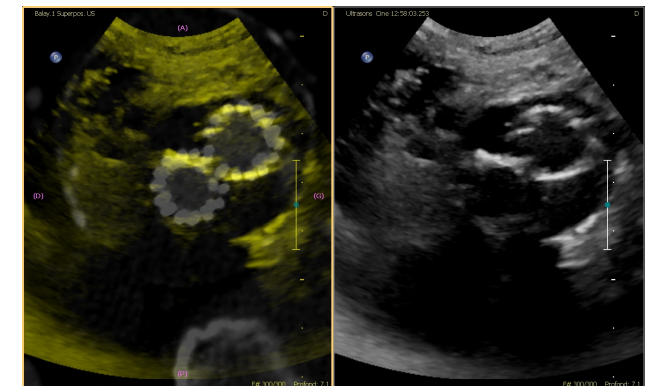


Actualités sur les Maladies Aortiques Nouveautés en écho-doppler



Professeure Gabrielle SARLON
Médecine vasculaire – CHU Timone



2014 ESC Guidelines on the diagnosis and treatment of aortic diseases

Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult

The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC)

Circulation

149 pages

ACC/AHA CLINICAL PRACTICE GUIDELINE

2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines

Table 3 Comparison of methods for imaging the aorta

Advantages/disadvantages	TTE	TOE	CT	MRI	Aortography
Ease of use	+++	++	+++	++	+
Diagnostic reliability	+	+++	+++	+++	++
Bedside/interventional use ^a	++	++	-	-	++
Serial examinations	++	+	++(+) ^b	+++	-
Aortic wall visualization ^c	+	+++	+++	+++	-
Cost	-	-	--	---	---
Radiation	0	0	---	-	--
Nephrotoxicity	0	0	---	--	---

Echo doppler abdominal ... ?

Table 5. Diagnostic Performance of Aortic Imaging Modalities

Parameter	CT	MRI	TTE	TEE	US
Availability	+++	++	+++	++	+++
Portability	-	-	+++	+++	+++
Speed of acquisition	+++	+	++	++	++
Spatial resolution	+++	++	++	+++	++
Temporal resolution	+	++	+++	+++	+++
Three-dimensional data set	+++	++	+	+	+
Arch branch vessel evaluation	+++	+++	++	+	NA
Evaluation of valve and ventricular function	+	++	+++	+++	NA

CT indicates computed tomography; MRI, magnetic resonance imaging; NA, not applicable; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography; US, abdominal aortic ultrasound; +++ excellent results; ++ good results; + fair results; and -, not available.

Le programme !

- Anévrisme de l'aorte abdominale
- Suivi post EVAR
- Perspectives : fusion, 3D

Le programme !

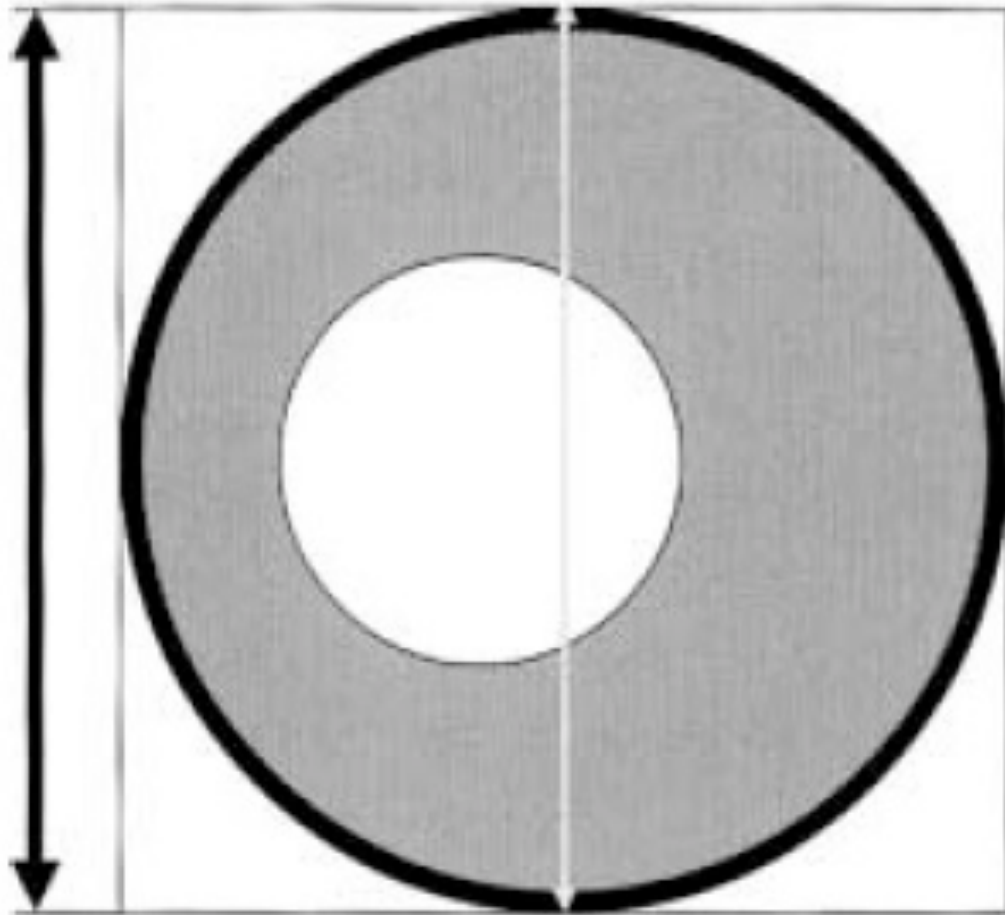
- **Anévrisme de l'aorte abdominale**
- Suivi post EVAR
- Perspectives : fusion, 3D

Echo-doppler aortique abdominal 2022 ACC/AHA

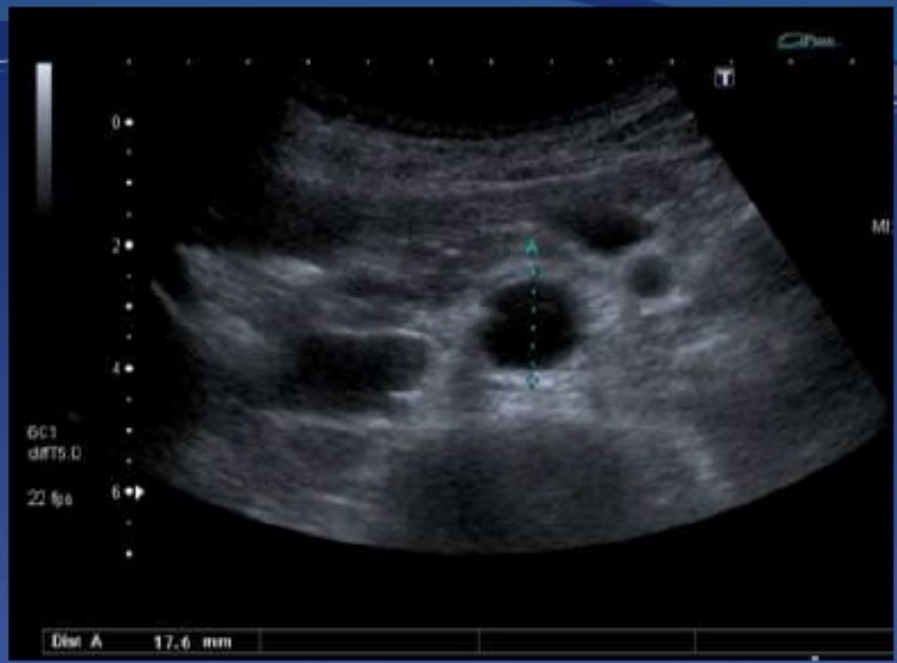
- Technique de choix pour le dépistage d'un AAA
- Diamètre maximal aortique de bord externe à bord externe ≥ 30 mm
- Sensibilité de diagnostic $\approx 100\%$
- Limites : obésité et gaz intestinaux
- Intérêt aussi dans le suivi EVAR, notamment avec du contraste

