Minimizing dose in complex EVAR procedures

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Disclosure

Speaker name:

Blandine MAUREL

I have the following potential conflicts of interest to report:

- ☒ Consulting : COOK, Philips
- ☐ Employment in industry
- ☐ Stockholder of a healthcare company
- ☐ Owner of a healthcare company
- ☐ Other(s)

- ☐ I do not have any potential conflict of interest

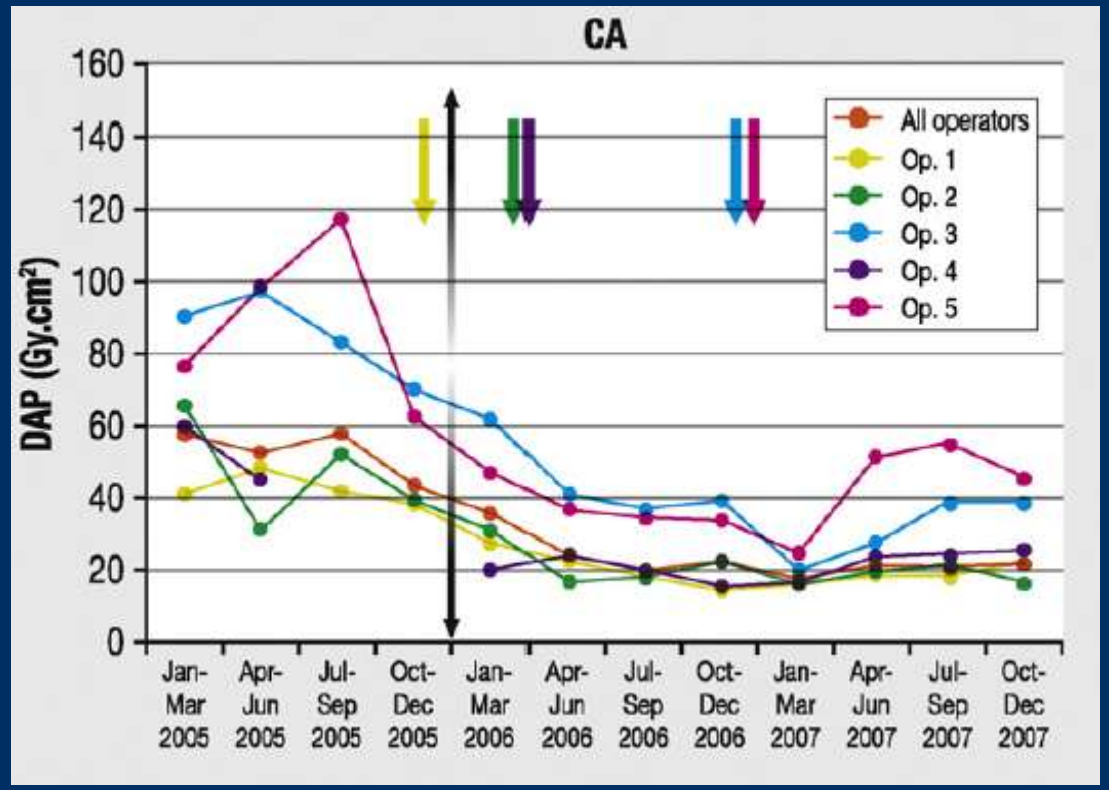
RADIATION EXPOSURE

- Patient

- Operator : exposed to daily very low doses over its entire career
  - ✓lenses injuries
  - ✓malignant tumours

Vascular news, June 2016

How minimizing dose in complex EVAR ?



Georges et al, Arch of CV Disease 2009

Cumulative radiation dose depend on :

- **Operator‘s expertise and awarness**
- **Imaging system**
- **Dose settings**

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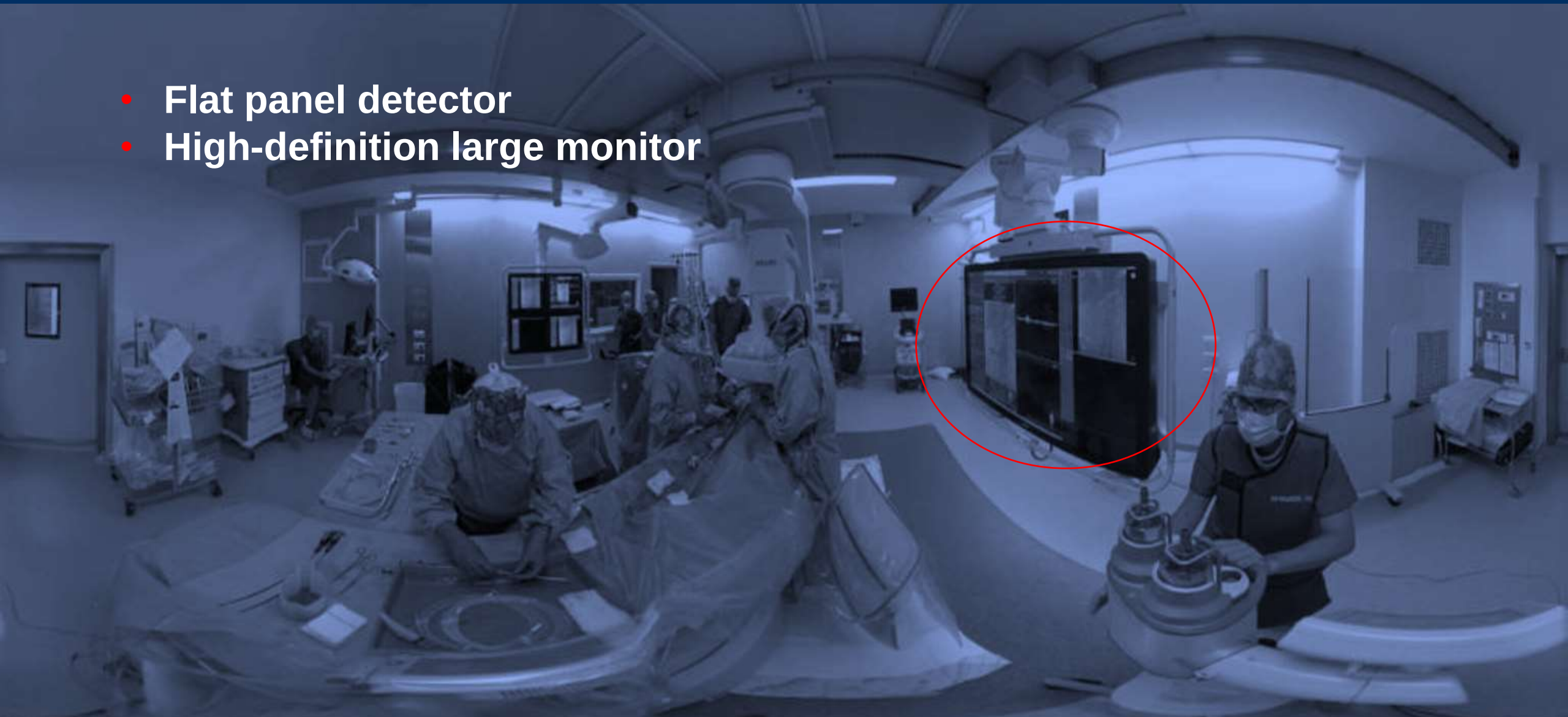
IMAGING ENVIRONMENT AND SETTINGS

