Golden rules to reduce radiation dose in the hybrid room to a minimum

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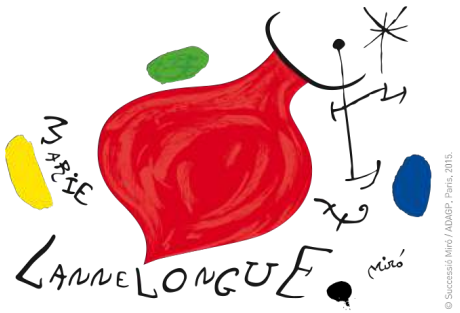
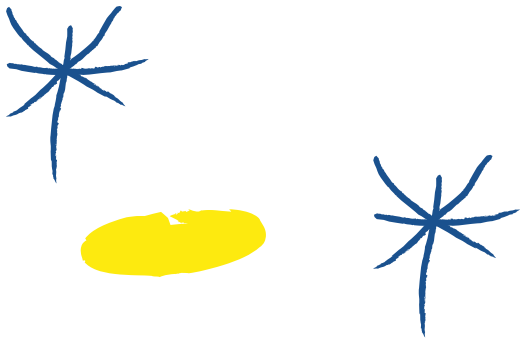
Disclosures

- Research support, Consulting
  - Cook Medical, GE Healthcare, Bentley





Literature overview
Where do we stand?

Impact of Hybrid Rooms with Image Fusion on Radiation Exposure during Endovascular Aortic Repair

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WHAT THIS PAPER ADDS

Experience has shown that the routine use of fusion during endovascular aneurysm repair has significantly reduced the exposure of patients and operators to X-rays and contrast volume injection during complex repairs, without jeopardising the overall procedure workflow.

Objective: To evaluate exposure to radiation during endovascular aneurysm repair (EVAR) performed with intraoperative guidance by preoperative computed tomographic angiogram fusion.

Methods: All consecutive patients who underwent standard bifurcated (BIF) or thoracic (THO), and complex fenestrated (FEN) or branched (BR) EVAR were prospectively enrolled. Indirect dose–area product (DAP), fluoroscopy time (FT), and contrast medium volume were recorded. These data were compared with a previously published prospective EVAR cohort of 301 patients and to other literature. Direct DAP and peak skin dose were measured with radiochromic films. Results are expressed as median (interquartile range).

Results: From December 2012 to July 2013, 102 patients underwent standard (56.8%) or complex (43.2%) EVAR. The indirect DAP (Gy.cm^2) was as follows: BIF 12.2 (8.7–19.9); THO 26.0 (11.9–34.9); FEN 43.7 (24.7–57.5); and BR 47.4 (37.2–108.2). The FT (min) was as follows: BIF 10.6 (9.1–14.7); THO 8.9 (6.0–10.5); FEN 30.7 (20.2–40.5); and BR 39.5 (34.8–51.6). The contrast medium volume (mL) was as follows: BIF 59.0 (50.0–75.0); THO 80.0 (50.0–100.0); FEN 105.0 (70.0–136.0); and BR 120.0 (100.0–170.0). When compared with a previous cohort, there was a significant reduction in DAP during BIF, FEN, and BR procedures, and a significant reduction of iodinated contrast volume during FEN and BR procedures. There was also a significant reduction in DAP during BIF procedures when compared with the literature ($p < .01$). DAP measurement on radiochromic films was strongly correlated with indirect DAP values ($r^2 = .93$).

Conclusion: The exposure of patients and operators to radiation is significantly reduced by routine use of image fusion during standard and complex EVAR.

Article history: Received 17 February 2014, Accepted 30 May 2014, Available online 17 July 2014

Keywords: Aorta, Endovascular procedures, Fusion imaging, Hybrid room, Radiation, Radiation protection

INTRODUCTION

The evolution of device technology has allowed physicians to perform more and more complex minimally invasive aortic endovascular repairs. Imaging systems have also evolved to facilitate these challenging procedures. For example, fixed-room flat panel detectors have demonstrated strong imaging superiority over standard fluoroscopic two-dimensional (2D) fluoroscopy imaging systems (mobile C-arms), which are limited by overheating and image degradation, particularly when performing complex endovascular aneurysm repair (EVAR).[1] Hybrid rooms, combining an optimal open surgical environment and advanced imaging capabilities are currently replacing mobile C-arms in the operating room.

The latest hybrid rooms have advanced imaging applications, such as contrast-enhanced cone beam computed tomography (CBCT; three-dimensional [3D] images acquired through a C-arm rotation around the patient), and preoperative computed tomography angiography (CTA) image fusion with live fluoroscopy to provide a "3D roadmap". The latter facilitates endovascular navigation and increases the accuracy of endograft implantation.[2,3] Despite the current widespread use of these new imaging applications, little has been published on their impact on exposure to ionising radiation.[4–6]

Published evidence suggests that repeated injections of contrast medium contribute to the development of lifelong nephropathy.[7] The effects of radiation are cumulative and put patients at deterministic risk of radiation injuries after exposure.[8] Also, clinical staff regularly exposed to radiation during everyday fluoroscopy-directed procedures are

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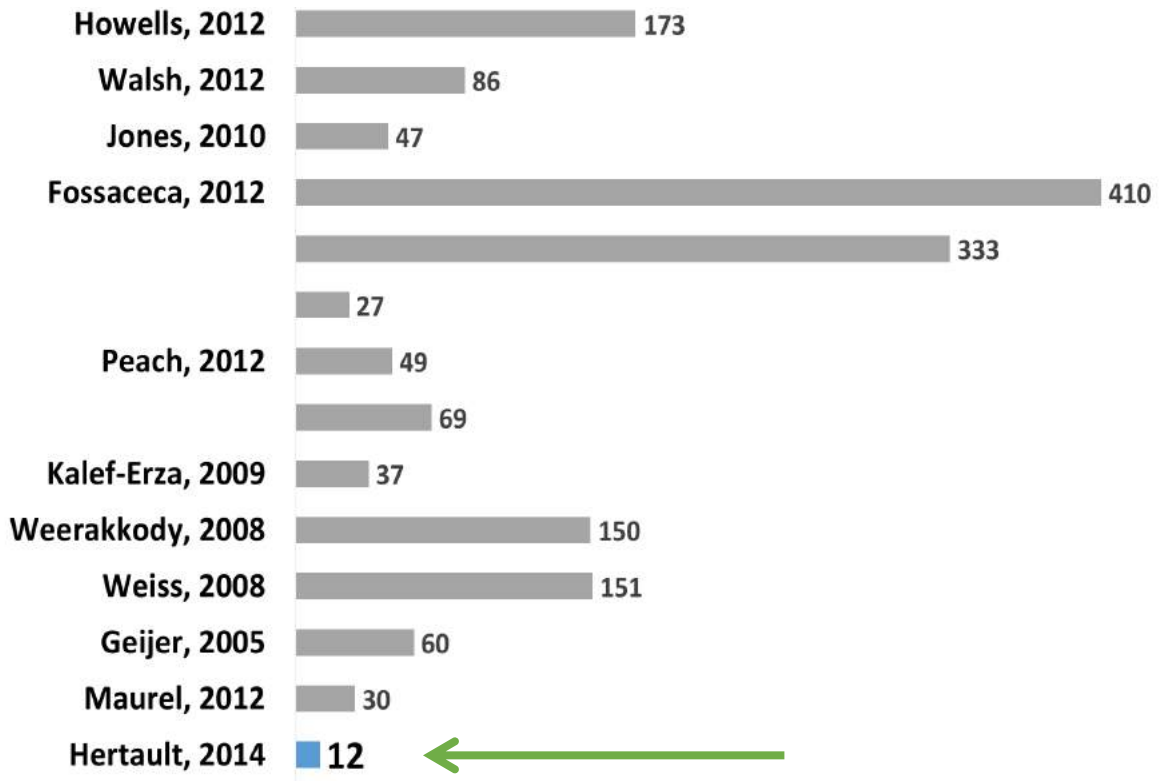
http://dx.doi.org/10.1016/j.ejvs.2014.05.026