Mesure du diamètre maximal externe

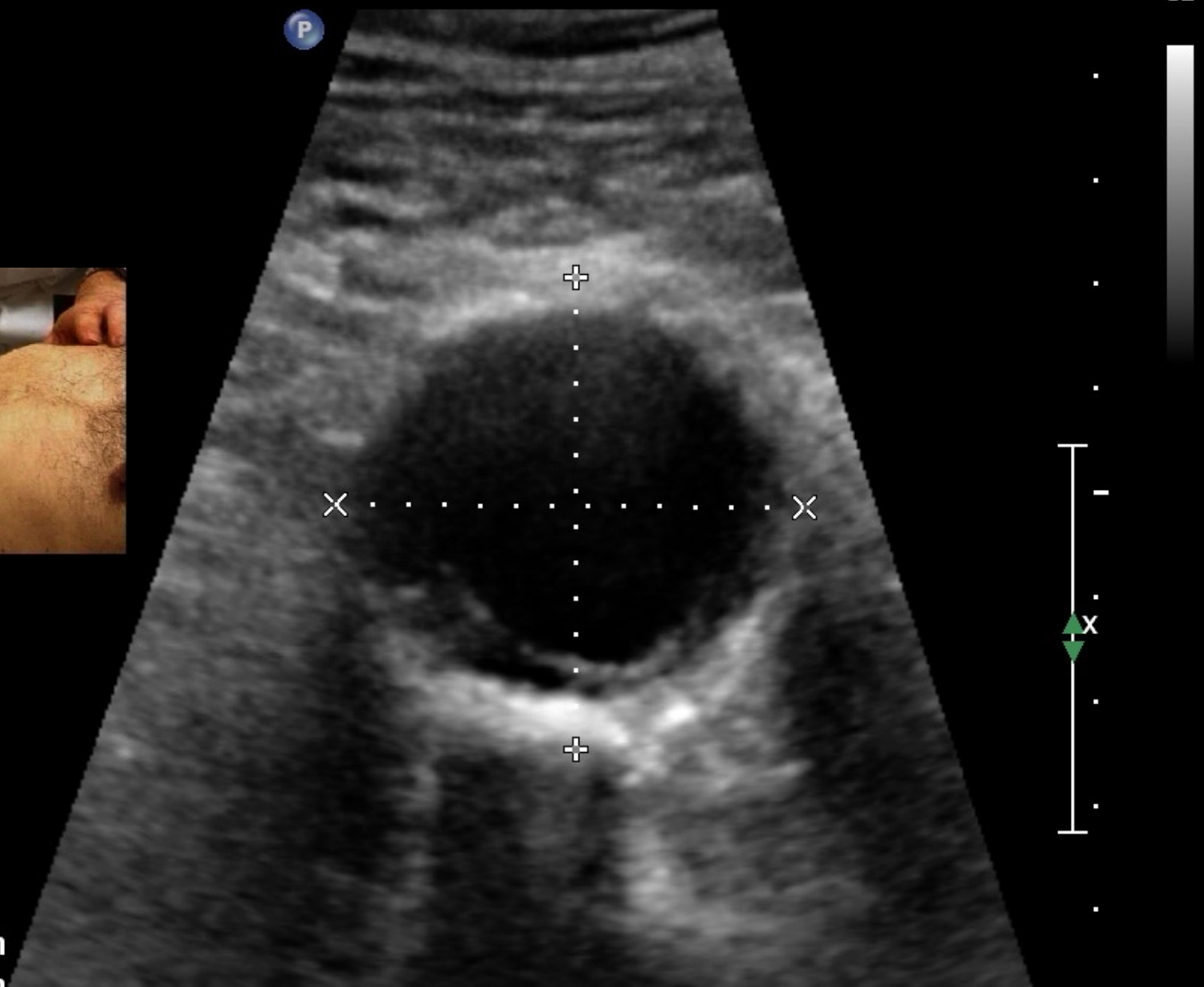
1. Diamètre max antéro-postérieur



Coupe transversale
Section circulaire stricte
Moyenne de 3 mesures



CI 52Hz
RV
Z 1.4
2D
38%
C 48
P Bas
HGén



✧ Dist 4.51 cm
✕ Dist 4.48 cm

CI 62Hz
RV

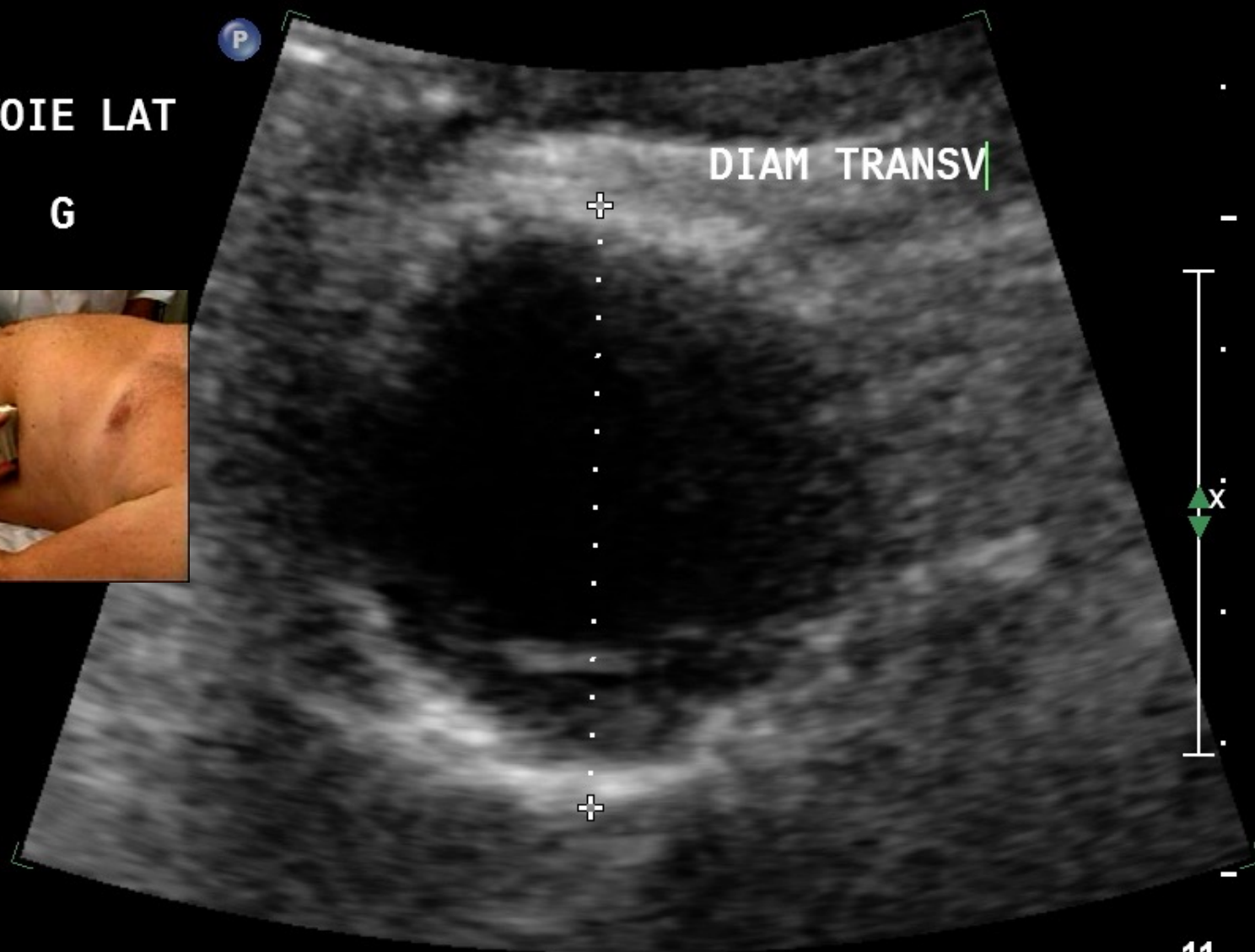
C2

2D
40%
C 48
P Bas
HGén

VOIE LAT

G

DIAM TRANSV



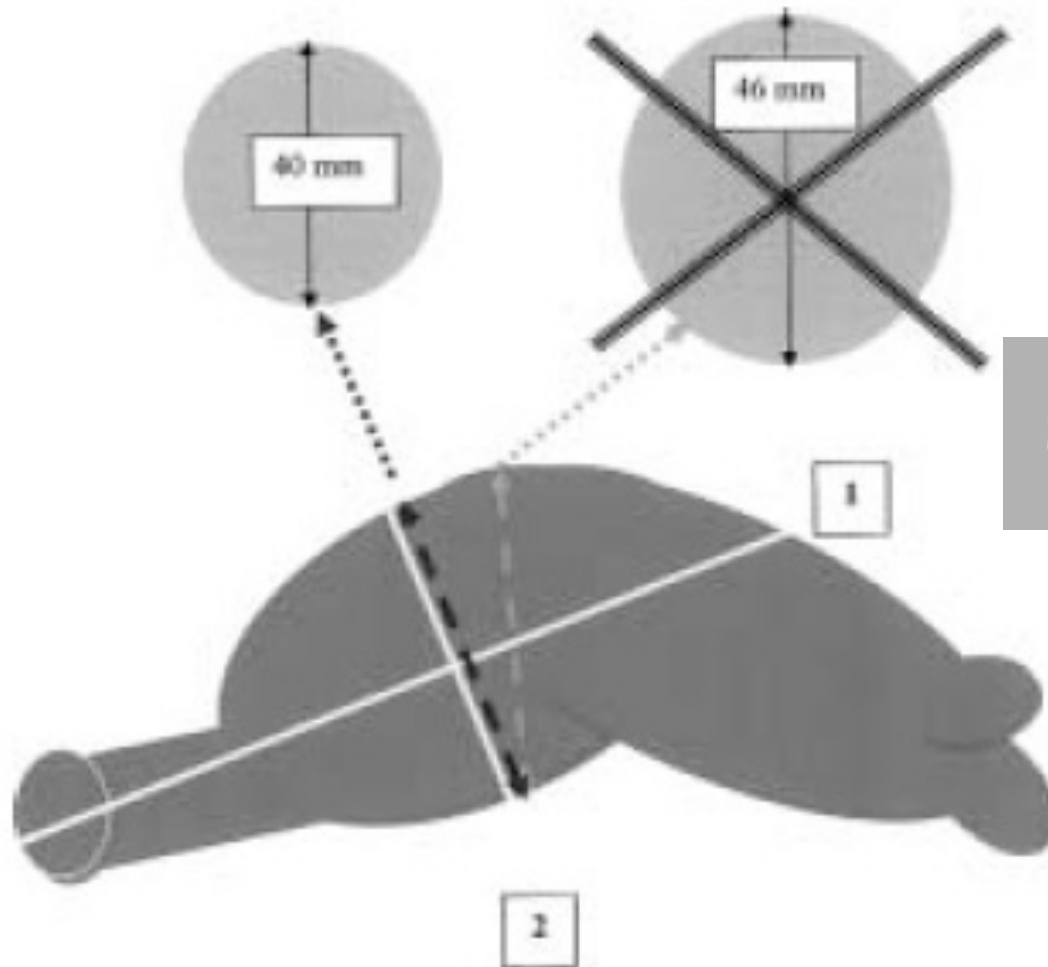
12

+ Dist 4.60 cm

11

Mesure du diamètre maximal externe

2. Diamètre max antéropostérieur

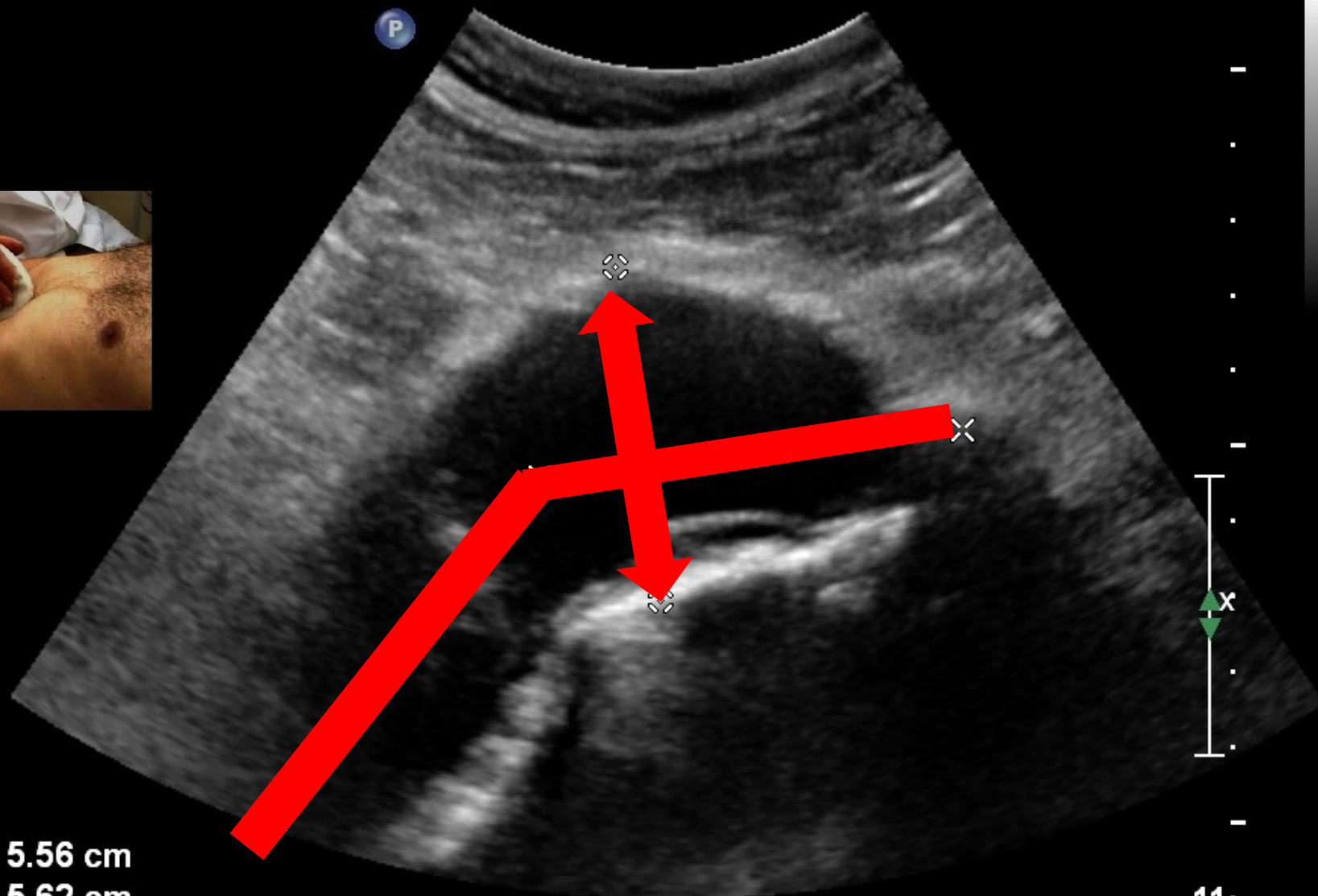