IMAGING ENVIRONMENT

- Flat panel detector

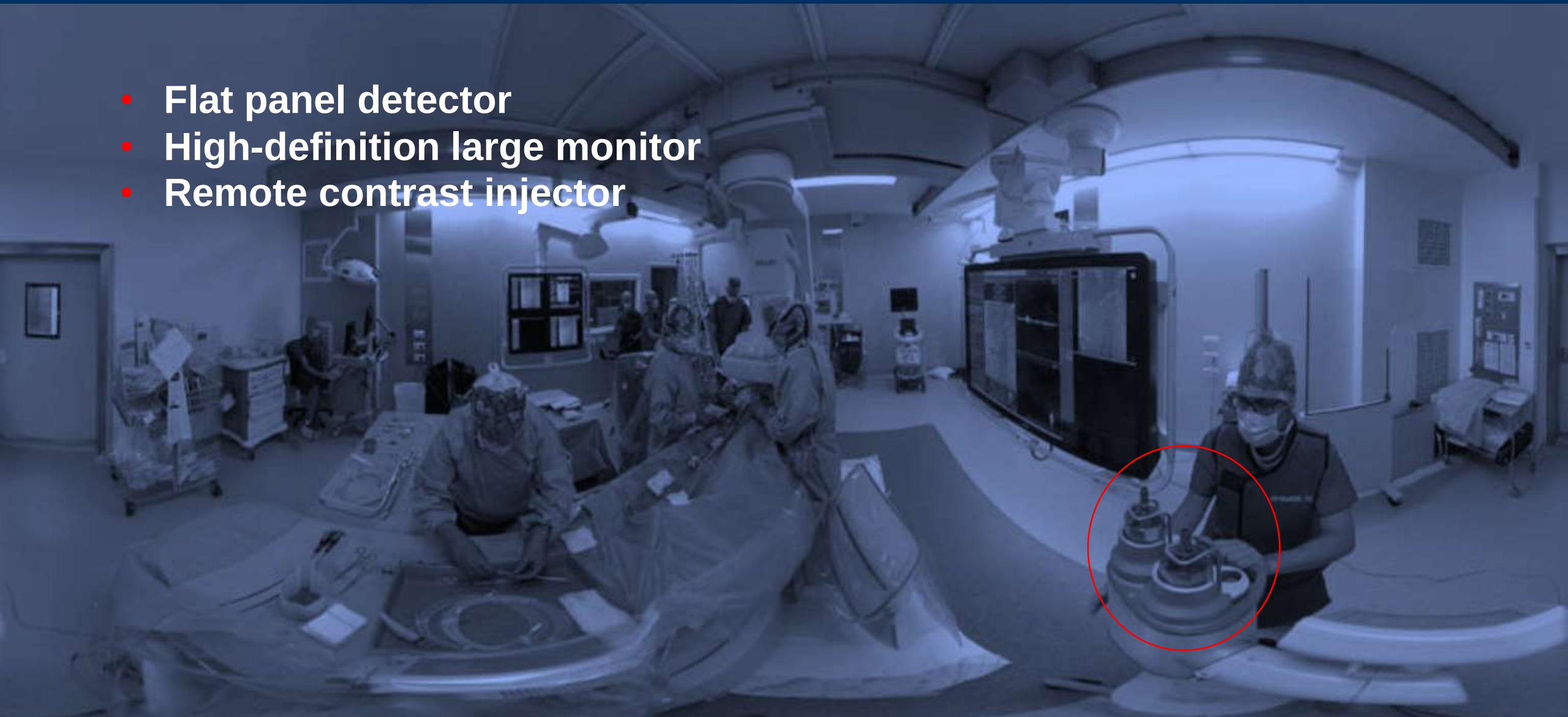
IMAGING ENVIRONMENT

- Flat panel detector
- High-definition large monitor



IMAGING ENVIRONMENT

- Flat panel detector
- High-definition large monitor
- Remote contrast injector

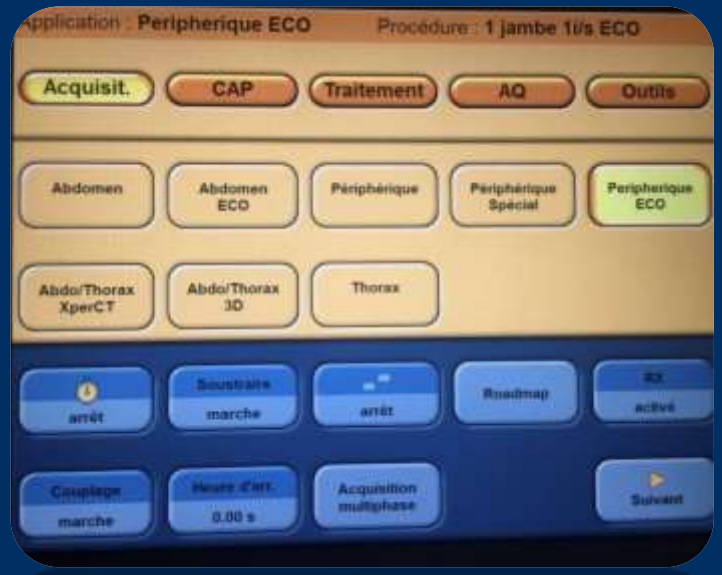


IMAGING ENVIRONMENT

- Flat panel detector
- High-definition large monitor
- Remote contrast injectors
- Full operator control at table side

SETTINGS

- Dose-reducing softwares
- Configuration, optimisation and calibration of the settings with engineer / medical physicist
- Various low dose protocols



Eur J Vasc Endovasc Surg (2020) 59, 295–300

Modern Image Acquisition System Reduces Radiation Exposure to Patients and Staff During Complex Endovascular Aortic Repair

Fiona Rohlffs *, Konstantinos Spanos, Eiko S. Debus, Franziska Heidemann, Nikolaos Tsilimparis, Tilo Kölbel

Department of Vascular Medicine, German Aortic Centre Hamburg, University Heart Centre, University Hospital Hamburg Eppendorf, Hamburg, Germany

WHAT THIS PAPER ADDS

This study was designed to investigate the radiation exposure risks during complex endovascular repair including fenestrated and branched endovascular aortic repair (EVAR) and thoracic endovascular aortic repair (TEVAR) procedures, and to demonstrate the benefit of dose reduction to staff and patients using a modern acquisition system.

Objective: Radiation damage during complex endovascular aortic repair (EVAR) is of major concern to patients and medical staff. This study investigates primarily the influence of different acquisition systems (Allura ClarityIQ vs. Allura Xper, Philips Healthcare, Best, the Netherlands) on radiation dose. Secondly, radiation exposure was analysed for operator positions as well as for procedure and patient specific parameters.

Methods: This was a retrospective study of prospectively collected data. The study prospectively included 62 consecutive patients (mean age 71.2 ± 8.4 years; 63% males) who underwent complex EVAR including fenestrated or branched EVAR of the thoraco-abdominal or the aortic arch from 30 June 2015 to 20 May 2016. In half the patients an advanced dose and real time image noise reduction technology (Allura ClarityIQ) was used, and in the other half the reference acquisition system (Allura Xper) was used. Patient demographics included age, gender, and body mass index.

Results: Sixty-two patients with mean age of 71.2 ± 8.4 years (63% males; 39/62) were treated using either Allura ClarityIQ or Allura Xper. Patients treated using Allura ClarityIQ had lower cumulative dose area product (18,948.3 ± 14,648.5 cGy cm^2 vs. 38,512.4 ± 24,105.4 cGy cm^2, $p < 0.001$) and air kerma (2237.9 ± 1808 mGy vs. 4031 ± 3260.2 mGy, $p = .010$) in comparison with patients treated using Allura Xper.