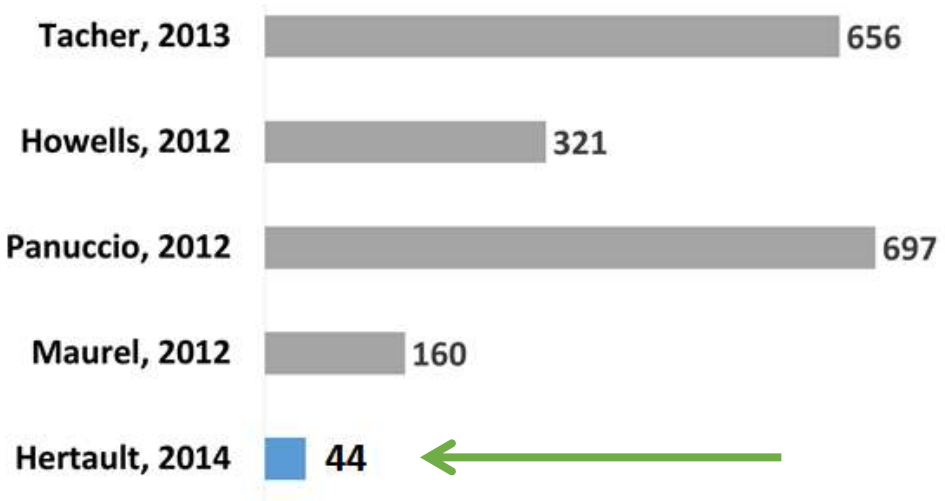
Literature overview
Where do we stand?

Median DAP (Gy.cm²) values reported in the Literature for Bifurcated EVAR procedures



Literature overview
Where do we stand?

Median DAP (Gy.cm²) values reported in the Literature for complex EVAR procedures



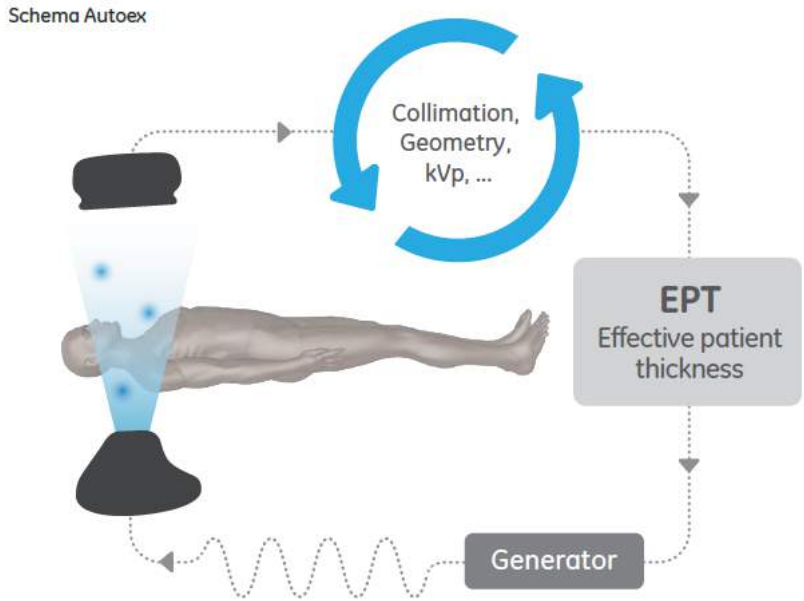
x3 to 15 times higher

System Basics

Detector High Detective Quantum Efficiency DQE

dose versus image quality and all detector components are summarized into DQE

Auto Exposure Management



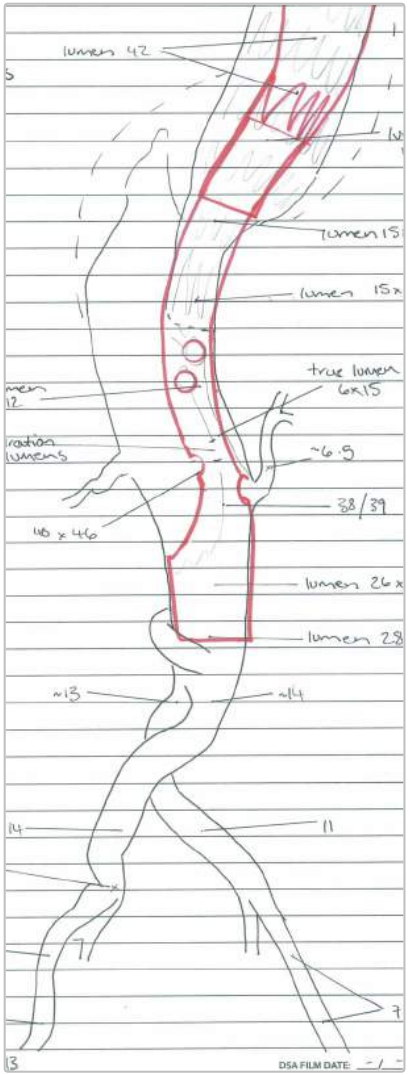
AutoEx optimizes imaging parameters, based on the estimated patient thickness, automatically and in real time
*When thickness increases, imaging chain loop and **auto exposure** increases dose rate to maintain same image quality at the detector level.*

