SRES
SURGICAL & RADIOLOGICAL ENDOVASCULAR SYMPOSIUM
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Centre de congrès
Oustau Calendal
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26 & 27 septembre
2024
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Débats / Controverses

Radioprotection : technique et résultats.

Débats ~~/ Controverses~~

~~**Radioprotection : technique et résultats.**~~

Exposition aux rayons X : Jusqu'où est-il acceptable d'aller?

Nord Vasculaire
Lille Métropole

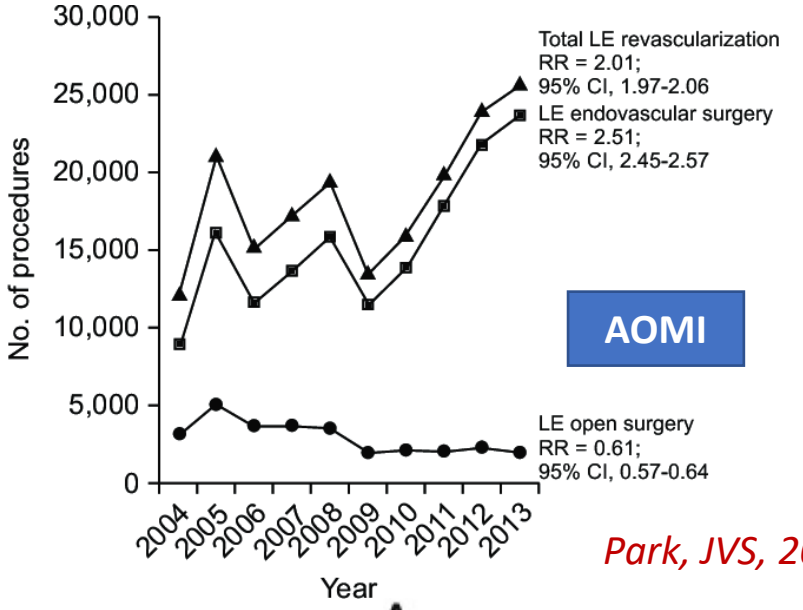
Marc Antoine VASSEUR

Martin ROUER

Adrien HERTAULT

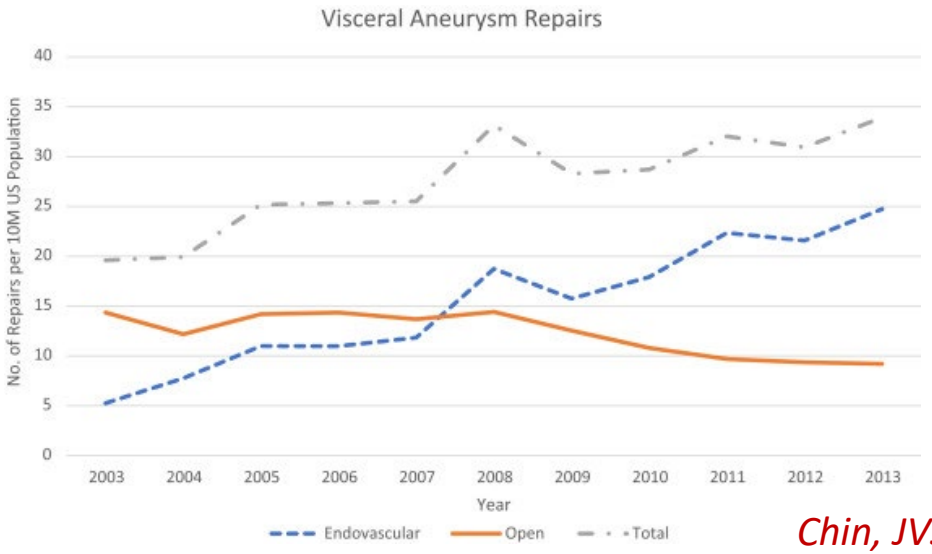
Teresa MARTIN-GONZALEZ

De plus en plus de procédures..



AOMI

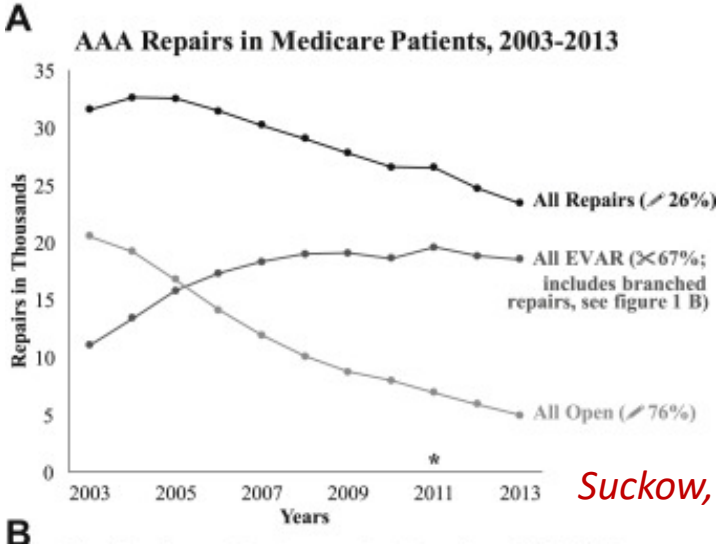
Park, JVS, 2017



ADA

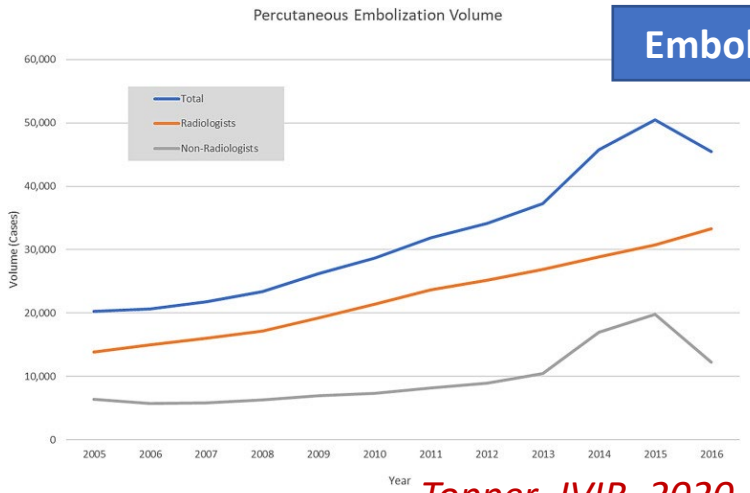
Chin, JVS, 2017

AAA



Suckow, JVS, 2018

Embolisation



Topper, JVIR, 2020

De plus en plus complexes

Arceau Mobile

Salle Hybride

Associées à un risque biologique

Effets déterministes

SEUIL

Sévérité corrélée à l'intensité

Prédictible

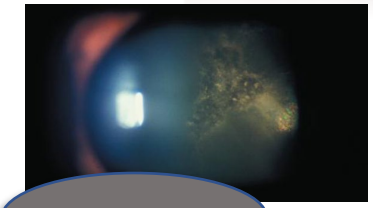
Sévérité prédictible

Dermite radique

Patient

Incidence 1/10 000 to 1/100 000

Incidence réelle = inconnue….