Conclusion: Advanced dose and real time image noise reduction technology, such as Allura ClarityIQ, is a useful tool to lower the amount of radiation for patient and staff during complex endovascular aortic procedures.

Keywords: Aorta, Branched stent graft, Endovascular therapy, Fenestrated stent graft, Radiation

Article history: Received 22 December 2018; Accepted 5 July 2019; Available online 20 December 2019

INTRODUCTION

The increased number and complexity of endovascular aortic procedures are directly associated with increased radiation exposure for both patients and staff. Fenestrated and branched endovascular aortic repairs (f/bEVAR) count as complex procedures that require longer operation times compared with standard EVAR.[1] Operator position changes between femoral and brachial access, as well as angulation of the C arm, are more frequently needed in these procedures, with the additional risk of increased radiation exposure.[2] Major complications of radiation are stochastic effects such as malignancy or deterministic effects such as cataract or skin damage.[3,4] To reduce these complications, awareness and knowledge of how to lower radiation exposure is essential. Modern imaging systems and personal dosimetry can also help to detect risk factors during more complex endovascular aortic procedures and increase procedural safety. New image processing software with integrated pixel shift functions has been reported to be beneficial in dose reduction, but current literature mainly focuses on cardiac, paediatric, or neuroradiological procedures.[5–7] For complex endovascular aortic procedures, few investigations have shown this beneficial effect.[8] This study investigates radiation exposure differences during complex endovascular aortic procedures for the patient and the medical staff, investigating different acquisition systems and operator positions, as well as procedure and patient specific parameters.

Recent European Society for Vascular Surgery (ESVS) guidelines state that radiation exposure has emerged as a potentially major occupational hazard in modern vascular surgery, causing safety concerns for healthcare workers and

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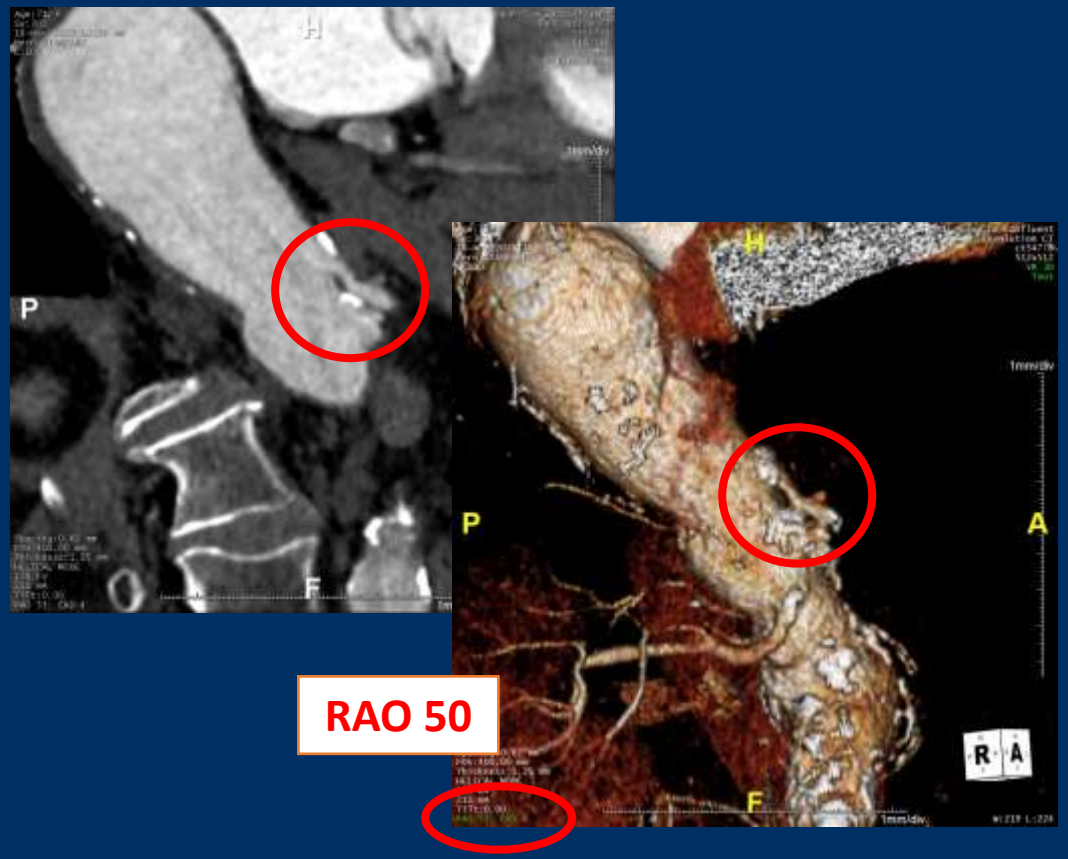
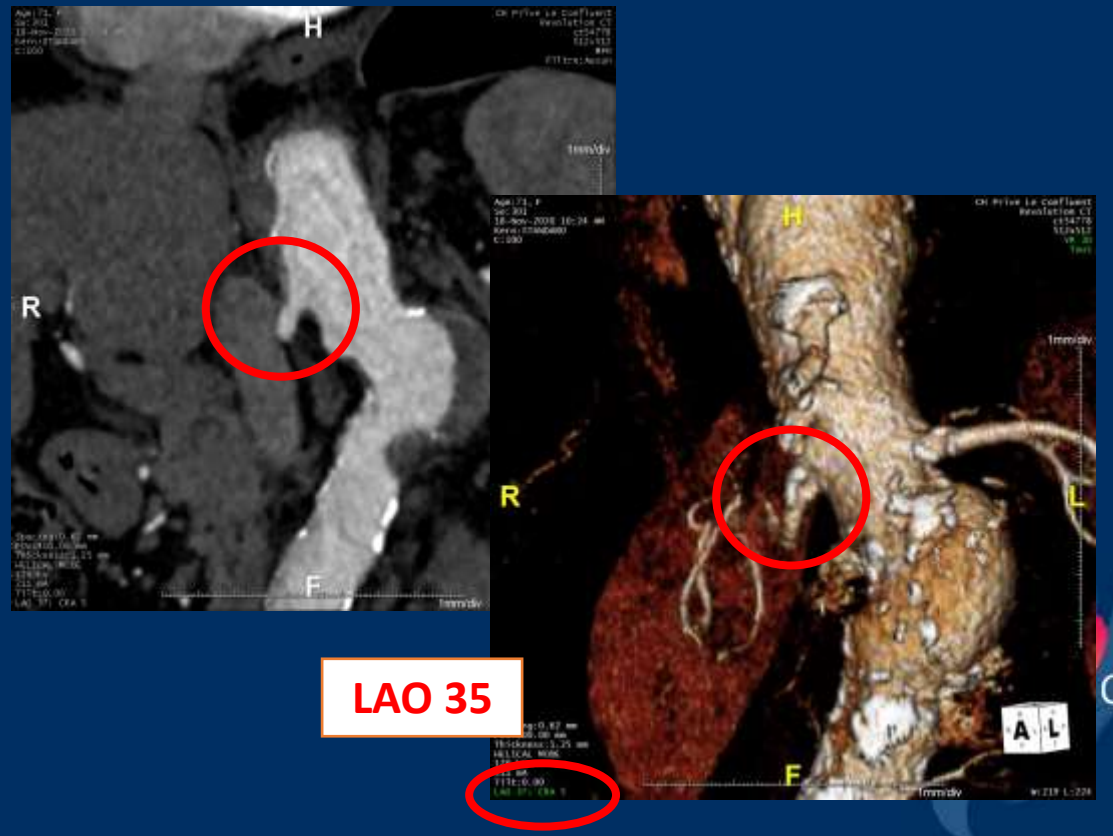
PRE-OPERATIVE PLANNING