Golden Rules

Before the procedure

Before the Procedure

Careful Pre-operative planning to define best working angulations



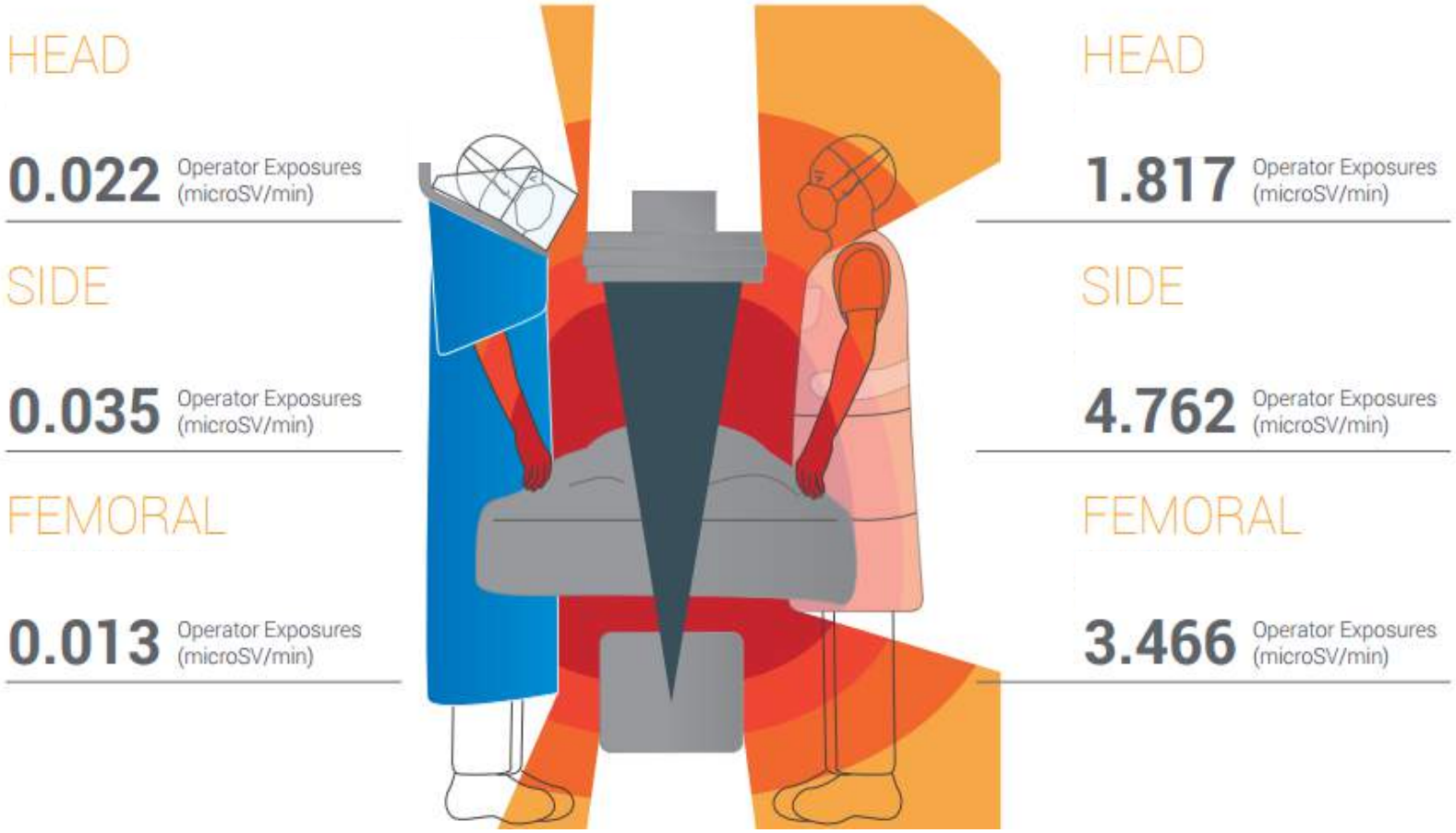
Before the Procedure

3D Volume preparation for Image Fusion

In the Hybrid Room

1 No lead, No X

Comparison of operator eye exposures when working from femoral region, side, or head of patient[1]

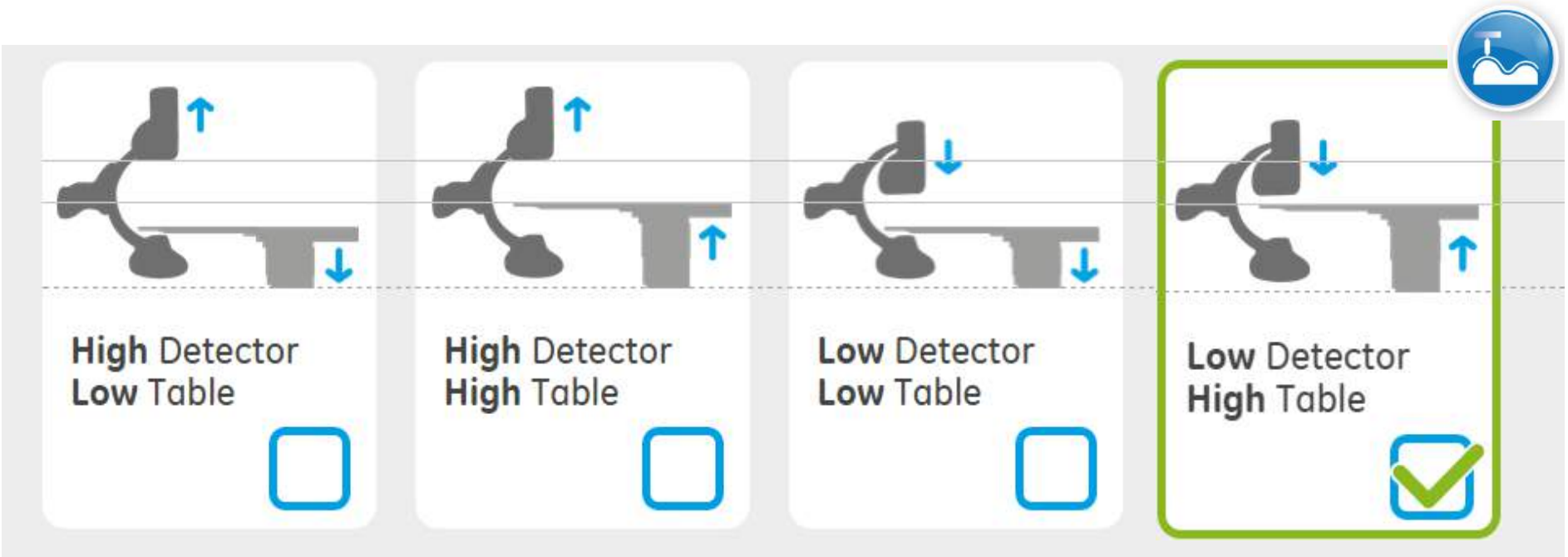


M.J. Ray, W.B. Taylor III, J.T. Weber, C.M. Savage. Comparison of Operator Eye Exposures When Working from Femoral Region, Side or Head of Patient, Journal of Vascular Interventional Radiology, Volume 23, Issue 3, Supplement, Page S127, March 2012

Paravent mobile individuel WD261

MAVIG

2 Optimize System Geometry



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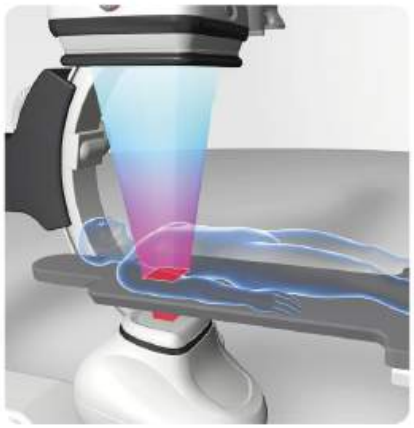
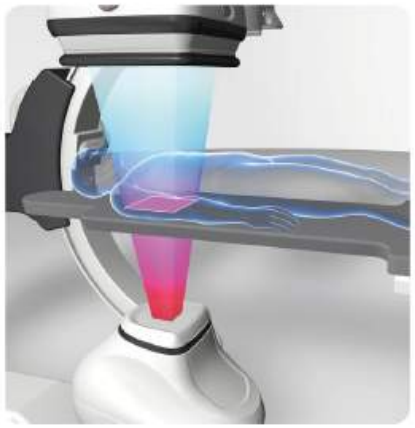
Why?