Soignant

Apparition décalée

Sur le dos

Peu connu

Effets stochastiques

PAS DE SEUIL

Sévérité non associée à l'intensité

Survenue non prévisible

Sévérité non prévisible

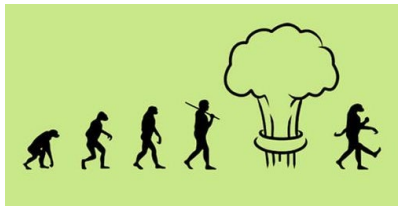
Occurrence augmente avec l'âge

Risque maintenu sur l'espérance de vie

Cancer solide et Leucémie

Malformations dans la descendance

Incidence??



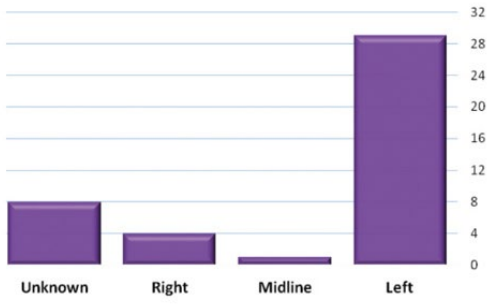
Soignants

Patient

Effets Stochastiques

Brain and Neck Tumors Among Physicians Performing Interventional Procedures

Ariel Roguin, MD, PhD[a,*], Jacob Goldstein, MD[b], Olivier Bar, MD[c], and James A. Goldstein, MD[d]



31 cases

Incidence > Population Gen.?

Roguin Am J Cardiol 2013

Somatic DNA damage in interventional cardiologists: a case-control study

Maria Grazia Andreassi,* Angelo Cioppa,† Nicoletta Botto,* Gordana Joksic,‡
Samantha Manfredi,* Chiara Federici,* Miodrag Ostojic,‡ Paolo Rubino,† and Eugenio Picano*,†

31 cardiologues interventionnels

vs .

31 cardiologues médicaux appariés

→ Altération ADN

→ Années de pratique

Andreassi FASEB 2005

Effets Stochastiques

Radiation-Induced DNA Damage in Operators Performing Endovascular Aortic Repair

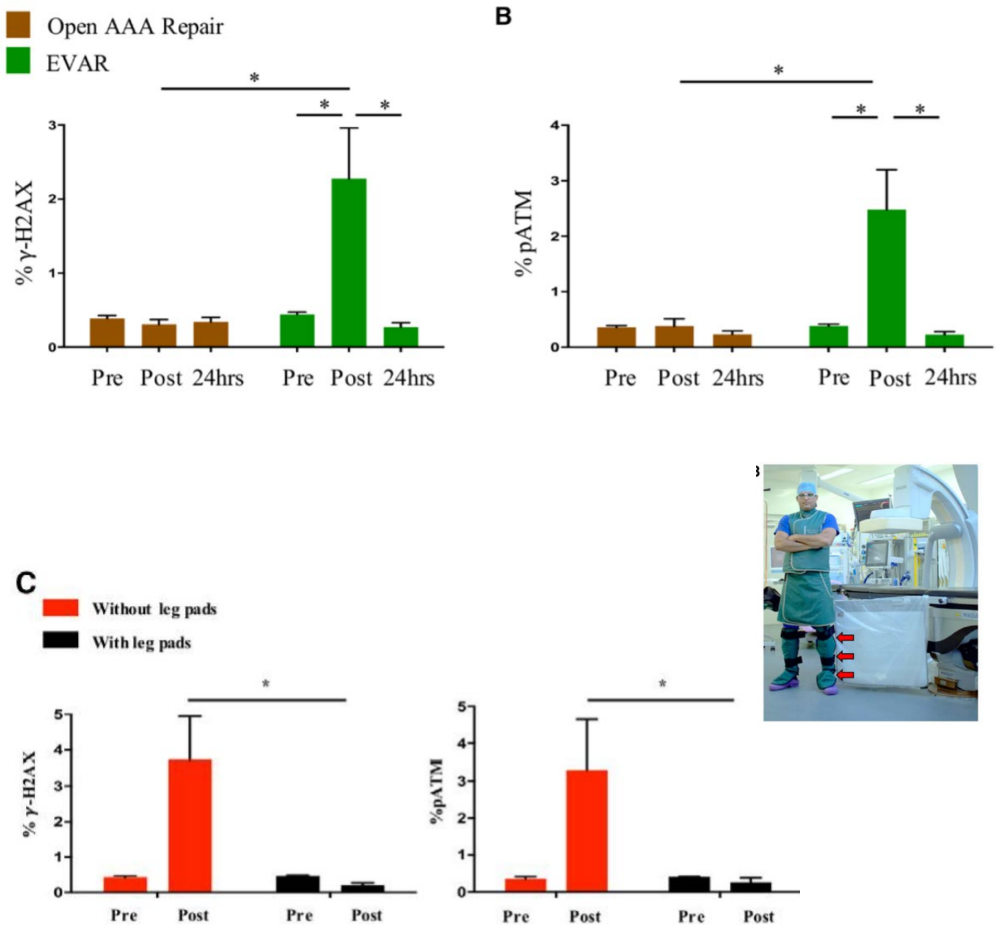
Editorial, see p 2417

BACKGROUND: Radiation exposure during fluoroscopically guided interventions such as endovascular aortic repair (EVAR) is a growing concern for operators. This study aimed to measure DNA damage/repair markers in operators perfoming EVAR.

METHODS: Expression of the DNA damage/repair marker, γ-H2AX and DNA damage response marker, phosphorylated ataxia telangiectasia mutated (pATM), were quantified in circulating lymphocytes in operators during the peri-operative period of endovascular (infrarenal, branched, and fenestrated) and open aortic repair using flow cytometry. These markers were separately measured in the same operators but this time wearing leg lead shielding in addition to upper body protection and compared with those operating with unprotected legs. Susceptibility to radiation damage was determined by irradiating operators' blood in vitro.

RESULTS: γ-H2AX and pATM levels increased significantly in operators immediately after branched endovascular aortic repair/fenestrated endovascular aortic repair ($P<0.0003$ for both). Only pATM levels increased after infrarenal endovascular aortic repair ($P<0.04$). Expression of both markers fell to baseline in operators after 24 hours ($P<0.003$ for both). There was no change in γ-H2AX or pATM expression after open repair. Leg protection abrogated γ-H2AX and pATM response after branched endovascular aortic repair/fenestrated endovascular aortic repair. The expression of γ-H2AX varied significantly when operators' blood was exposed to the same radiation dose in vitro ($P<0.0001$).