PRE OPERATIVE PLANNING

- Pre op registration of target vessels angulations





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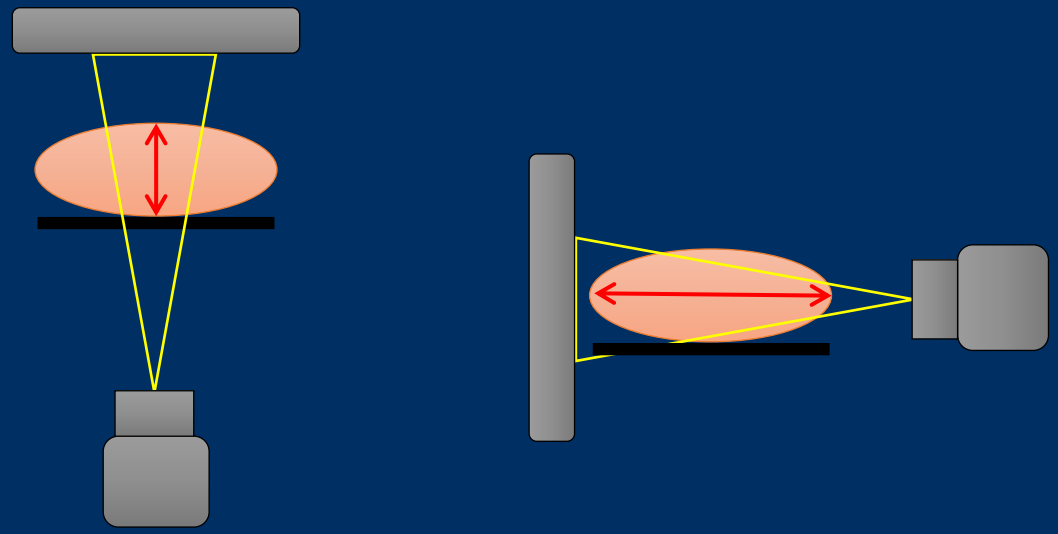
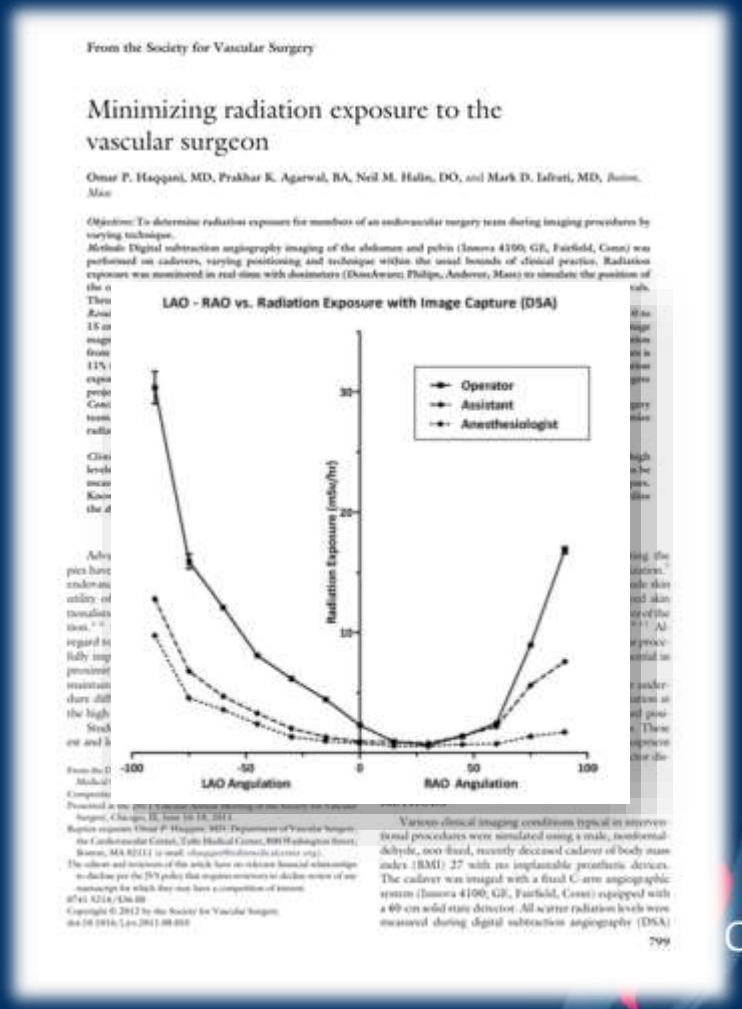
DURING THE PROCEDURE : ALARA principles

OPERATOR‘S EXPERTISE : ALARA

Reduction of the dose

- **Limit steep angulation and go back to AP**





From the Society for Vascular Surgery

Minimizing radiation exposure to the vascular surgeon

Omar P. Haqqani, MD, Prakhar K. Agarwal, BA, Neil M. Hallin, DO, and Mark D. Iafrati, MD, *Boston, Mass*

Objectives: To determine radiation exposure for members of an endovascular surgery team during imaging procedures by varying technique.

Methods: Digital subtraction angiography imaging of the abdomen and pelvis (Innova 4100; GE, Fairfield, Conn) was performed on cadavers, varying positioning and technique within the usual bounds of clinical practice. Radiation exposure was monitored in real-time with dosimeters (DoseAware; Philips, Andover, Mass) to simulate the position of

Various clinical imaging conditions typical in interventional procedures were simulated using a male, nonformaldehyde, non-fixed, recently deceased cadaver of body mass index (BMI) 27 with no implantable prosthetic devices. The cadaver was imaged with a fixed C-arm angiographic system (Innova 4100; GE, Fairfield, Conn) equipped with a 40-cm solid state detector. All scatter radiation levels were measured during digital subtraction angiography (DSA)