High Detector / **Low** Table



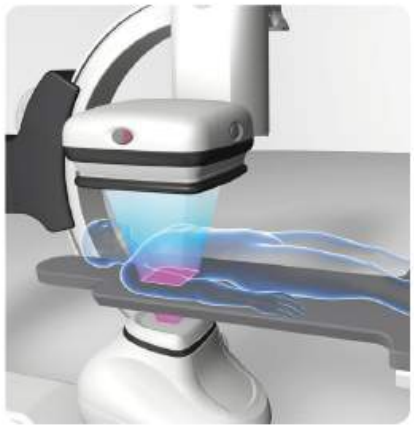
Air Kerma at patient skin

High Detector / **High** Table



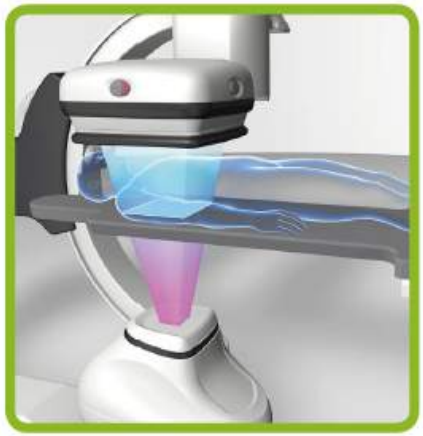
Air Kerma at patient skin

Low Detector / **Low** Table



Air Kerma at patient skin

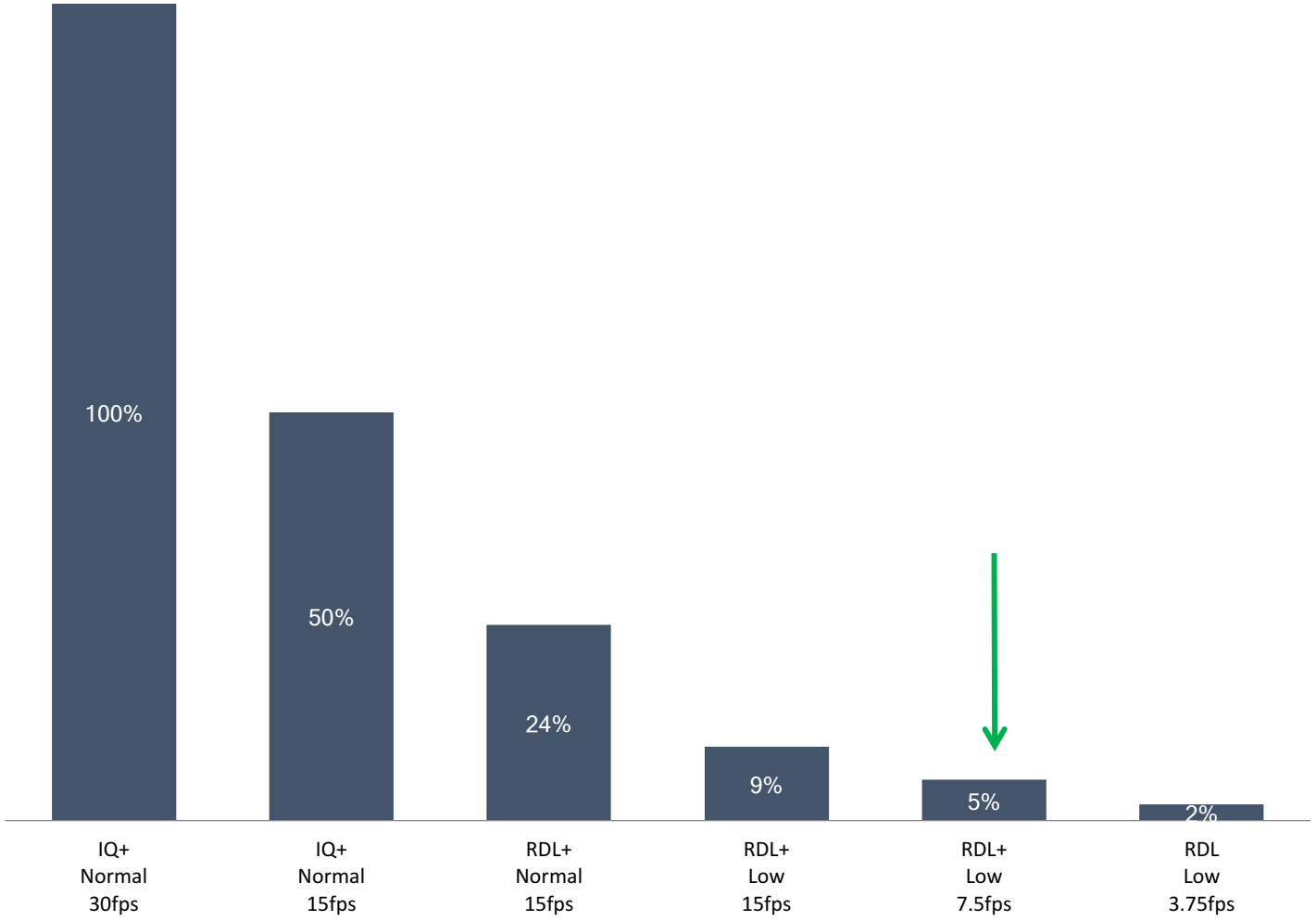
Low Detector / **High** Table



Air Kerma at patient skin

Haqqani J Vasc Surg 2012

3 Use lowest acceptable protocol & frame rate

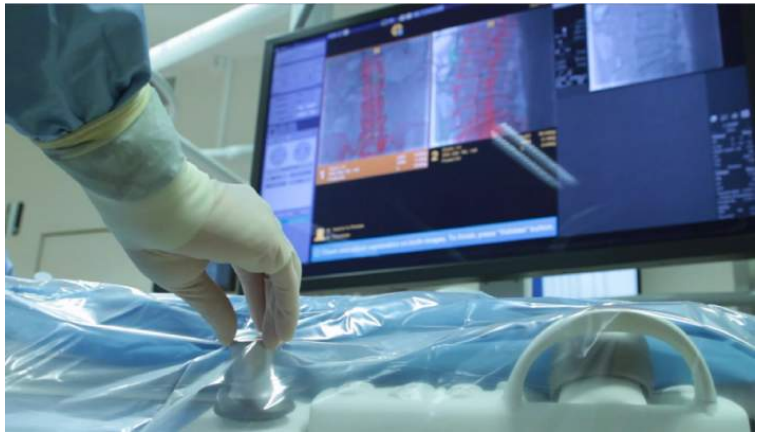


[1] Dose ratios mentioned are air kerma rate ratios measured according to IEC 60601-2-43 conditions. Field Of View of 20cm. In clinical use, the results of dose reduction techniques will vary depending on the clinical task, patient size, anatomical location and clinical practice. Physicians assisted by a physicist as necessary has to determine the appropriate settings for each specific clinical task.