CONCLUSIONS: This is the first study to detect an acute DNA damage response in operators performing fluoroscopically guided aortic procedures and highlights the protective effect of leg shielding. Defining the relationship between this response and cancer risk may better inform safe levels of chronic low-dose radiation exposure.



El-Sayed, Circ., 2017

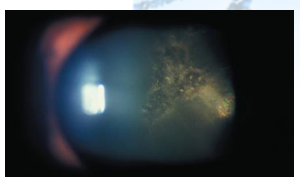
Quelles justifications aux risques?

Balance Bénéfices/Risques

Aucune concession possible

- Diagnostiquer
- Traiter
- Soulager
- Prévenir

- La vocation
- La reconnaissance
- L'estime de soi
- Le salaire



Quelles justifications aux risques?

Pathologies fonctionnelles

Patients jeunes

Eur J Vasc Endovasc Surg (xxxx) xxx, xxx

EJVES Open Access

CLINICAL PRACTICE GUIDELINE DOCUMENT

European Society for Vascular Surgery (ESVS) 2023 Clinical Practice Guidelines on Radiation Safety☆

Bijan Modarai [a,*], Stéphan Haulon [a], Elizabeth Ainsbury [a], Dittmar Böckler [a], Eliseo Vano-Carruana [a], Joseph Dawson [a], Mark Farber [a], Isabelle Van Herzeele [a], Adrien Hertault [a], Joost van Herwaarden [a], Ashish Patel [a], Anders Wanhainen [a], Salome Weiss [a]

ESVS Guidelines Committee [b], Frederico Bastos Gonçalves, Martin Björck, Nabil Chakfé, Gert J. de Borst, Raphaël Coscas, Nuno V. Dias, Florian Dick, Robert J. Hinchliffe, Stavros K. Kakkos, Igor B. Koncar, Philippe Kolh, Jes S. Lindholt, Santi Trimarchi, Riikka Tulamo, Christopher P. Twine, Frank Vermassen

Document Reviewers [c], Klaus Bacher, Elias Brountzos, Fabrizio Fanelli, Liliana A. Fidalgo Domingos, Mauro Gargiulo, Kevin Mani, Tara M. Mastracci, Blandine Maurel, Robert A. Morgan, Peter Schneider

Comment je gère au quotidien?

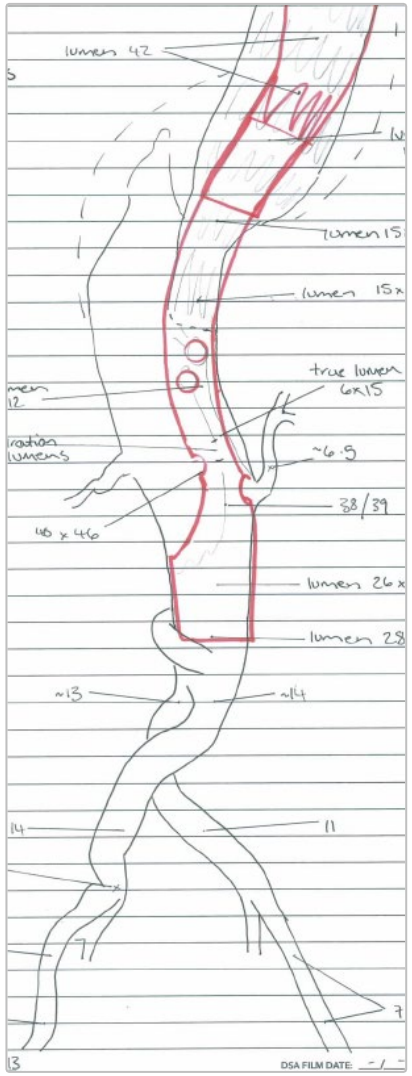
Balance Bénéfices/Risques = **Balance Qualité Image/Dose**

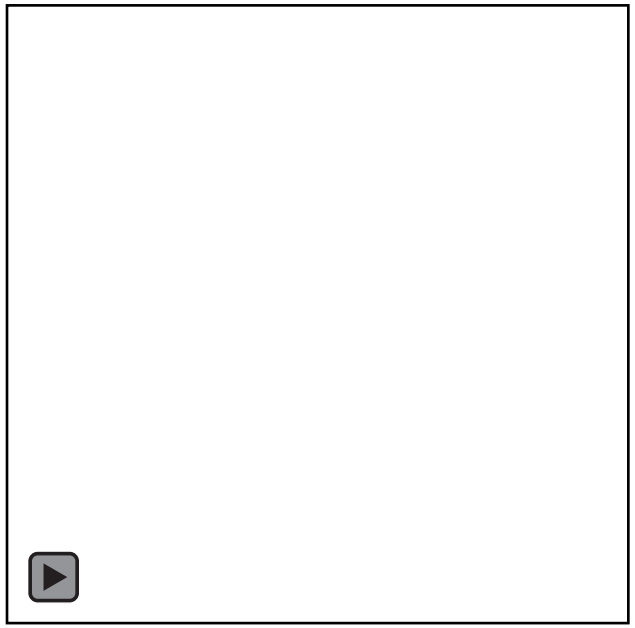
Principe « ALARA »

- **Règles de bonne pratique**
- **Avancées technologiques**

« As Low As Reasonably Achievable »