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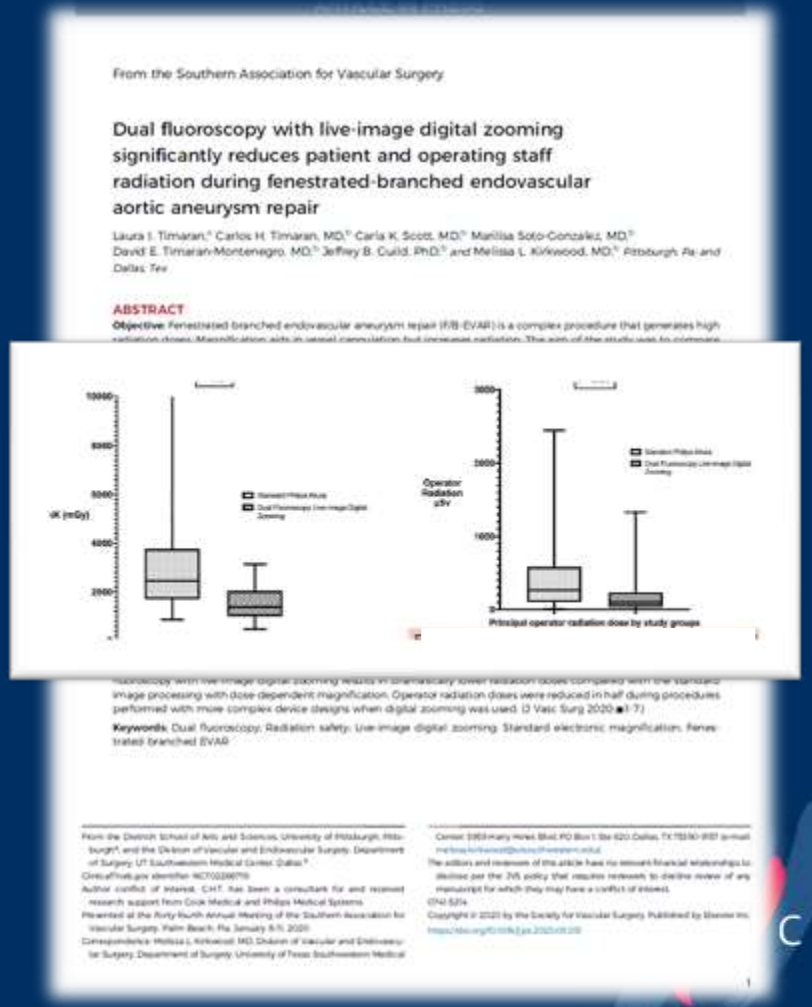
OPERATOR‘S EXPERTISE : ALARA

Reduction of the dose

- **Maximum collimation combined with digital zoom**



From the Southern Association for Vascular Surgery

Dual fluoroscopy with live-image digital zooming significantly reduces patient and operating staff radiation during fenestrated-branched endovascular aortic aneurysm repair

Laura I. Timaran,[a] Carlos H. Timaran, MD,[b] Carla K. Scott, MD,[b] Marilisa Soto-Gonzalez, MD,[b] David E. Timaran-Montenegro, MD,[b] Jeffrey B. Cuild, PhD,[b] and Melissa L. Kirkwood, MD,[b] Pittsburgh, Pa, and Dallas, Tex

ABSTRACT

Objective: Fenestrated branched endovascular aneurysm repair (F/B-EVAR) is a complex procedure that generates high

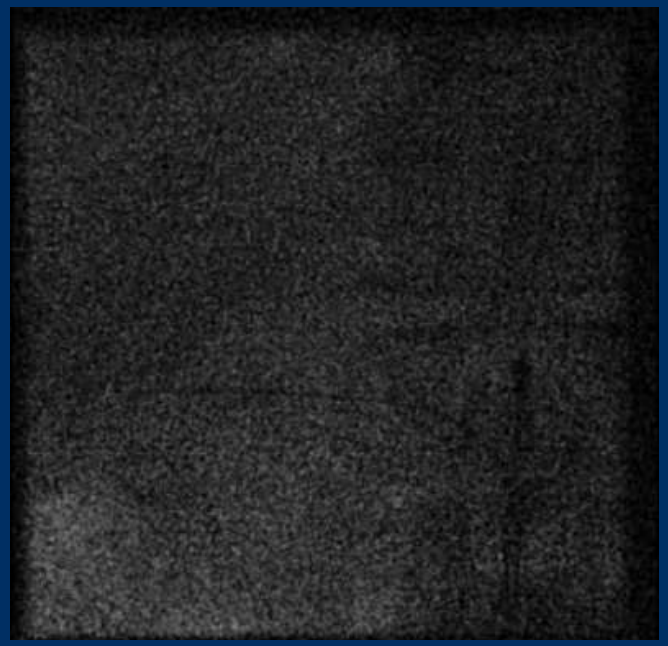
image processing with dose-dependent magnification. Operator radiation doses were reduced in half during procedures performed with more complex device designs when digital zooming was used. (J Vasc Surg 2020;■:1-7.)

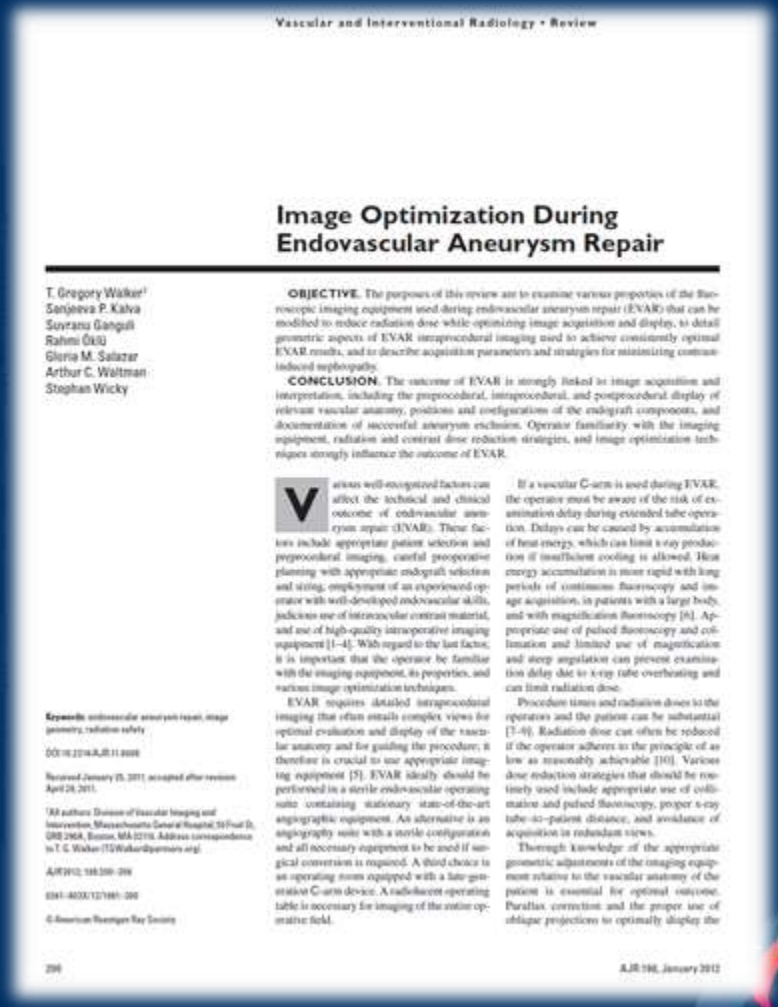
Keywords: Dual fluoroscopy; Radiation safety; Live-image digital zooming; Standard electronic magnification; Fenestrated branched EVAR

OPERATOR‘S EXPERTISE : ALARA

Reduction of the dose

- Replace DSA by fluoro loops





Vascular and Interventional Radiology • Review

Image Optimization During Endovascular Aneurysm Repair

T. Gregory Walker
Sanjeeva P. Kalva
Suvranu Ganguli
Rahmi Öklü
Gloria M. Salazar
Arthur C. Waltman
Stephan Wicky

OBJECTIVE. The purposes of this review are to examine various properties of the fluoroscopic imaging equipment used during endovascular aneurysm repair (EVAR) that can be modified to reduce radiation dose while optimizing image acquisition and display, to detail geometric aspects of EVAR intraprocedural imaging used to achieve consistently optimal EVAR results, and to describe acquisition parameters and strategies for minimizing contrast-induced nephropathy.

CONCLUSION. The outcome of EVAR is strongly linked to image acquisition and interpretation, including the preprocedural, intraprocedural, and postprocedural display of relevant vascular anatomy, positions and configurations of the endograft components, and documentation of successful aneurysm exclusion. Operator familiarity with the imaging equipment, radiation and contrast dose reduction strategies, and image optimization techniques strongly influence the outcome of EVAR.

