrid-OR systems

ALARA principle mandatory

Key points: pulsed and limited Fluoro, min. angulation and max. collimation

Imaging Fusion significantly reduce radiation for patients and operators compared to mobile C-arm systems
Thank you for your attention !!!

REDUCE RADIATION EXPOSURE
YOU CAN HAVE AN IMPACT

Interventionalists and their staff are exposed to high amounts of radiation due to the long, complicated procedures performed every day and their proximity to the radiation source.

EVERY DAY HEALTHCARE PROFESSIONALS ARE EXPOSED TO THE HARMFUL EFFECTS OF RADIATION

6-fold increase¹
NEARLY 40% OF THE INCREASED EXPOSURE IS RELATED TO CARDIOVASCULAR IMAGING AND INTERVENTION

RADIATION EXPOSURE

1980 2014