Avant la procédure





Planning sur console de reconstruction

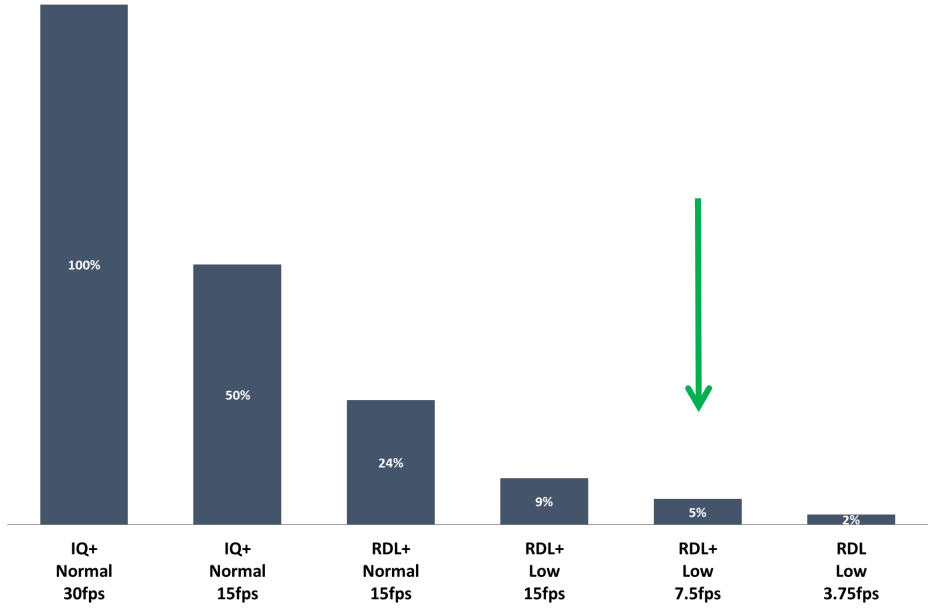
Réduire la dose émise

Temps de scopie

Enlever son pied de la pédale

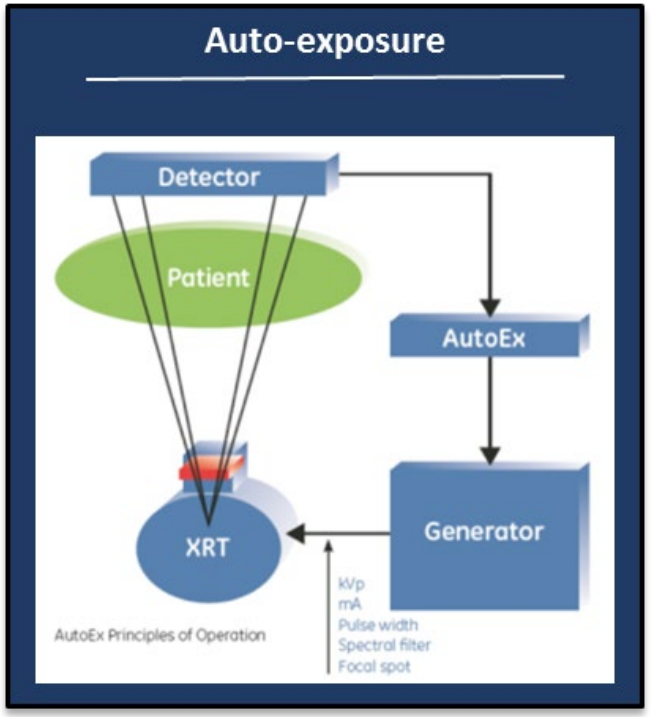
Ne prendre que les images utiles

20 fps

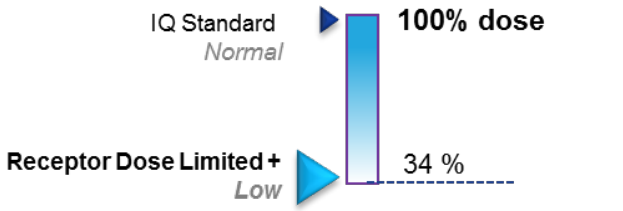


Réduire la dose émise

Réglages “usine”

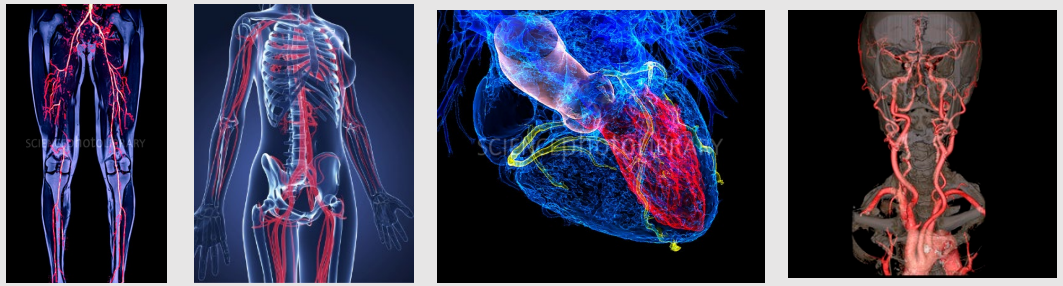


Auto kV, mA settings (Acq. protocol)
& Normal/Low dose setting (table side control)