Various well-recognized factors can affect the technical and clinical outcome of endovascular aneurysm repair (EVAR). These factors include appropriate patient selection and preprocedural imaging, careful preoperative planning with appropriate endograft selection and sizing, employment of an experienced operator with well-developed endovascular skills, judicious use of intravascular contrast material, and use of high-quality intraoperative imaging equipment [1–4]. With regard to the last factor, it is important that the operator be familiar with the imaging equipment, its properties, and various image optimization techniques.

EVAR requires detailed intraprocedural imaging that often entails complex views for optimal evaluation and display of the vascular anatomy and for guiding the procedure; it therefore is crucial to use appropriate imaging equipment [5]. EVAR ideally should be performed in a sterile endovascular operating suite containing stationary state-of-the-art angiographic equipment. An alternative is an angiography suite with a sterile configuration and all necessary equipment to be used if surgical conversion is required. A third choice is an operating room equipped with a late-generation C-arm device. A radiolucent operating table is necessary for imaging of the entire operative field.

If a vascular C-arm is used during EVAR, the operator must be aware of the risk of exposure delay during extended tube operation. Delays can be caused by accumulation of heat energy, which can limit x-ray production if insufficient cooling is allowed. Heat energy accumulation is more rapid with long periods of continuous fluoroscopy and image acquisition, in patients with a large body, and with magnification fluoroscopy [6]. Appropriate use of pulsed fluoroscopy and collimation and limited use of magnification and steep angulation can prevent examination delay due to x-ray tube overheating and can limit radiation dose.

Procedure times and radiation doses to the operators and the patient can be substantial [7–9]. Radiation dose can often be reduced if the operator adheres to the principle of as low as reasonably achievable [10]. Various dose reduction strategies that should be routinely used include appropriate use of collimation and pulsed fluoroscopy, proper x-ray tube–to–patient distance, and avoidance of acquisition in redundant views.

Thorough knowledge of the appropriate geometric adjustments of the imaging equipment relative to the vascular anatomy of the patient is essential for optimal outcome. Parallax correction and the proper use of oblique projections to optimally display the

Keywords: endovascular aneurysm repair, image geometry, radiation safety

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0361–803X/12/1981–299

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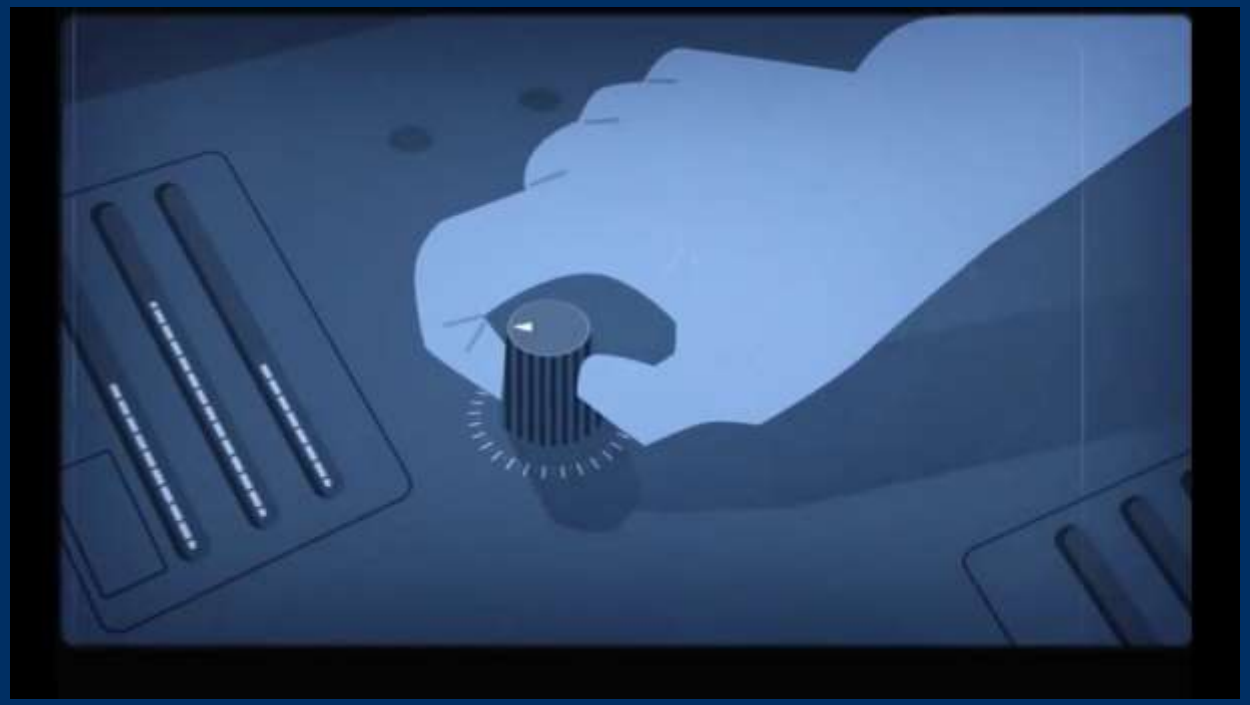
AJR:198, January 2012

OPERATOR‘S EXPERTISE : ALARA

Reduction of the number of images

- **Limit the pedal time**
- **Use low dose settings by default**
- **Adjust table and C-arm positioning on the area of interest without X-rays, using fusion imaging**