Coupe longitudinale
Diamètre orthogonal à l'axe du flux
Moyenne de 3 mesures

CI 34Hz
RV

C2

2D
40%
C 48
P Bas
HGén

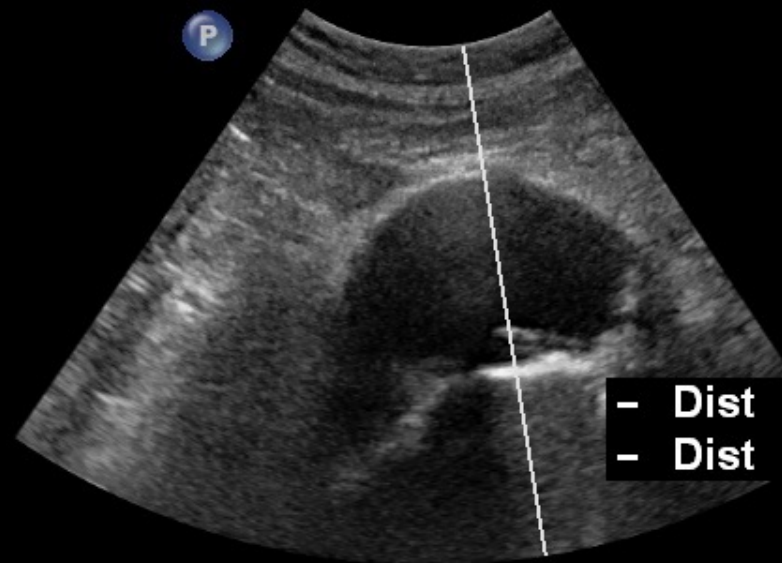


- + Dist 5.56 cm
- × Dist 5.62 cm
- ◇ Dist 4.45 cm

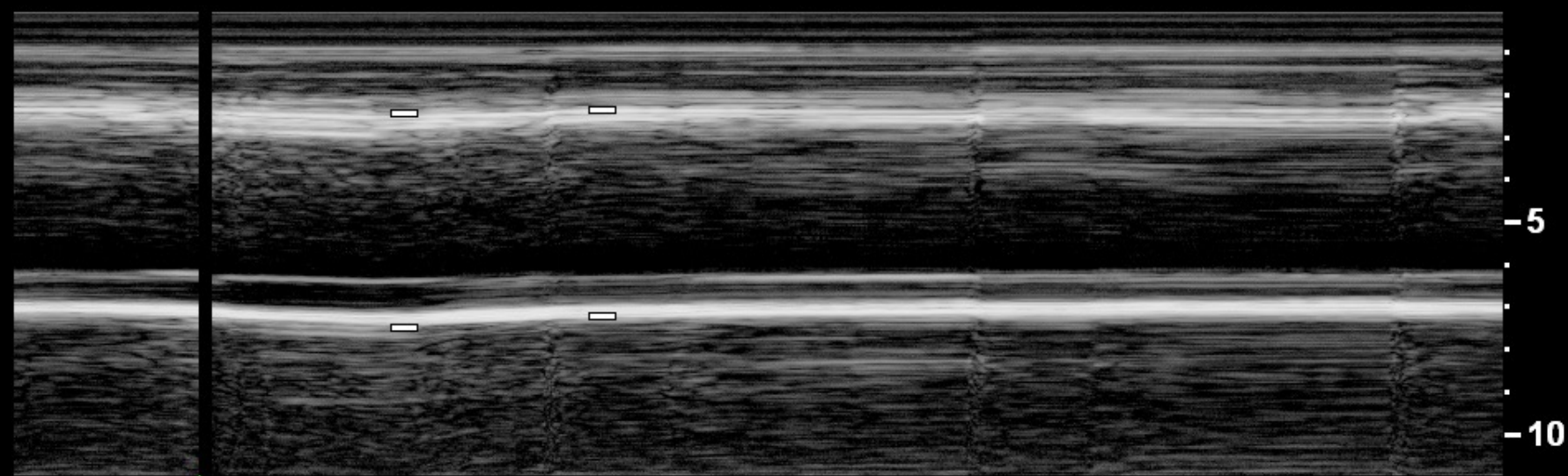
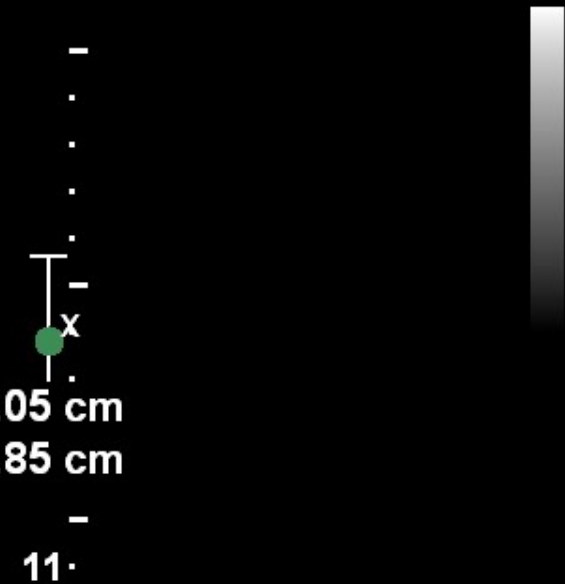
CI 32Hz
RV

C2

2D / TM
40% 40%
C 55
P Moy
HGén



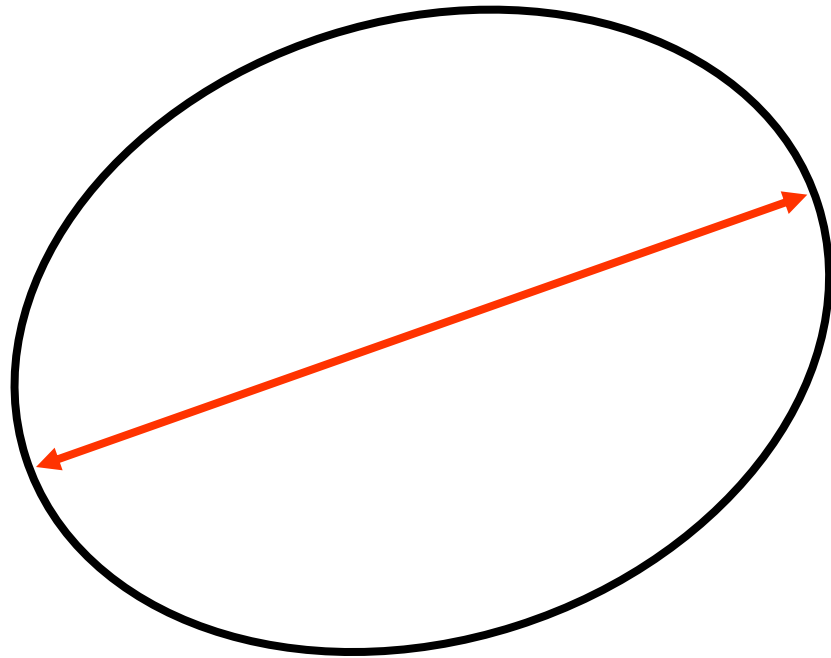
- Dist 5.05 cm
- Dist 4.85 cm



3.6s

Mesure du diamètre maximal externe

3. Diamètre max



Coupe transversale
Section elliptique