Ratio Qualité d’image/Dose

Définir des protocoles dédiés



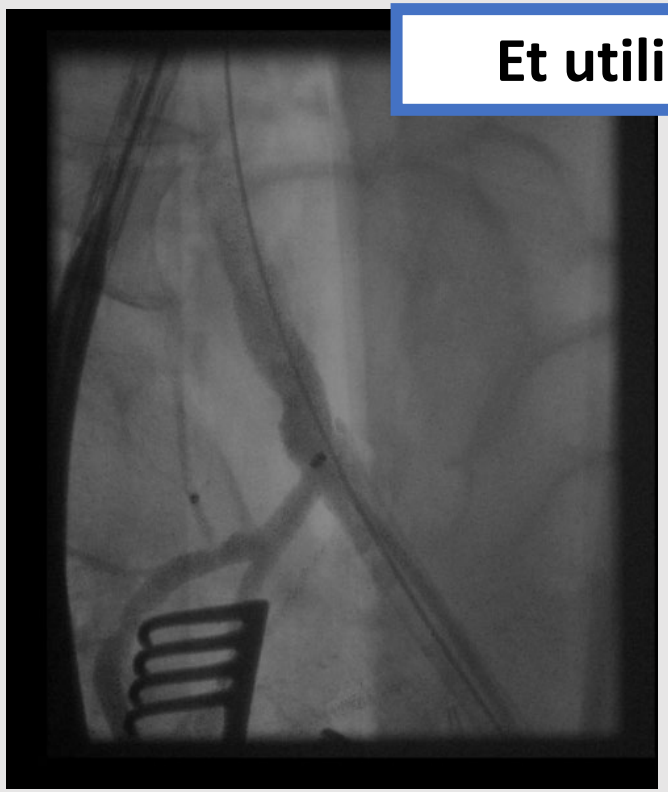
Réduire la dose émise

Modes de scopie

1 DSA image ~ 500 fluoro images

Fluoro enregistrée numériquement

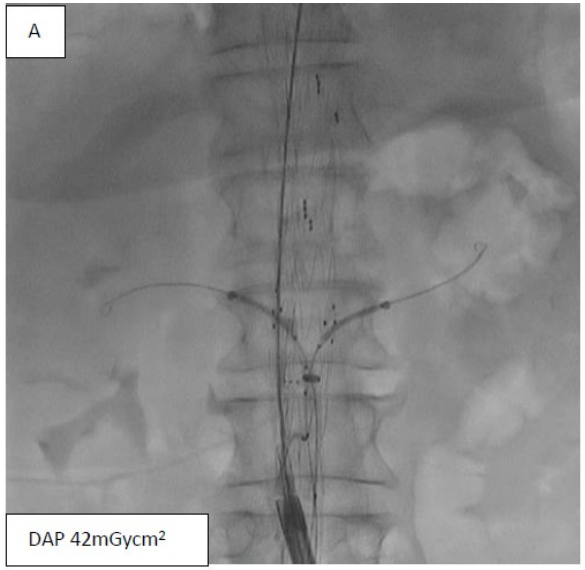
Et utilisée pour les masques



Réduire la dose émise

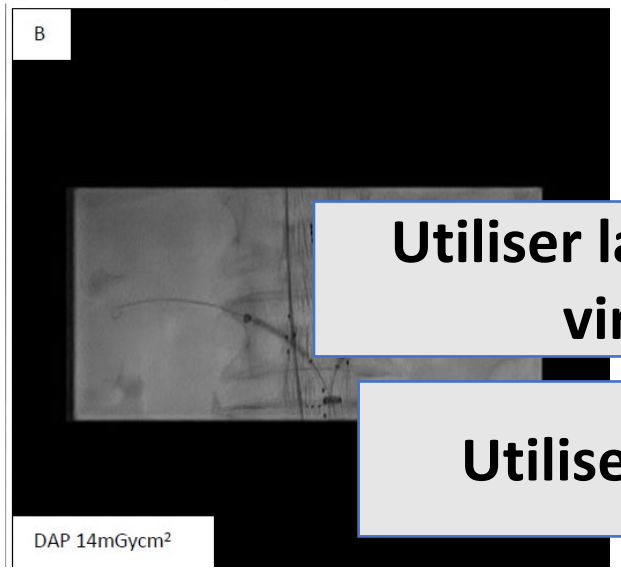
Collimation

Reduction proportionnelle à la surface



Diminue le scatter

Divisée par 3

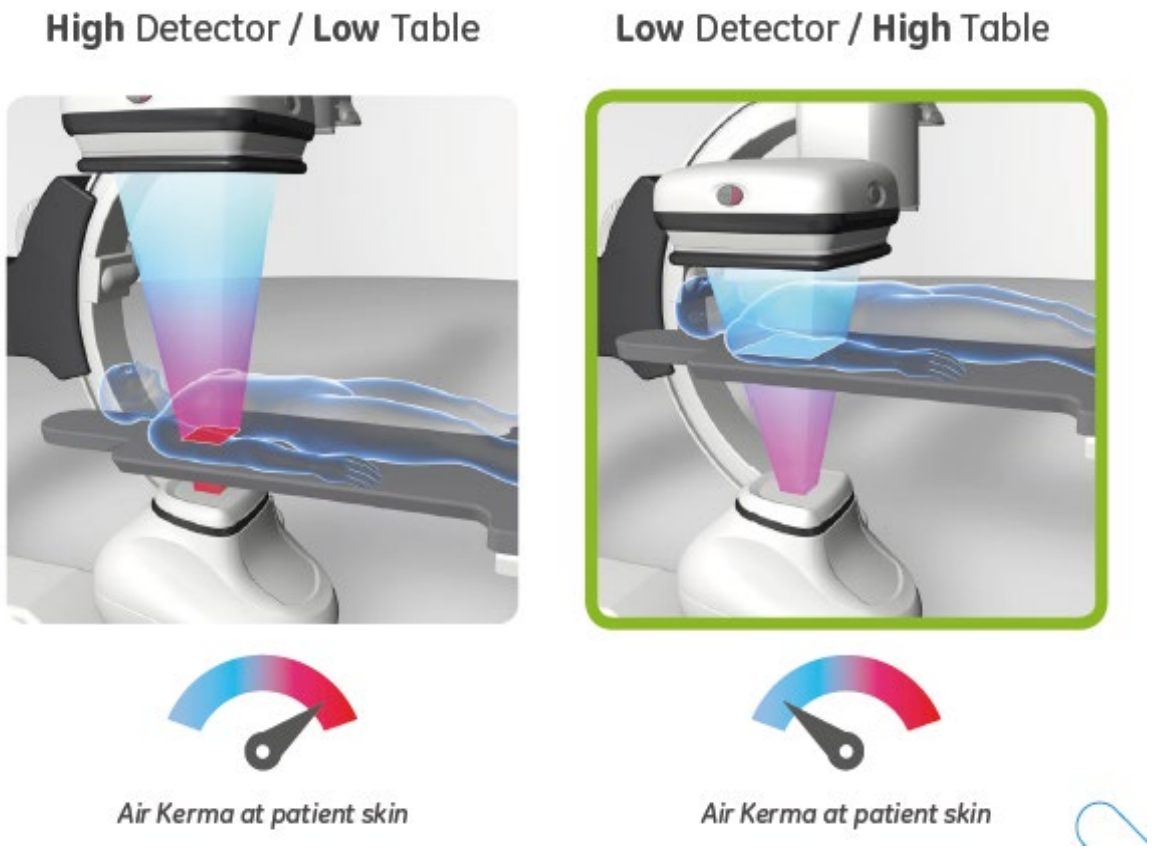


Utiliser la collimation virtuelle

Utiliser la fusion

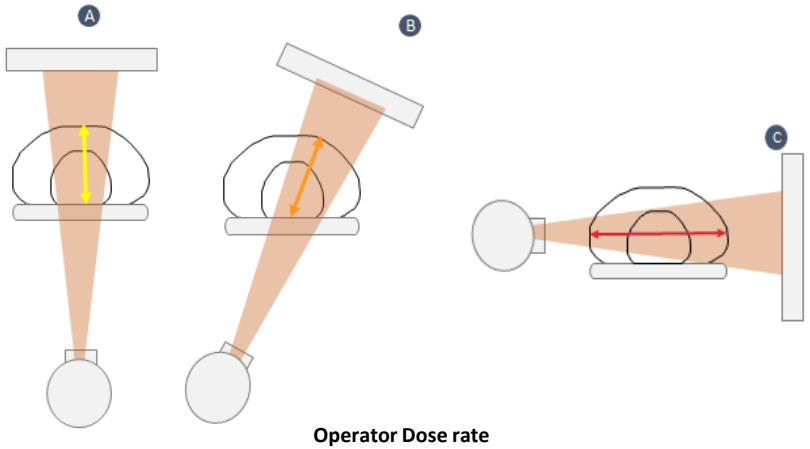
Réduire la dose émise

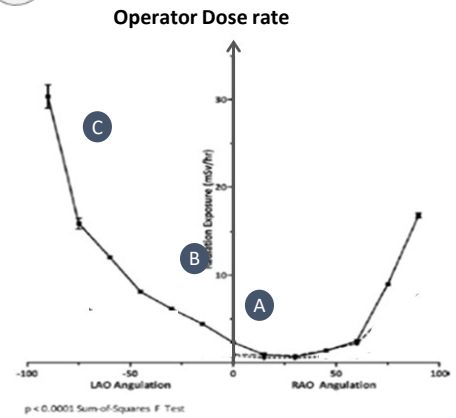
Gestion de la géométrie de la chaine image