4 Routinely use Image Fusion

and get the best of your pre-operative dataset

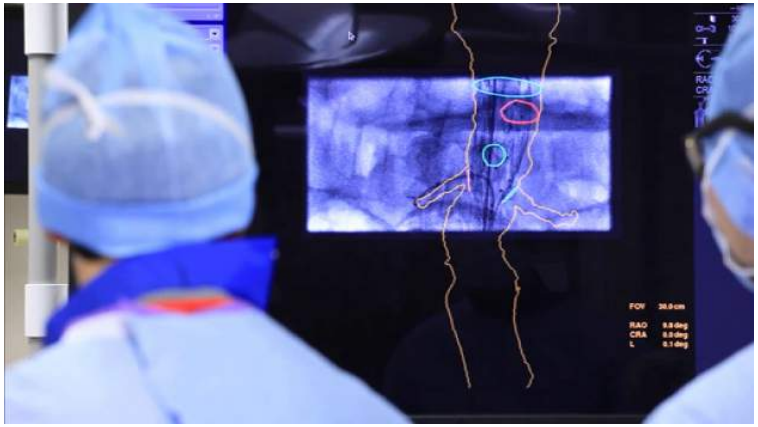
Register with Bi-view (2D/3D registration)



Find working position without X-ray

Fine tune 3D mask at table side

Use Digital Zoom



Why?

Some facts :

60% collimated area is 60% dose saved.

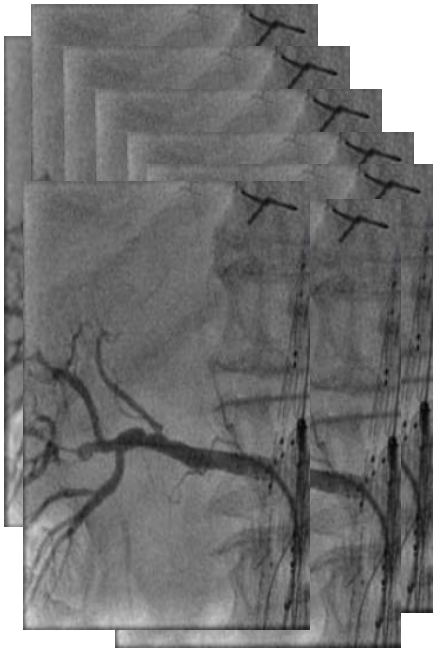
On a bifurcated EVAR exam of 30 Gy.cm², 18 Gy.cm² can be saved just by using collimation

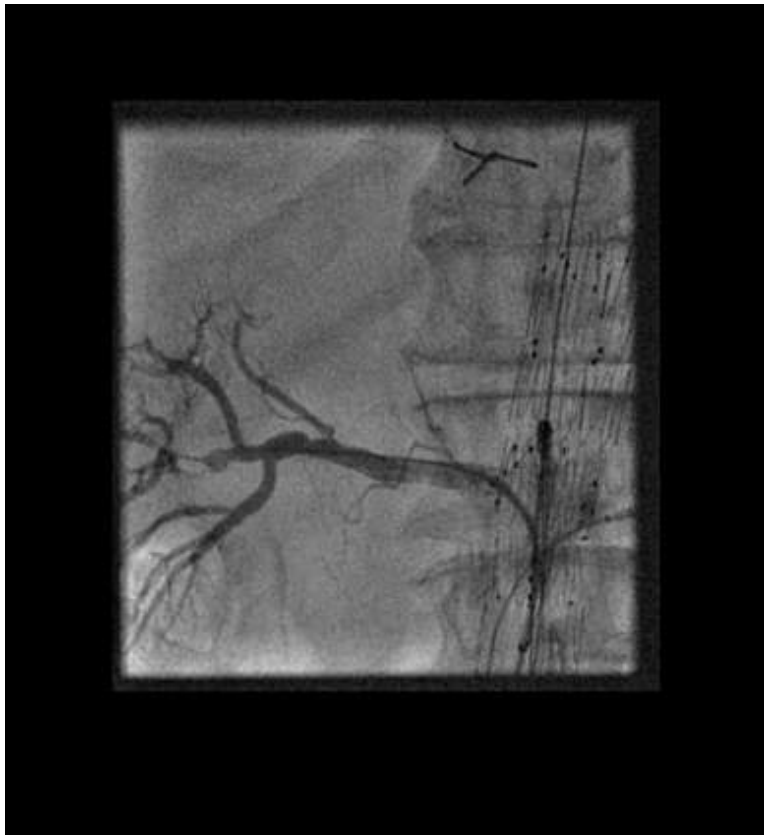
DAPtot = 30 Gy.cm² (non-collimated)
DAPtot x (1-0,6) = 12 Gy.cm² (60% collimated)
DAPsaved = 18 Gy.cm² (dose savings)

In Lille, Baseline for bifurcated EVAR is 12Gy.cm² an in average image is collimated by 60%.