Diamètre maximal
Moyenne de 3 mesures

CI 58Hz
12cm

2D
53%
C 48
P Bas
Pén



× Dist 4.06 cm
+ Dist 6.65 cm



Figure 19. Algorithm for Identifying Patients to Screen for Abdominal Aortic Aneurysm.

Colors correspond to Class of Recommendations in Table 2. AAA indicates abdominal aortic aneurysm.

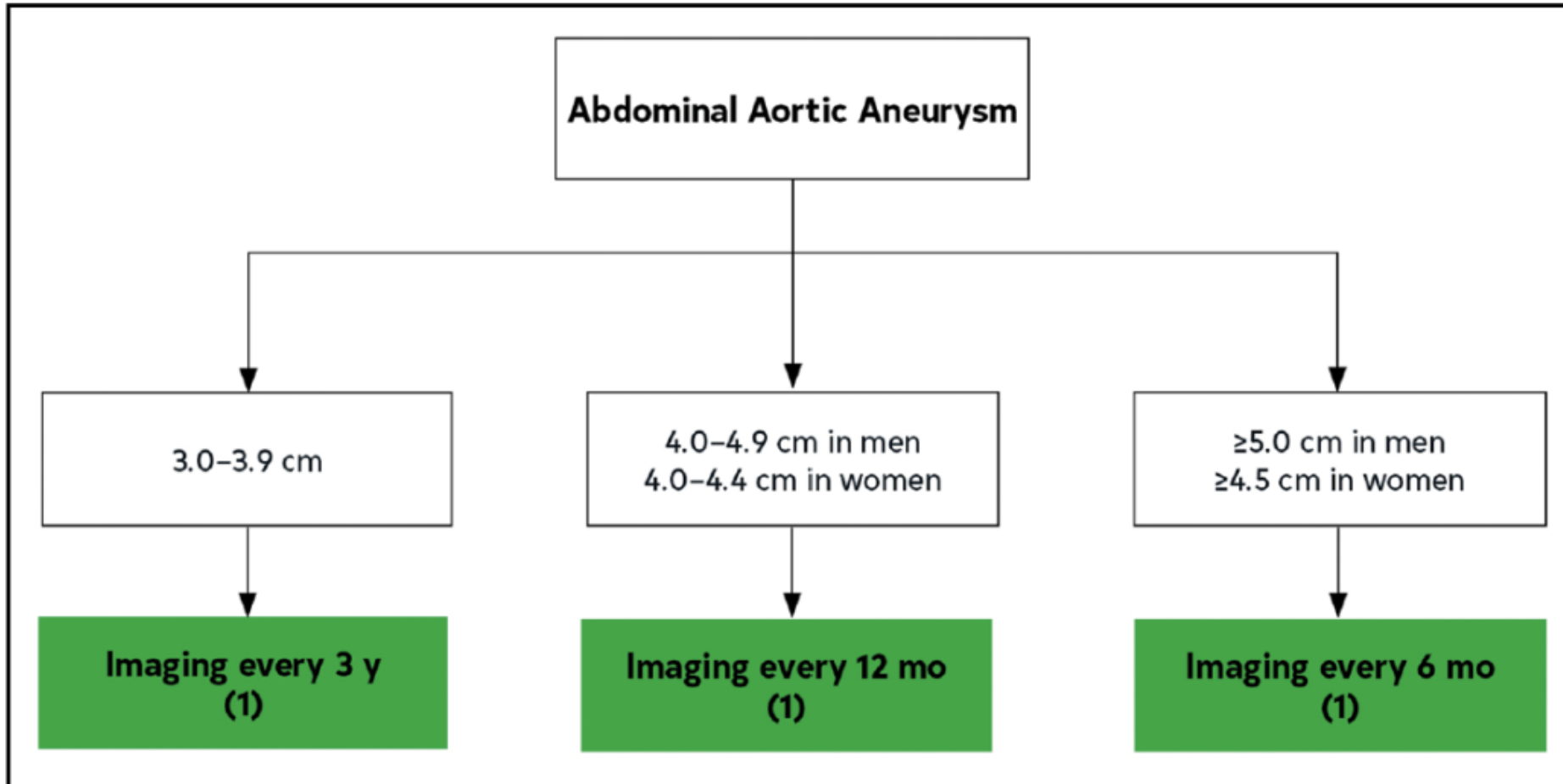


Figure 20. The Frequency of Surveillance Imaging of Abdominal Aortic Aneurysms Based on Current Aortic Diameter. Color corresponds to Class of Recommendations in Table 2.

Le programme !