Réduire la dose émise

Gestion des angulations





Technologies de reduction de la dose

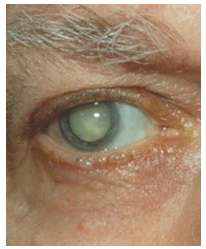
Magnification & Zoom Virtuel

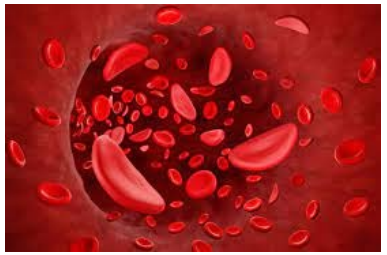
Utilisation de dalle

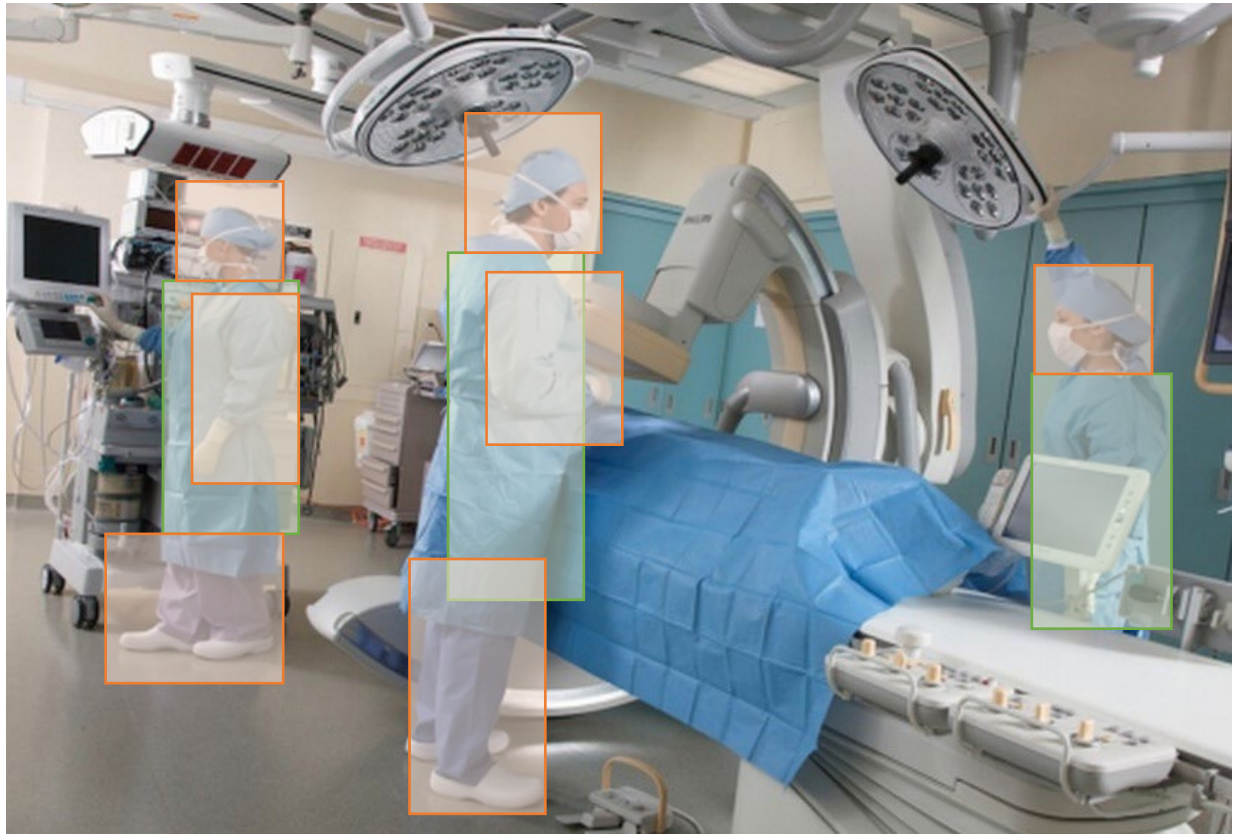
Technologies de reduction de la dose

Utilisation de la fusion d’images

Se Protéger







Les résultats - Etude #1

UseFluoro/DSA

Limit time on pedal

Use Collimation

Avoid Magnification

Avoid Angulations

Control your system geometry

Evaluation of Radiation during EVAR Performed on a Mobile C-arm CME

B. Maurel, J. Sobocinski, P. Perini, M. Guillou, M. Midulla, R. Azzaoui, S. Haulon*

Department of Vascular Surgery and Radiology, Hôpital Cardiologique, CHRU de Lille, France

WHAT THIS PAPER ADDS

- Attempts at reducing radiation exposure using collimators, pulsed fluoroscopy and short fluoroscopy times are mandatory during EVAR. Our study provides useful information regarding patient radiation exposure for simple and complex aortic EVAR.

A R T I C L E I N F O

Article history:
Received 22 July 2011
Accepted 14 September 2011
Available online 2 November 2011

Keywords:
Radiation
EVAR
Endograft

A B S T R A C T

Background: The aim of this study was to evaluate radiation exposure during aortic endovascular aneurysm repair (EVAR) on a mobile C-arm using a low dose and pulse mode.
Methods: We performed a retrospective analysis of a prospectively maintained database on patients undergoing EVAR. Indirect dose measurements of dose area product (DAP, mGy m^2) calculated by the C-arm (OEC 9900MD), fluoroscopic time (FT), type of procedure, contrast media volume and body mass index were analysed.
To confirm the correlation between direct and indirect DAP measurements, direct dose was measured with radiochromic films on a sample of 15 patients. Film grey level response was calibrated according to a reference dose measurement performed with a calibrated dosimeter. DAP and peak skin dose (PSD, Gy) were measured on each film. Correlation between DAP from direct and indirect measures, and between DAP and PSD, were analysed.
Results: From January 2009 to April 2011, 335 patients underwent EVAR. Complete data were available on 301 procedures including 188 bifurcated, 54 fenestrated, 28 thoracic, 20 branched and 11 aorto-uni-iliac endografts implantation. The respective median FT and DAP was 9.36 min (1.8–67) and 3 mGy m^2 (0.4–28); 27.2 min (2–69) and 7.3 mGy m^2 (1.2–29); 7.75 min (1.2–19.1) and 2 mGy m^2 (0.3–11); 42.98 min (2.4–95.4) and 15.95 mGy m^2 (2.98–77.7); 6.2 min (0.5–36.3) and 2 mGy m^2 (0.3–11). Direct DAP measurement on radiochromic films was strongly correlated with DAP values provided by the C-arm ($r = 0.98$). PSD correlated weakly with DAP.
DAP was significantly increased ($p < 0.001$) in patients with a body mass index >30. Contrast media volume was significantly increased in the branched endograft group.
Conclusion: Indirect DAP values measured by the C-arm are accurate to evaluate radiation exposure. Compared to the literature, our values for standard procedures are significantly decreased by the usage of low dose and pulse mode. DAP for fenestrated and branched procedures was comparable to published DAP values with standard procedures using a regular fluoroscopic mode.
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301 patients