5 Limit DSA runs

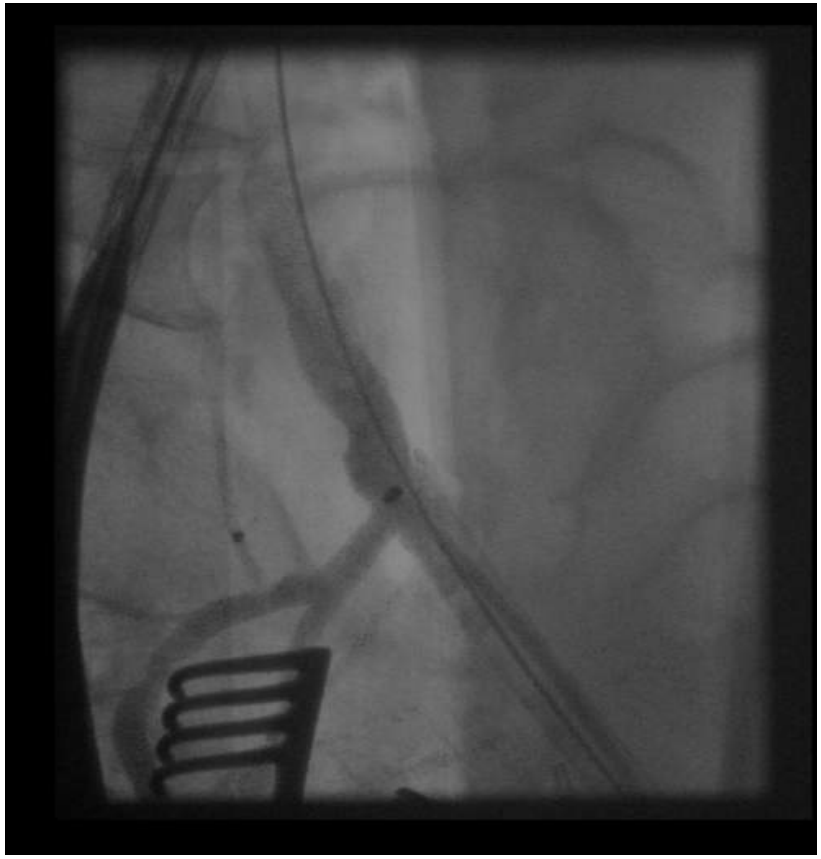
In term of dose,
1 DSA image ~ 500 fluoro images

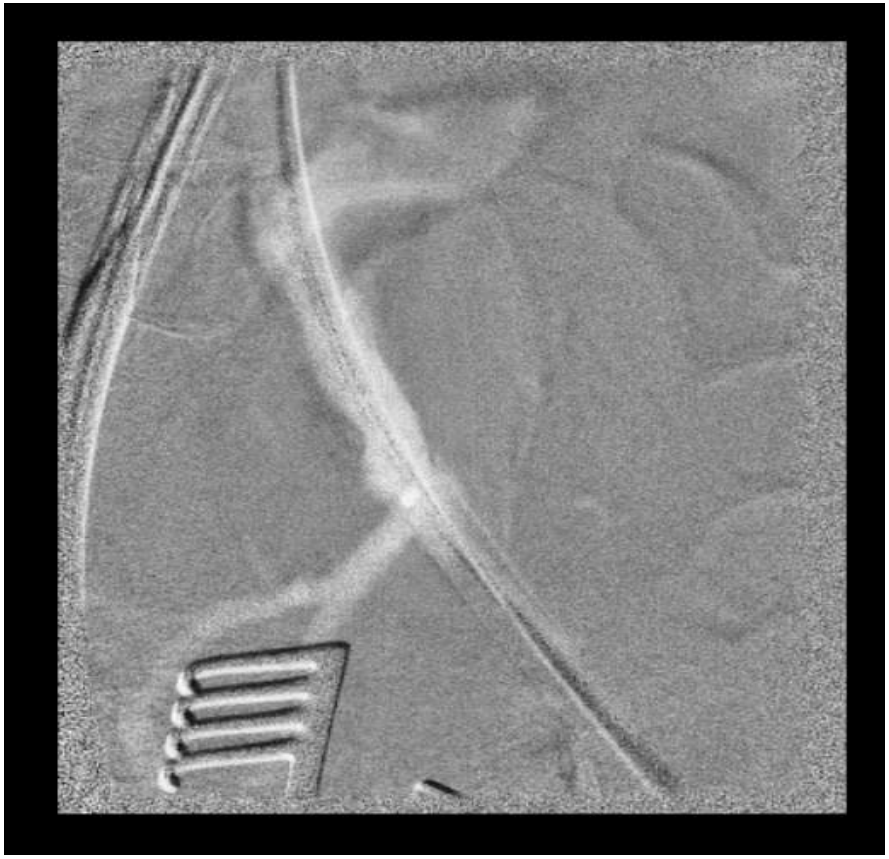




Prefer fluoroloop instead of DSA, except for completion angio or difficult situations