- Anévrisme de l'aorte abdominale
- **Suivi post EVAR**
- Perspectives : fusion, 3D

Echo-doppler de contraste après EVAR

NON SYSTEMATIQUE

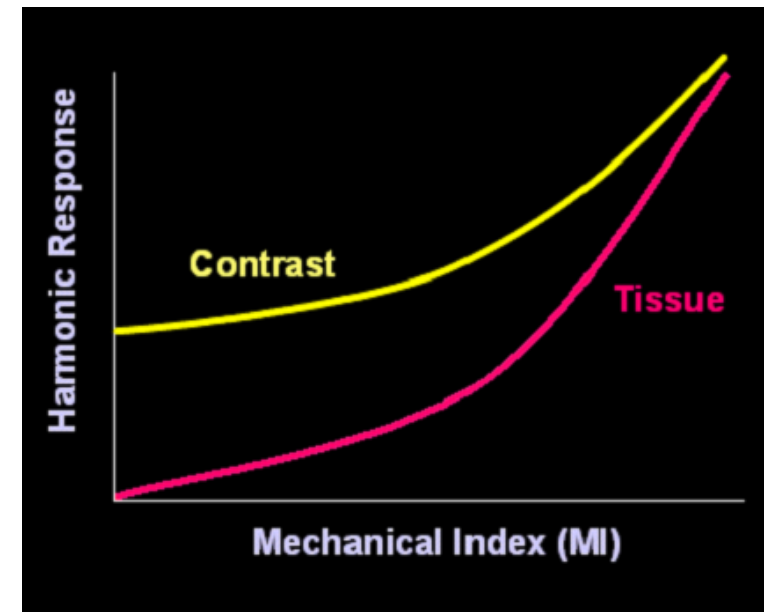
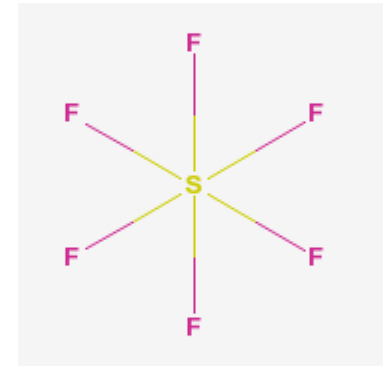
- Suspicion d'endofuite :
 - Augmentation du diamètre du sac $\geq 5\text{mm}$
 - Plages anéchogènes ou hypoéchogènes dans le thrombus
 - Pulsatilité du sac anévrisimal
- Référence si contre-indication au scanner ou IRM
- En complément d'un scanner pour caractériser une endofuite

Sonovue® / Bracco

Propriétés physico-chimiques



- Compressibilité : succession de dilatation et de contraction sous l'effet des US
- Index mécanique :
 - bas = résonance
 - haut = destruction
- Mode spécifique : harmonique, IM bas



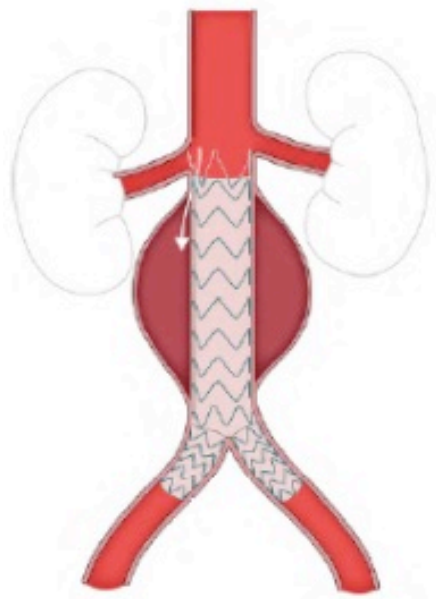
Sonovue® / Bracco

Modalités

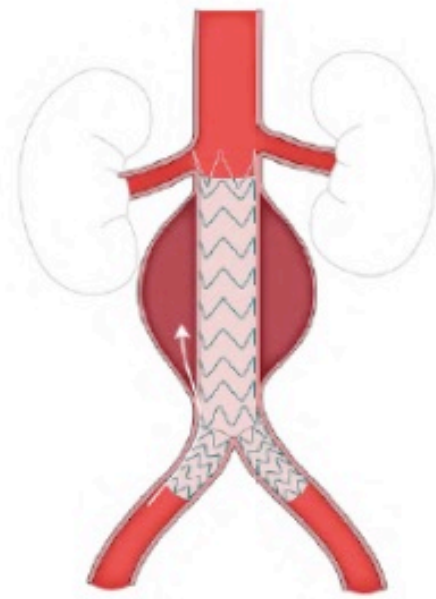


- Précautions d'emploi
- VVP
- Injection de 2,5ml suivie d'un rinçage rapide par 5ml de NaCl