30 Gy.cm²

Les résultats - Etude #2

Après 2012, utilisation d'une salle hybride

Impact de la fusion

Move gantry

Position table

Adjust Collimation

Reduce fluorotime

Decrease Dose

Reduce X-ray need

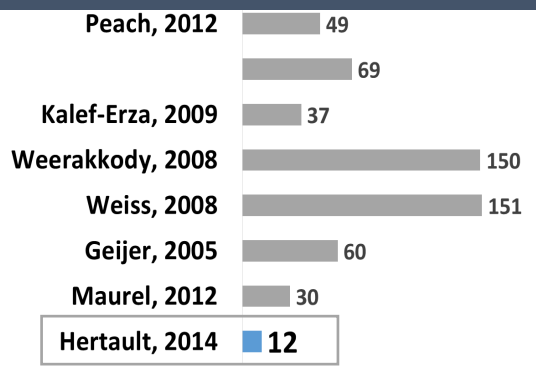
Les résultats - Etude #2

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

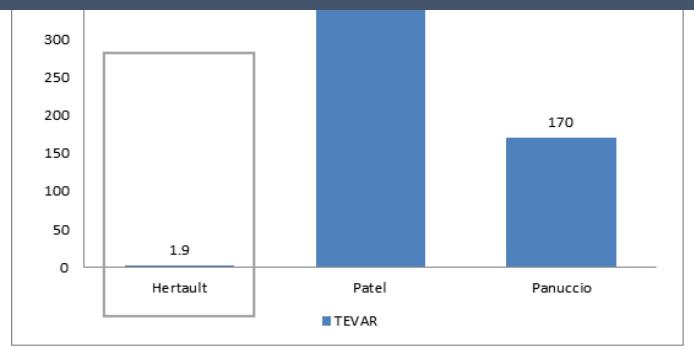
Operator exposure over the lead apron per procedure type

Procedure type	Median operator exposure (µSv)
Branched + four-fenestrated endografts	23.1 (6.3–248.0)
Two- or three-fenestrated endografts	9.1 (1.8–67.7)

Could these results be achievable elsewhere?



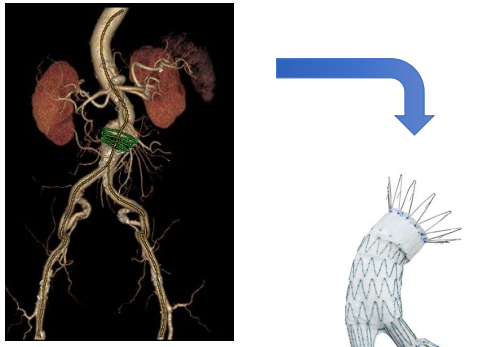
X 34 times

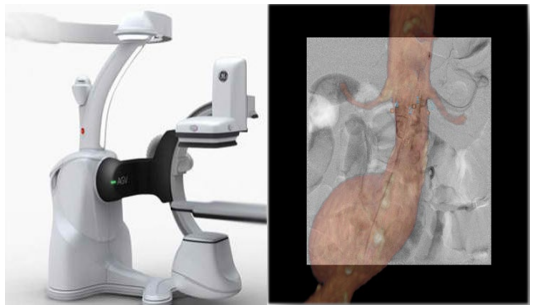


Patel Eur J Vasc Endovasc Surg. 2013
Panuccio J Vasc Surg 2011
Hertault, Eur J Vasc Endovasc Surg. 2014