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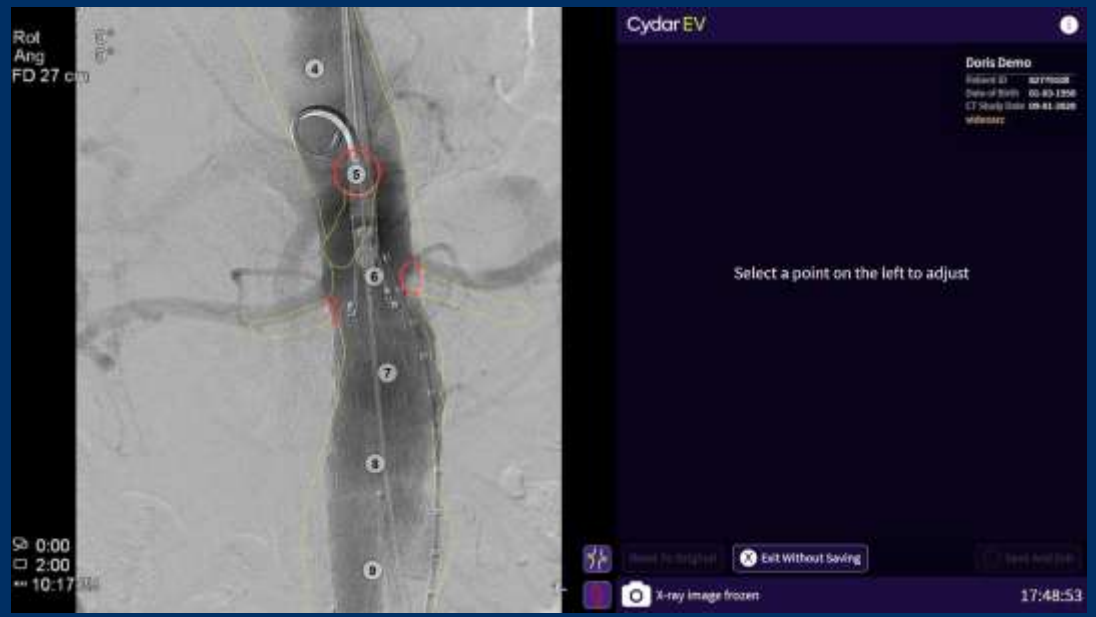
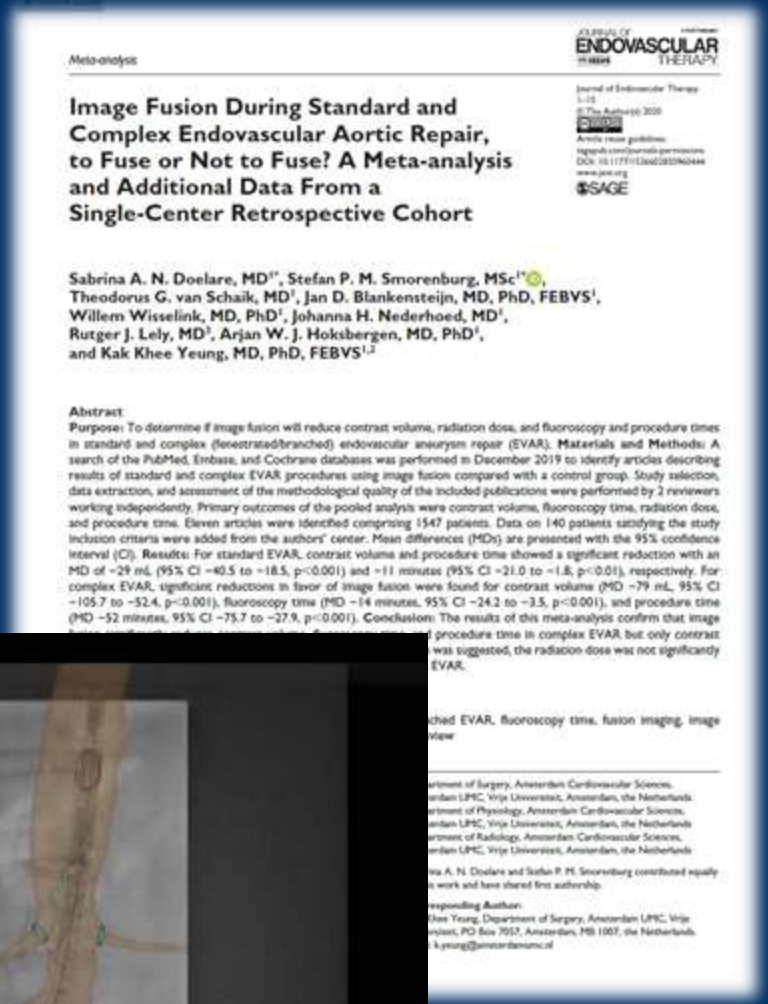
ADVANCED IMAGING SYSTEMS AND ALTERNATIVE TO X-RAYS

FUSION IMAGING

- Reduces contrast volume, fluoroscopy time, and procedure time in complex EVAR
- Must be adjustable : translation or deformation





Meta-analysis

JOURNAL OF ENDOVASCULAR THERAPY

Image Fusion During Standard and Complex Endovascular Aortic Repair, to Fuse or Not to Fuse? A Meta-analysis and Additional Data From a Single-Center Retrospective Cohort

Journal of Endovascular Therapy

SAGE

Sabrina A. N. Doelare, MD[1*], Stefan P. M. Smorenburg, MSc[1*], Theodorus G. van Schaik, MD[1], Jan D. Blankensteijn, MD, PhD, FEBVS[1], Willem Wisselink, MD, PhD[1], Johanna H. Nederhoed, MD[1], Rutger J. Lely, MD[1], Arjan W. J. Hoksbergen, MD, PhD[1], and Kak Khee Yeung, MD, PhD, FEBVS[1,2]

Abstract

Purpose: To determine if image fusion will reduce contrast volume, radiation dose, and fluoroscopy and procedure times in standard and complex (fenestrated/branched) endovascular aneurysm repair (EVAR). **Materials and Methods:** A search of the PubMed, Embase, and Cochrane databases was performed in December 2019 to identify articles describing results of standard and complex EVAR procedures using image fusion compared with a control group. Study selection, data extraction, and assessment of the methodological quality of the included publications were performed by 2 reviewers working independently. Primary outcomes of the pooled analysis were contrast volume, fluoroscopy time, radiation dose, and procedure time. Eleven articles were identified comprising 1547 patients. Data on 140 patients satisfying the study inclusion criteria were added from the authors' center. Mean differences (MDs) are presented with the 95% confidence interval (CI). **Results:** For standard EVAR, contrast volume and procedure time showed a significant reduction with an MD of −29 mL (95% CI −40.5 to −18.5, p<0.001) and −11 minutes (95% CI −21.0 to −1.8, p<0.01), respectively. For complex EVAR, significant reductions in favor of image fusion were found for contrast volume (MD −79 mL, 95% CI −105.7 to −52.4, p<0.001), fluoroscopy time (MD −14 minutes, 95% CI −24.2 to −3.5, p<0.001), and procedure time (MD −52 minutes, 95% CI −75.7 to −27.9, p<0.001). **Conclusion:** The results of this meta-analysis confirm that image [illegible] procedure time in complex EVAR but only contrast [illegible] was suggested, the radiation dose was not significantly [illegible] EVAR.

[illegible]ched EVAR, fluoroscopy time, fusion imaging, image [illegible]view

[illegible]artment of Surgery, Amsterdam Cardiovascular Sciences, [illegible]erdam UMC, Vrije Universiteit, Amsterdam, the Netherlands [illegible]artment of Physiology, Amsterdam Cardiovascular Sciences, [illegible]erdam UMC, Vrije Universiteit, Amsterdam, the Netherlands [illegible]artment of Radiology, Amsterdam Cardiovascular Sciences, [illegible]erdam UMC, Vrije Universiteit, Amsterdam, the Netherlands

[illegible]ia A. N. Doelare and Stefan P. M. Smorenburg contributed equally [illegible] work and have shared first authorship.