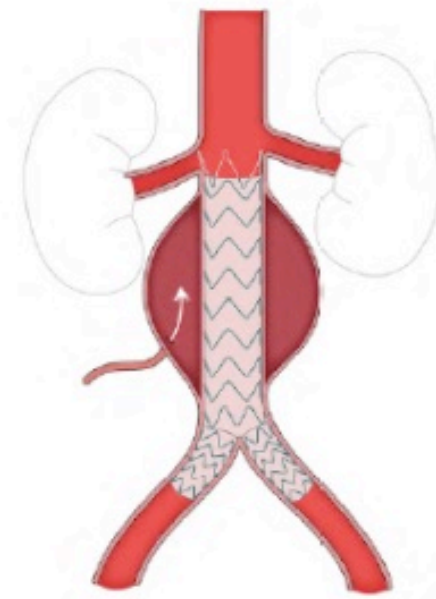
Type Ia



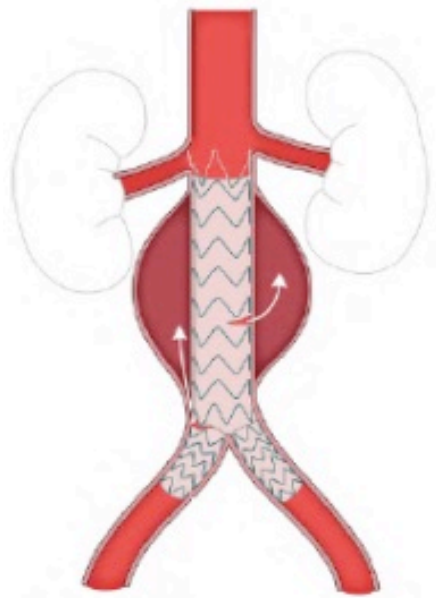
Type Ib



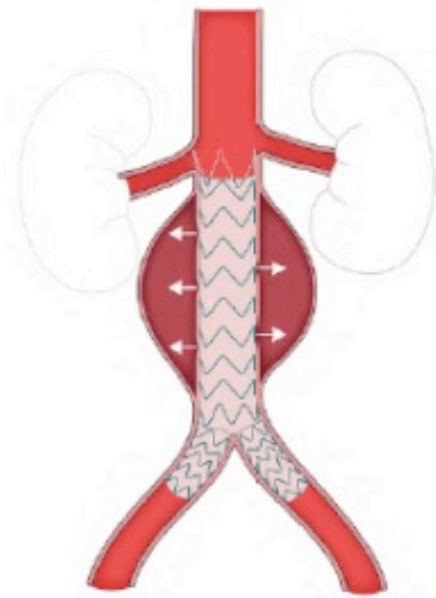
Type II



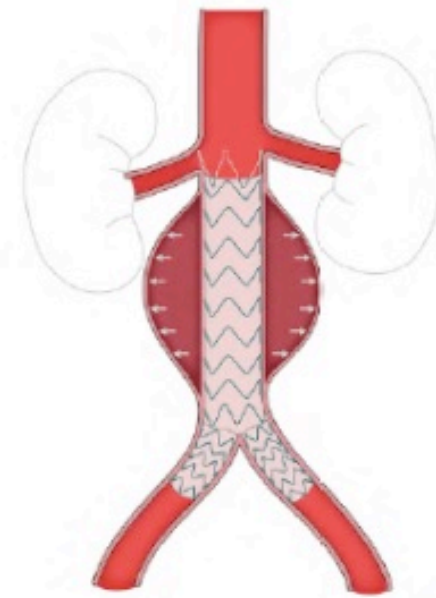
Type III



Type IV



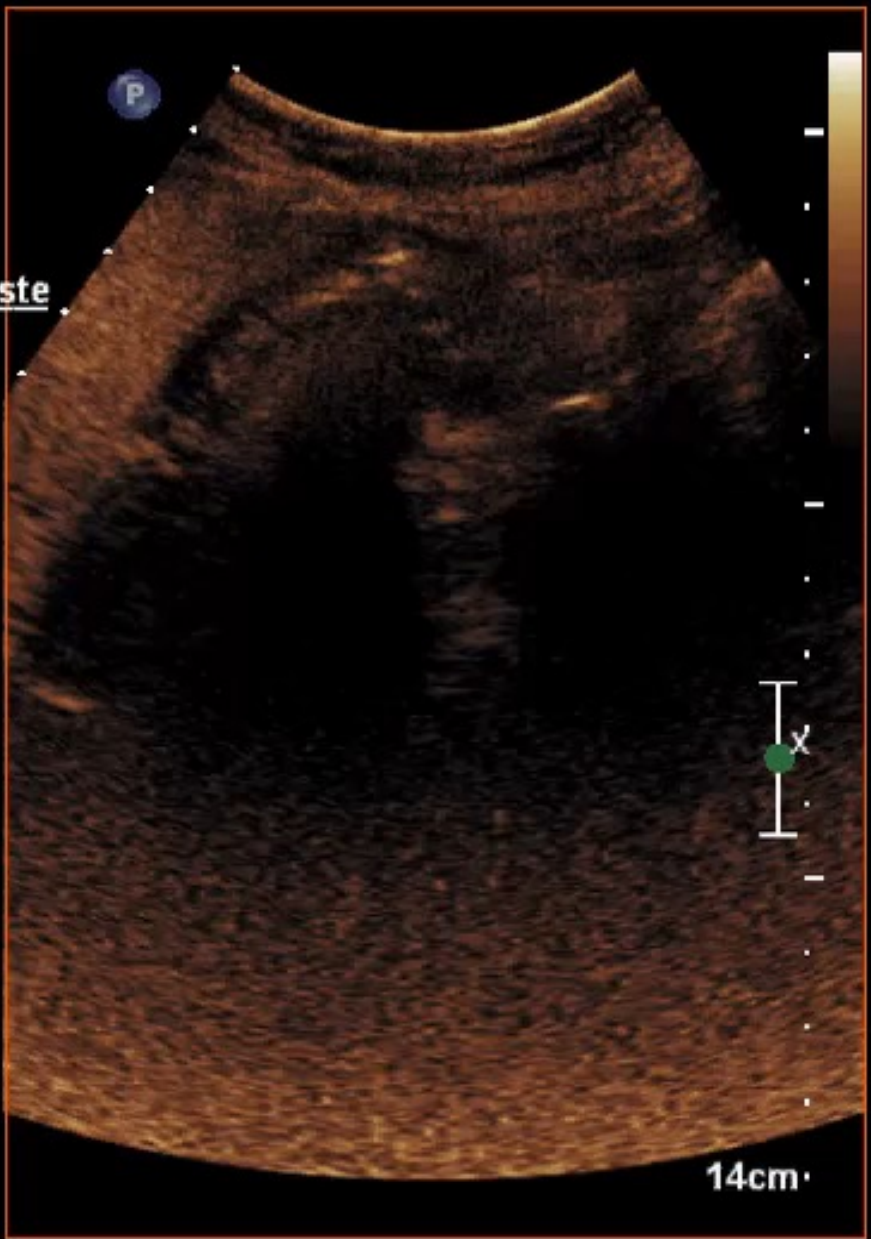
Type V



AORTE
C5-1
8Hz
RS

Tissu
85%
C 55
Gén
IM0.06

Contraste
58%
C 50
Gén
IM0.06



TIS0.0 MI 0.06 G
MI 0.76 F

M3



CI 14Hz
D1

2D
83%
C 40
P Moy
GénC

C2



JPEG
9.0

*** bpm

CI 20Hz
D1

2D
76%
C 40
P Arrêt
GénC

C2



JPEG
10⁻
*** bpm

Résultats de la littérature

- Echo-doppler standard :
 - 21 études, 2601 patients
 - Sensibilité **77%** (95% CI 64-86%)
 - Spécificité **94%** (95% CI 88-97%)
- Echo-doppler de contraste :
 - 7 études, 288 patients
 - Sensibilité **98%** (95% CI 90-99%)
 - Spécificité **88%** (95% CI 78-94%)

Recommendations for Surveillance After AAA Repair
 Referenced studies that support the recommendations are summarized in the [Online Data Supplement](#).

COR	LOE	Recommendations
1	B-NR	1. In patients with AAA treated with EVAR, baseline surveillance imaging with CT is recommended at 1 month postoperatively ^{1,2} ; if there is no evidence of endoleak or sac enlargement, continued surveillance with duplex ultrasound at 12 months and then annually thereafter is recommended. ^{1,3,4}
2a	C-LD	2. In patients with AAA treated with EVAR who are undergoing annual surveillance imaging duplex ultrasound, additional cross-sectional imaging with CT or MRI of the abdomen and pelvis every 5 years postoperatively is reasonable. ⁵⁻⁸
2a	C-LD	3. In patients with AAA treated with EVAR and abnormal findings (Table 21) on any surveillance duplex ultrasound, additional cross-sectional imaging with CT or MRI is reasonable. ⁹
2a	C-LD	4. In patients with AAA treated with complex EVAR, a modified surveillance imaging plan that combines cross-sectional imaging and duplex ultrasound of target vessels is reasonable. ^{10,11}
2a	C-LD	5. In patients with AAA who have undergone open repair, surveillance imaging with CT or MRI of the abdominopelvic aorta within 1 year postoperatively and then every 5 years thereafter is reasonable. ^{5,6}



Le programme !

- Anévrisme de l'aorte abdominale
- Suivi post EVAR
- **Perspectives : fusion, 3D**

Perspectives : Imagerie de Fusion

Synchroniser l'image ultrasonore obtenue en direct, avec une imagerie scanner, IRM, ou TEP acquise préalablement

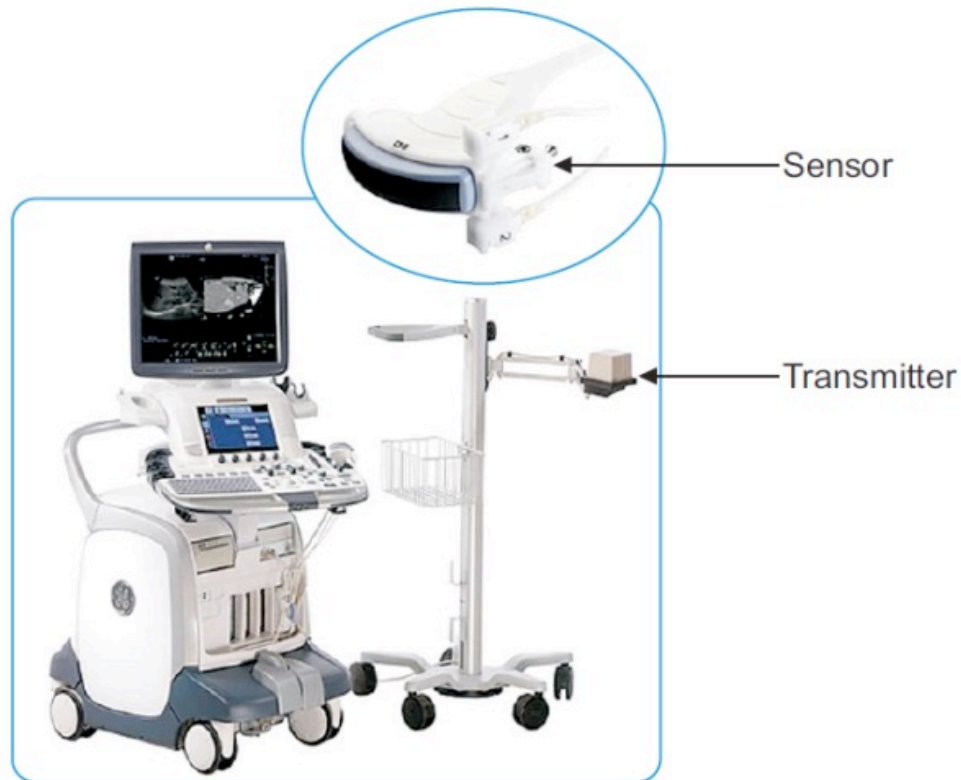
US

Real - Time
Low cost examination
No patient irradiation

**MR
CT
PET**

Extended field of view
Not patient dependent
Easy image interpretation

Principe : Imagerie de Fusion



- 1.** Un capteur fixé sur la sonde d'échographie ou une sonde spécifique
- 2.** Un ordinateur qui reçoit les mouvements et qui génère les projections
- 3.** Procédure de synchronisation des données et d'affichage en deux écrans

Fig. 1. Ultrasound system. This system was equipped with an electromagnetic tracking system, a transmitter and a small sensor mounted on the ultrasound probe.