Les résultats - Etude #3

MULTICENTRIC
REVAR Study





February 2016 → November 2016

Common Low Dose protocol

Image protocol: RDL+
Fluoro: 7,5 fps
DSA: 4 fps

Fusion Imaging training

Manual & Cloud-based data recording

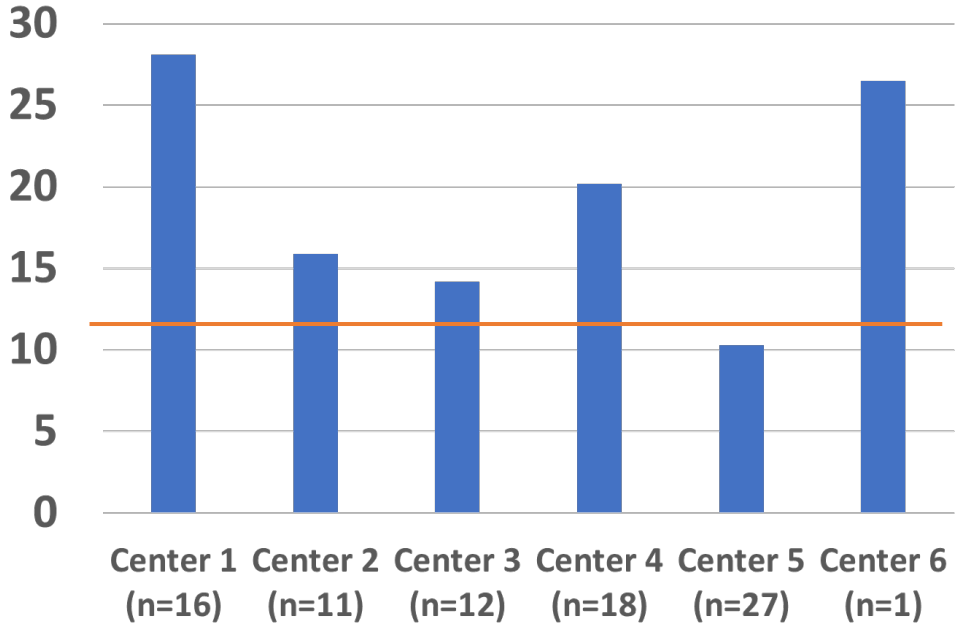
GE, Discovery IGS 730 or 740

Les résultats - Etude #3

Technical success	100%
Additional Procedures	11 patients

85 patients	
90.4% male	
75 yo	
BMI 27.4	
Time on WS	5 min
Registration	4 min

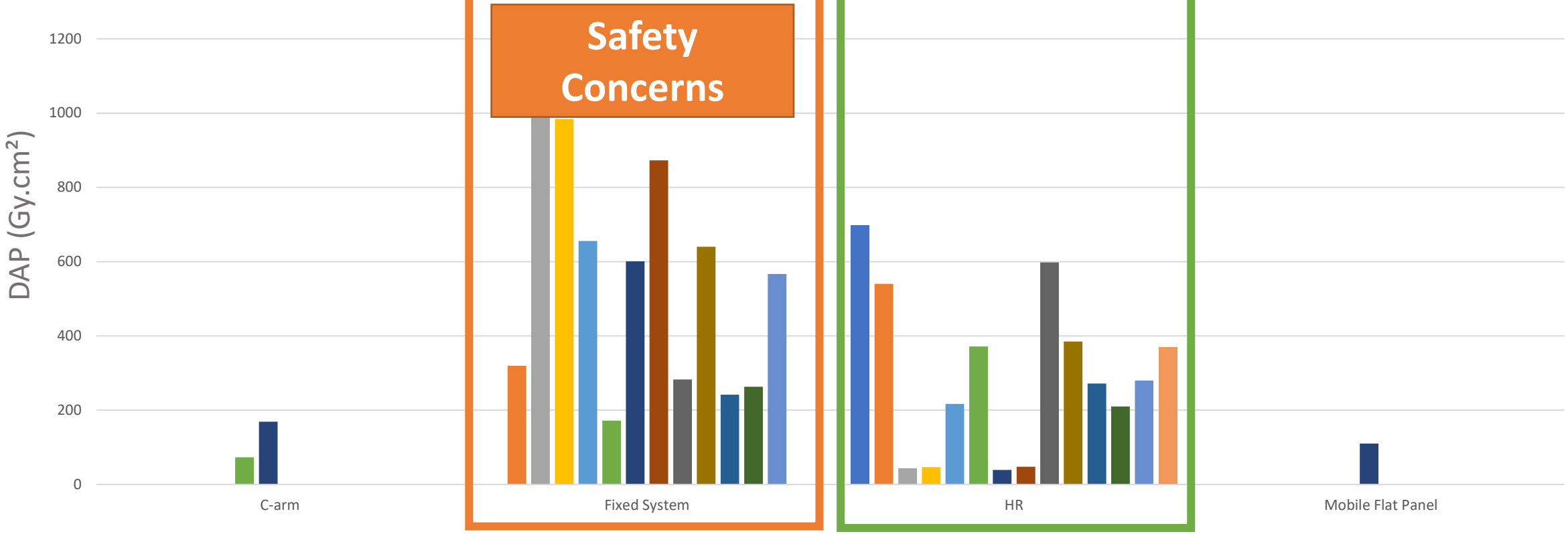
Median DAP	14.7 Gy.cm²



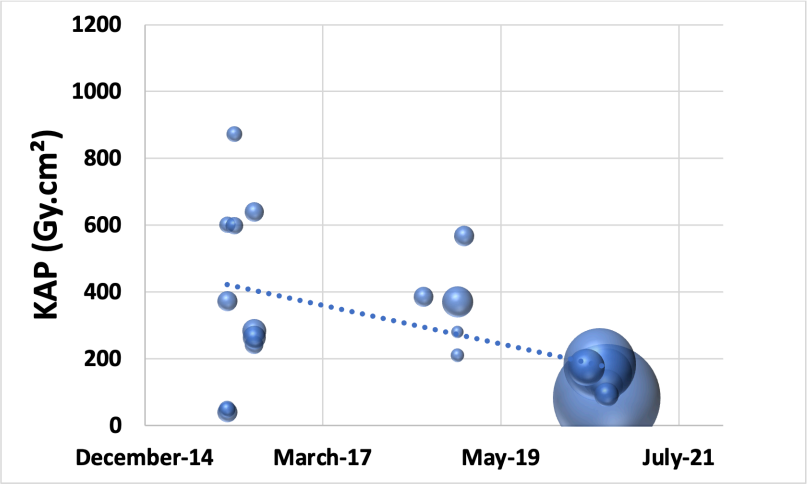
Les résultats - Etude #4

F/BEVAR

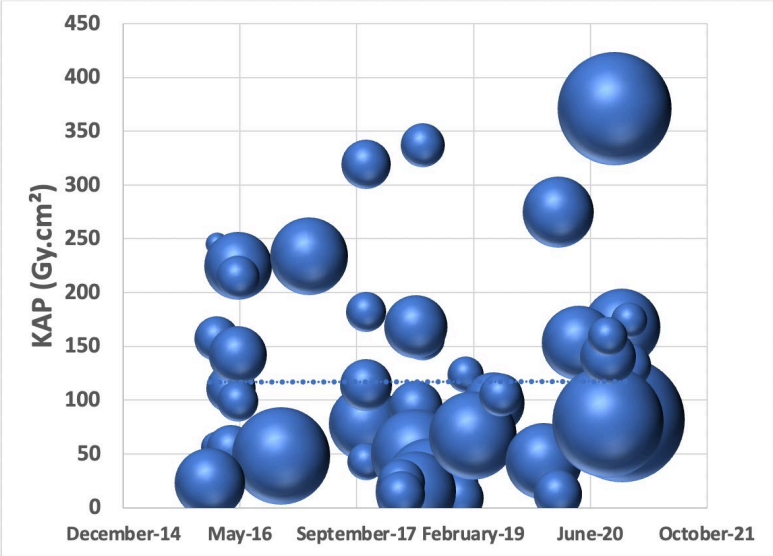
	C-arm	Fixed System	HR	Mobile Flat Panel
n	2	12	14	1
Dose range	73 ; 159	172-1188	39-696	110



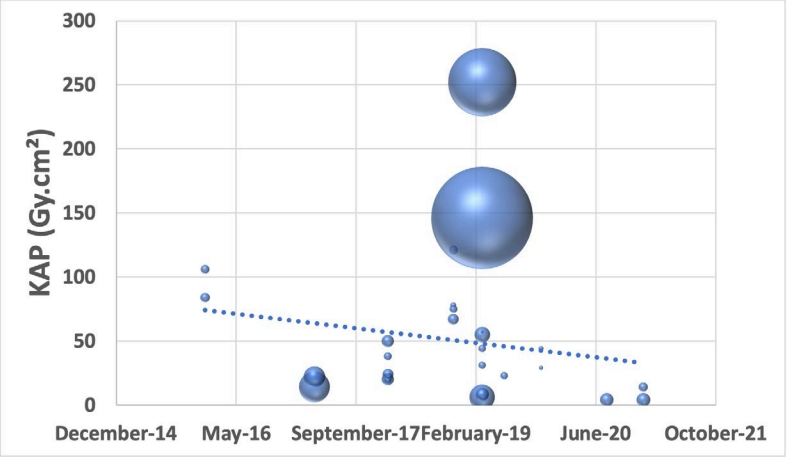
Les résultats - Etude #5



Fenestrated/branched aortic repair



Infra-renal EVAR



Lower limb intervention

En Conclusion

L’exposition des soignants est un problème réel

Aucune concession n’est possible

Les règles de bonne pratique doivent être appliquées

Les équipements de protection individuelle sont indispensables

A la mémoire de Lucie