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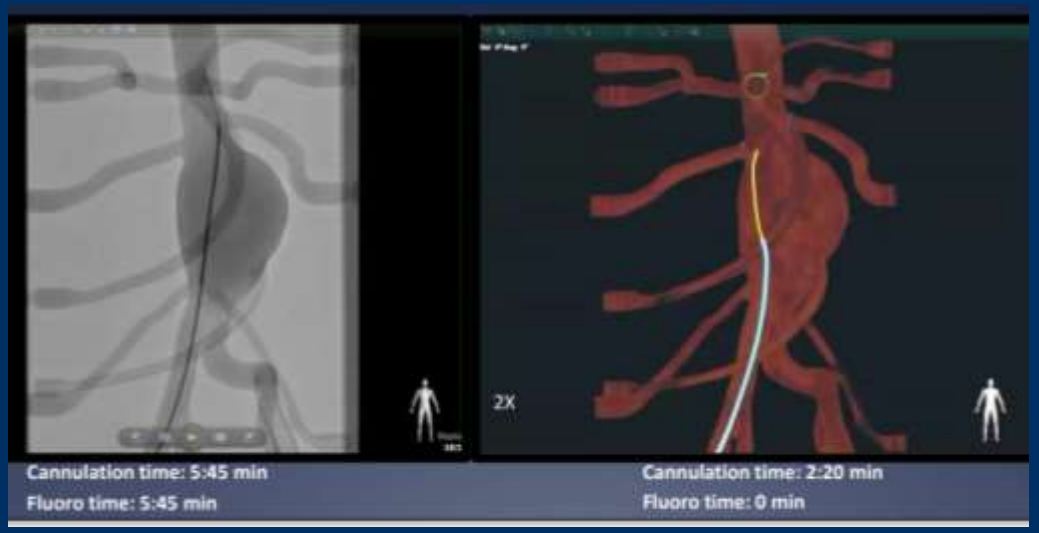
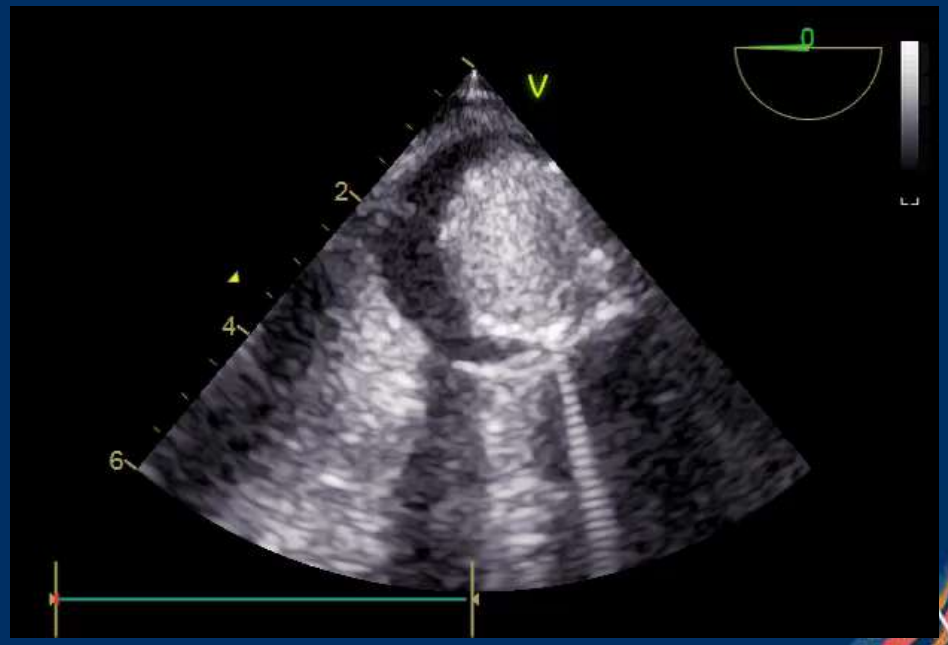
[illegible]k.yeung@amsterdamumc.nl

ALTERNATIVE IMAGING MODALITIES

- Contrast enhanced ultrasound
- Contrast enhanced trans-esophageal echocardiography
- IVUS
- FORS





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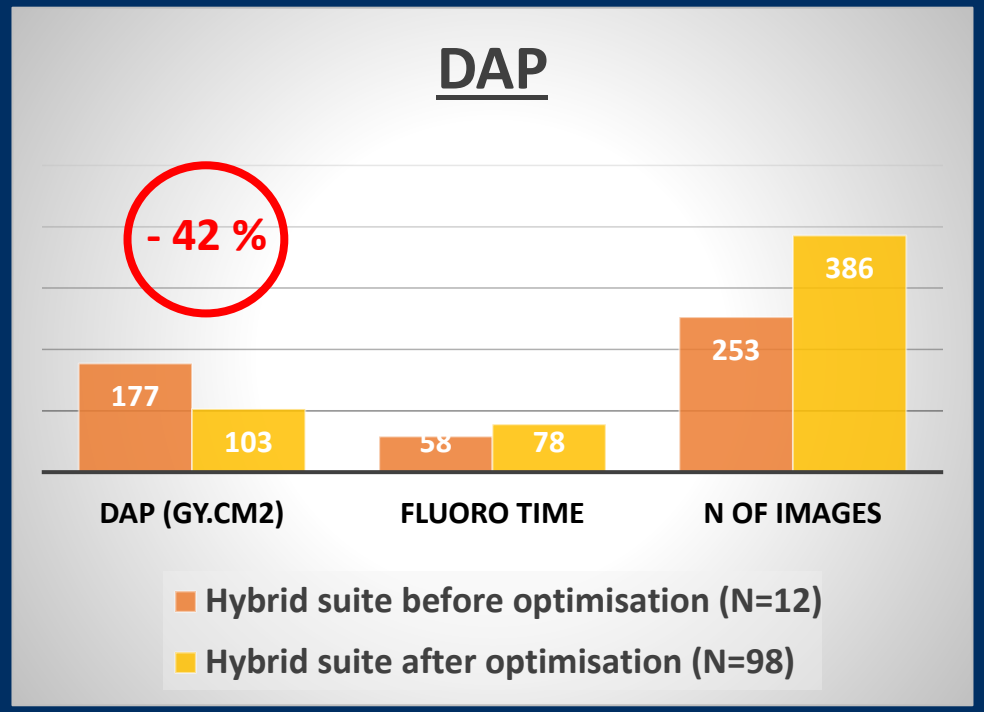
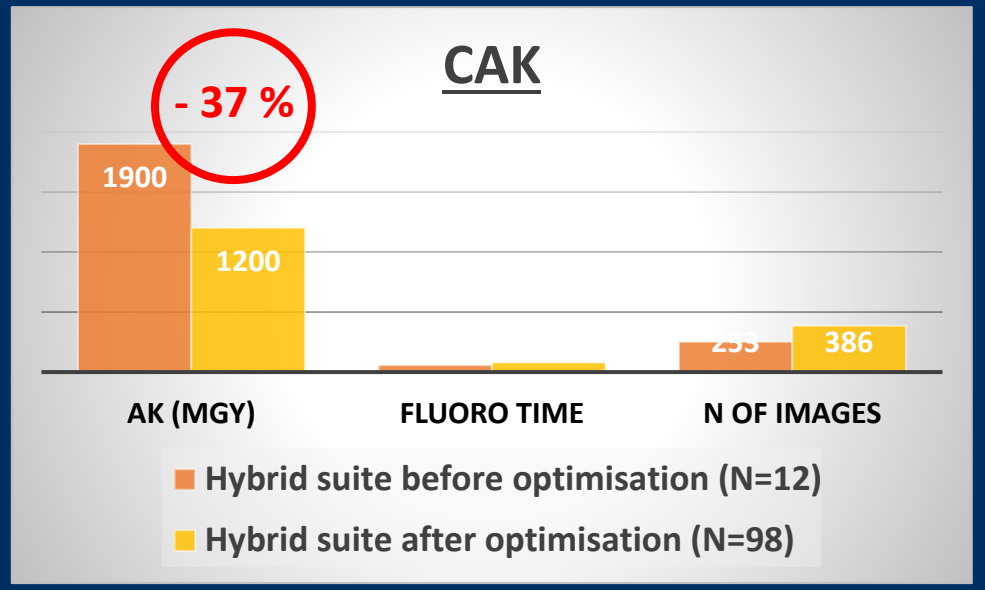
OUR EXPERIENCE

Our experience before / after optimisation of the hybride suite during FBEVAR





TAKE HOME MESSAGE

- Settings optimisation to work by default with the lowest dose for an acceptable image quality
- Imaging environment : hybrid suite with large monitor
- Application of the ALARA principles
- Alternative to X-rays


"DANS LA VIE
RIEN N'EST À CRAINDRE...
...TOUT EST À COMPRENDRE"
MARIE CURIE

THANK YOU