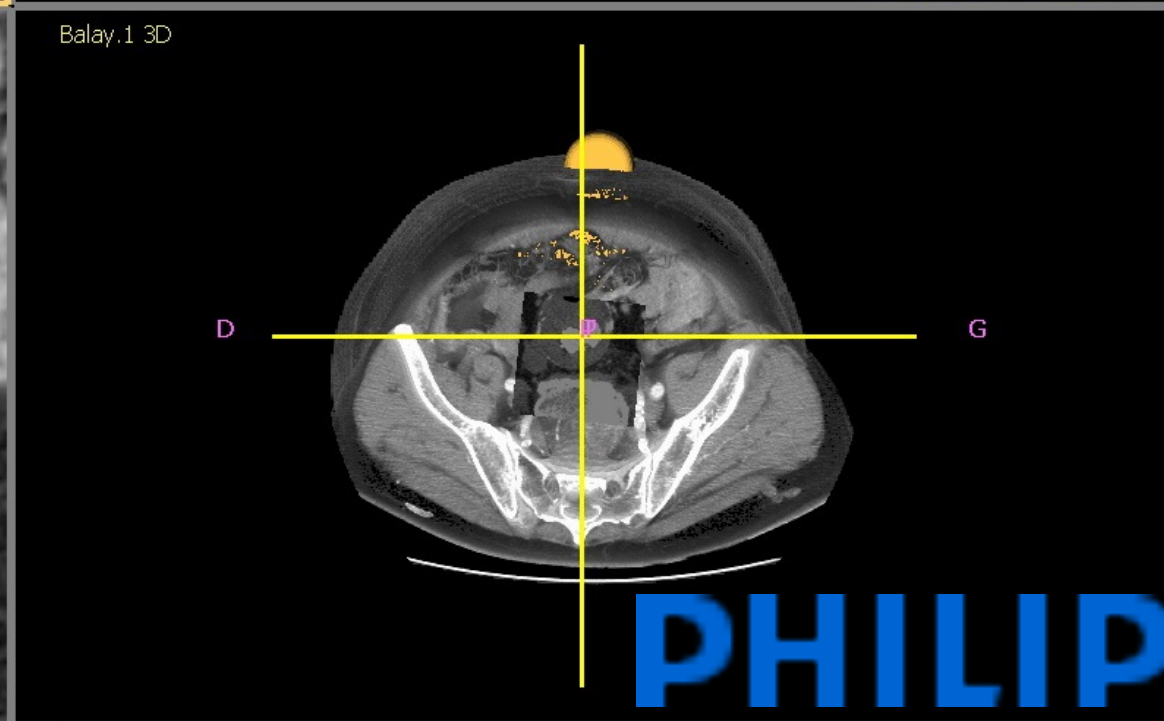
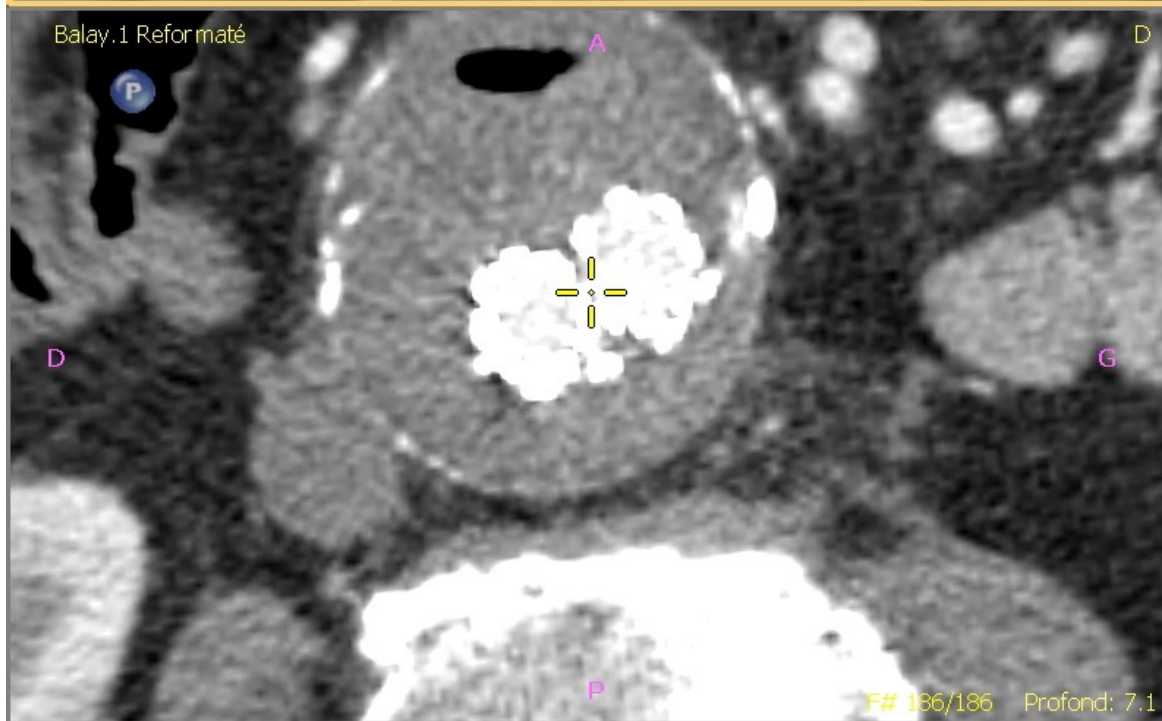
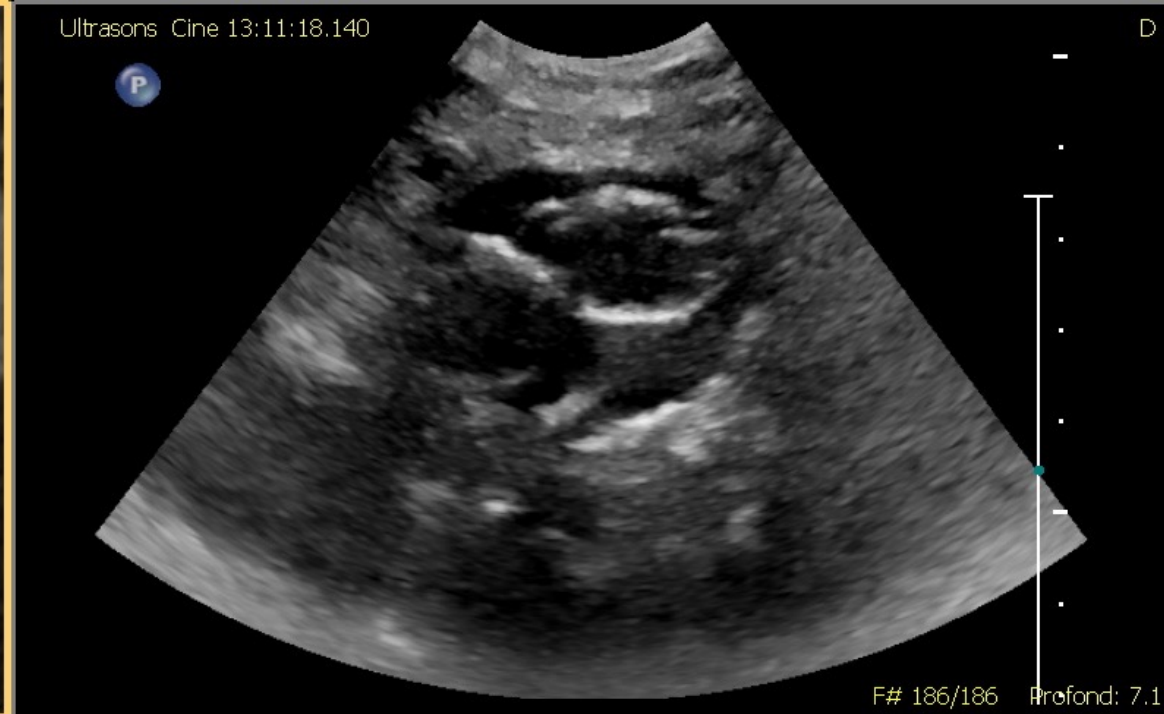
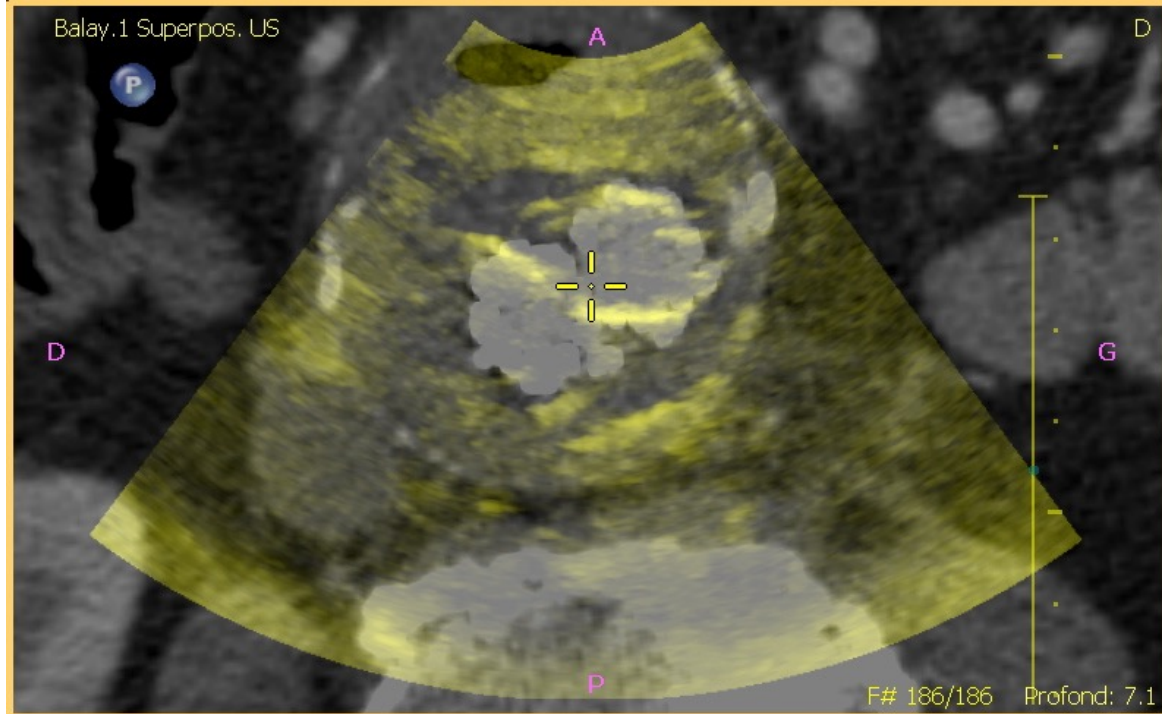
LOGIQ E9 US (GE Healthcare, Milwaukee, WI, USA)