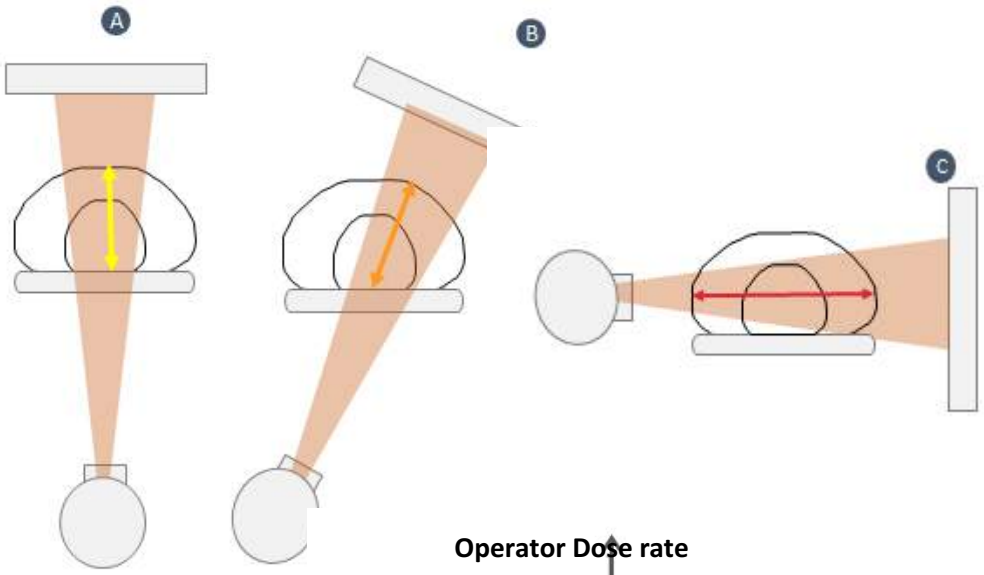
5 Limit DSA runs

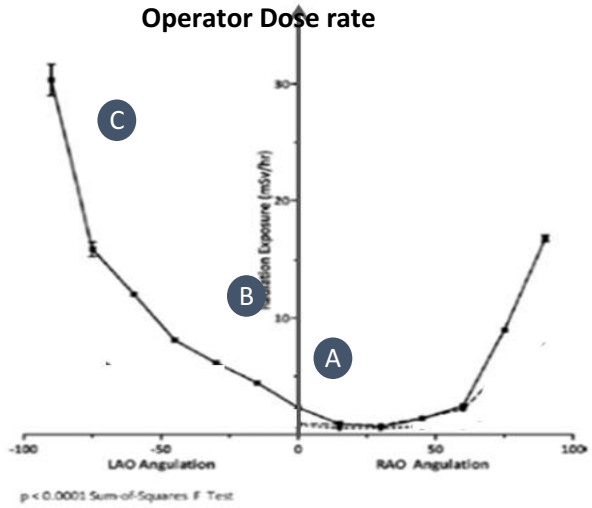




Use fluoro roadmap

6 Limit C-arm angulation





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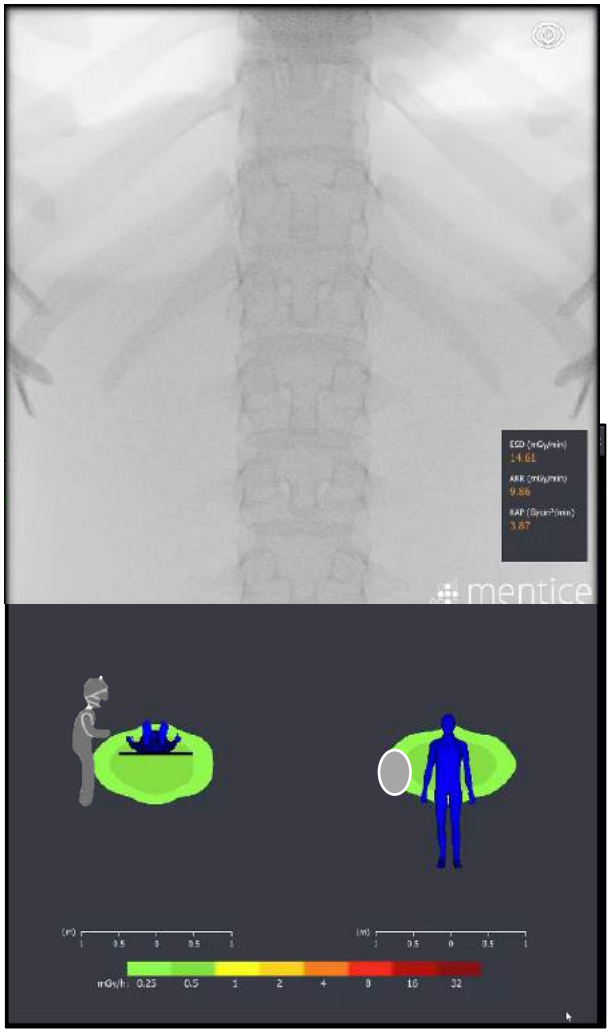


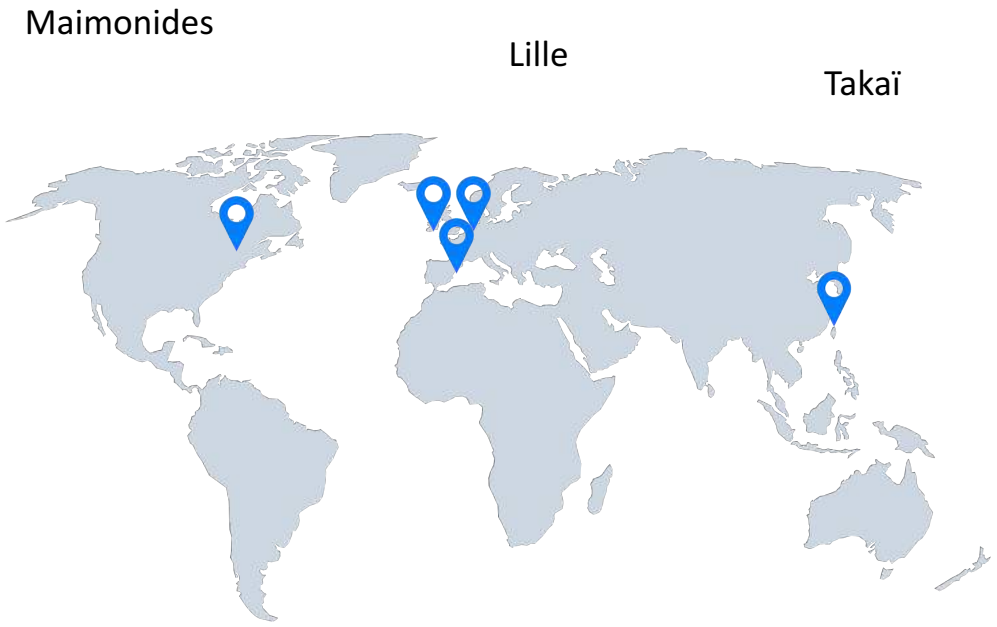
When LAO/RAO angle are >30°, patient & operator dose rate increases exponentially.
Same with CRA/CAU >15°

Could these results be achievable elsewhere?

MULTICENTRIC

REVAR Study

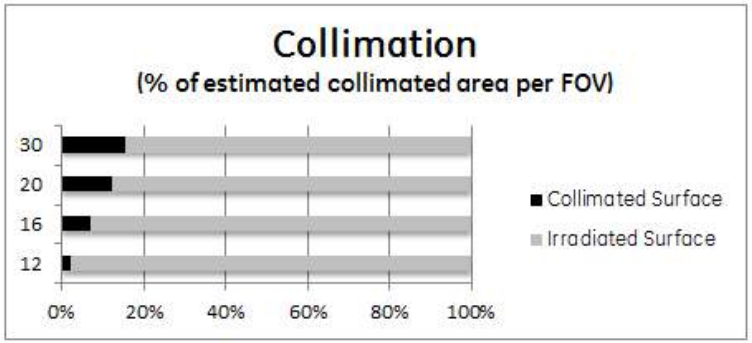
Radiation Evaluation during EVAR

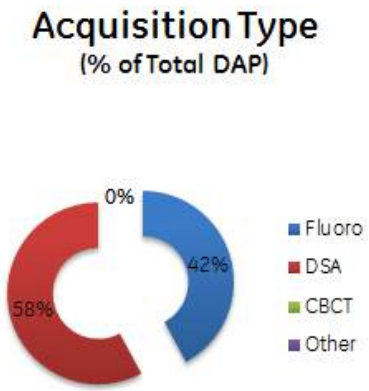


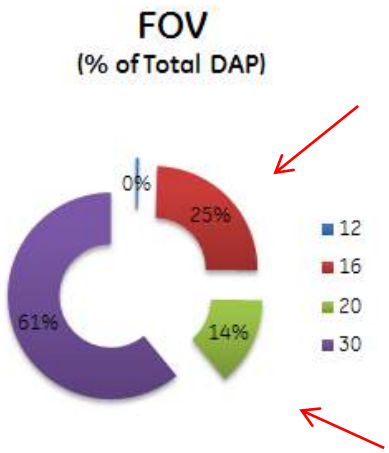
Pre study Result – The Importance of practice feedbacks

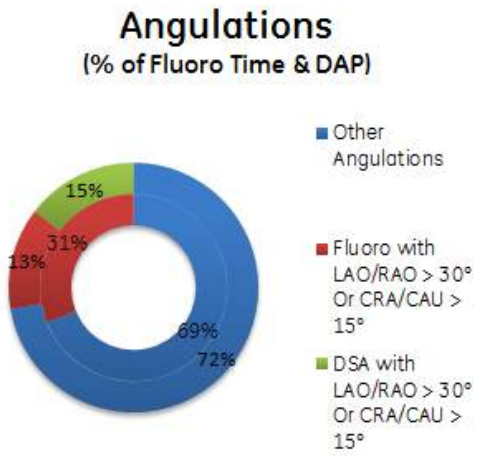
Site X prior the study

Mean AK (Gy)	**0.23**
Mean DAP (Gy.cm²)	**37.37**
Mean Fluorotime (min)	14.93
Number of DSA Frames per Exam	142.90
Mean EPT (cm)	22.08
Mean SID (m)	1.17
Number of Exams	**10**



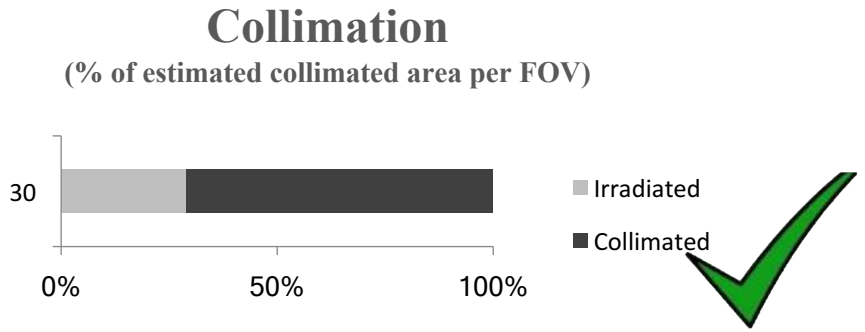


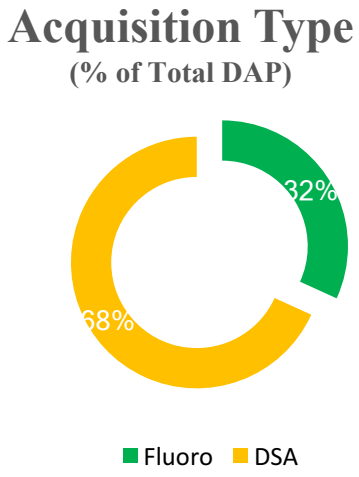


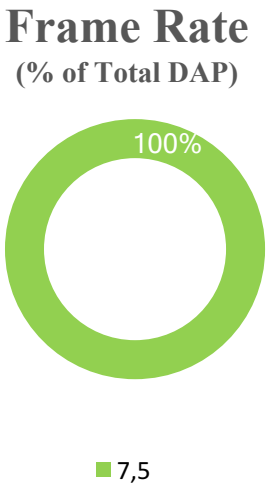


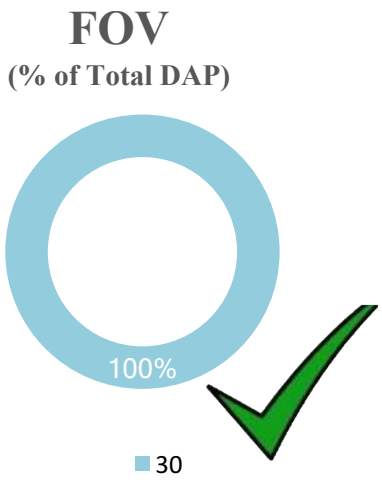
After Practice analysis and dedicated training…

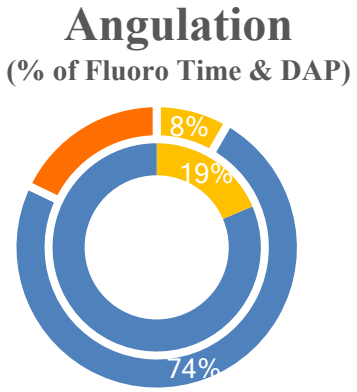
Number Of Cases	**8**
MeanDAP	16.5 Gy.cm²
MeanAK	0.105 Gy
Mean Fluoro Time	14.05 min
Mean SID	1.15 m







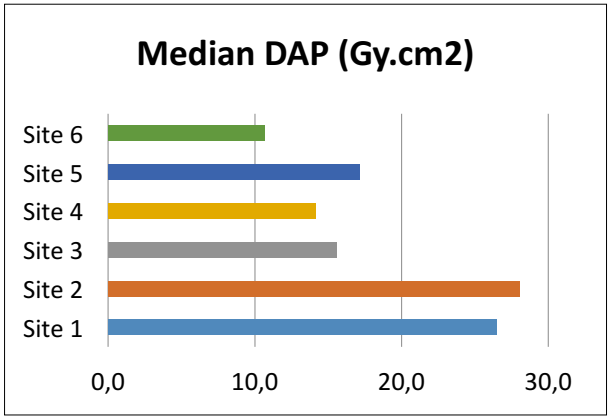


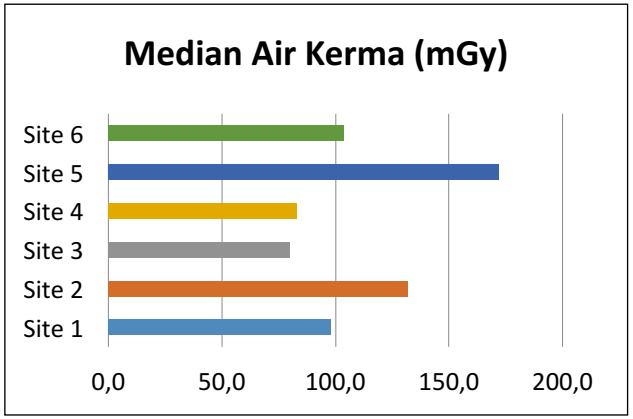


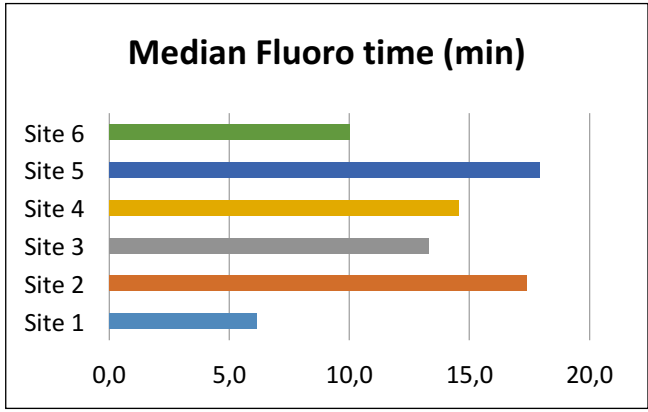
… DAP divided by 2 thanks to better FOV & Collimation management

Dose Reduction in the Hybrid Room

REVAR study preliminary results







Achieving consistent low dose results for EVAR across sites
Median DAP < 30 Gycm2, AK < 200 mGy

Conclusion

- Low dose technology design must be associated with good practices
- Each step has a huge impact on dose results
- Routine use of fusion imaging with full control at table side enables to achieve low dose results for EVAR in multiple centers
- Integrated workflow of EVAR ASSIST from sizing to CBCT including fusion imaging help reduce total dose & contrast throughout patients' hospital stay

http://www3.gehealthcare.com/en/products/categories/interventional_image_guided_systems/assist/evar_assist