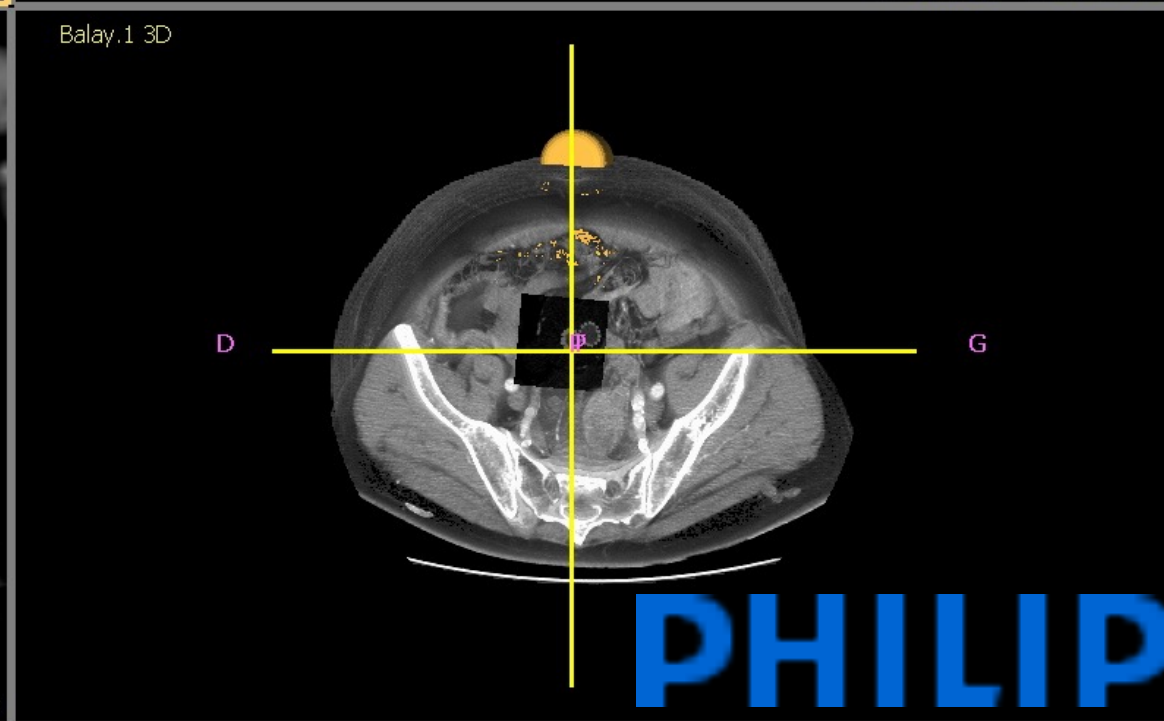
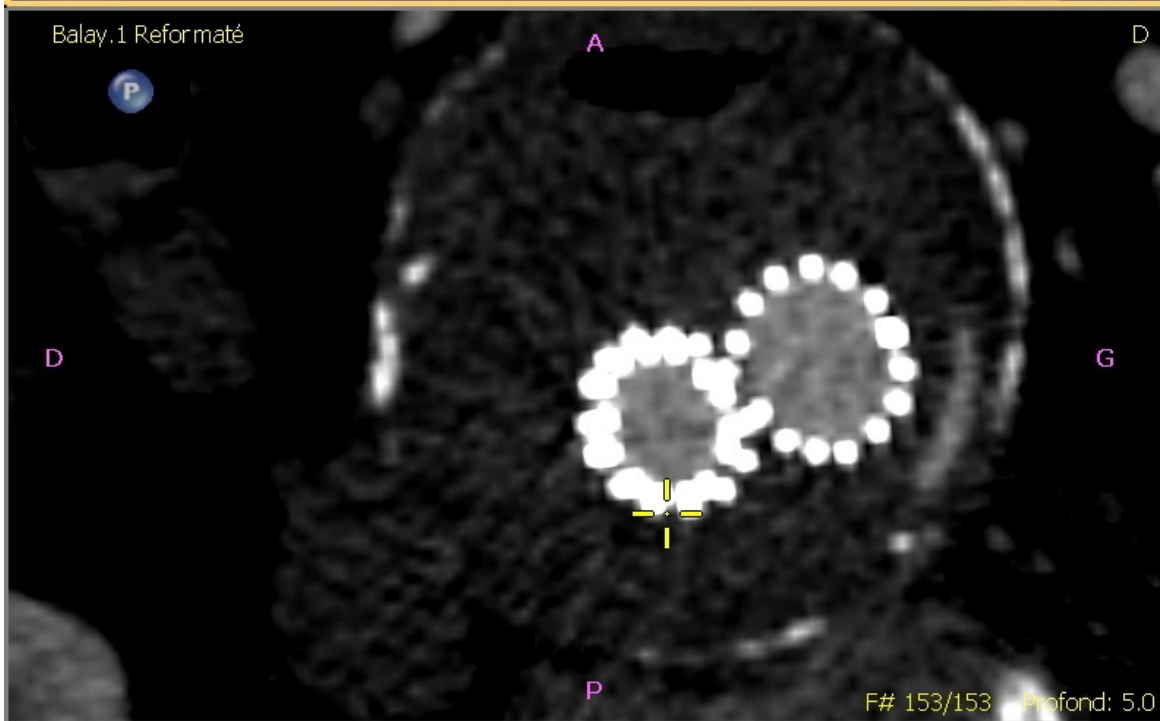
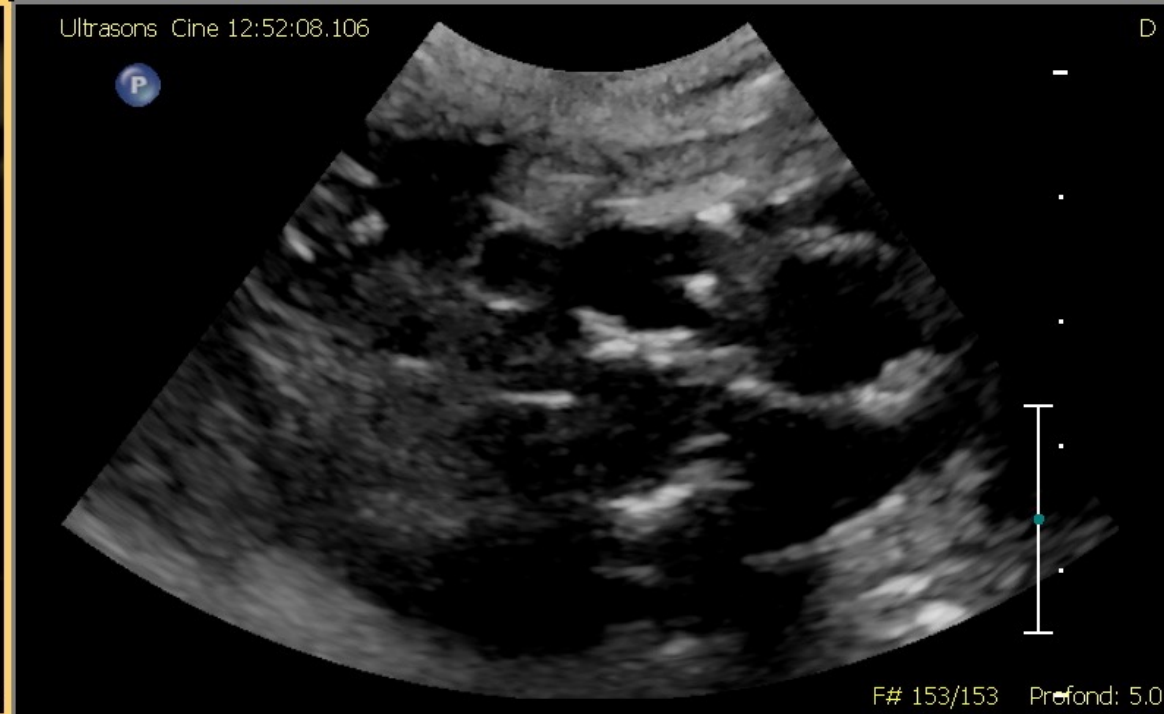
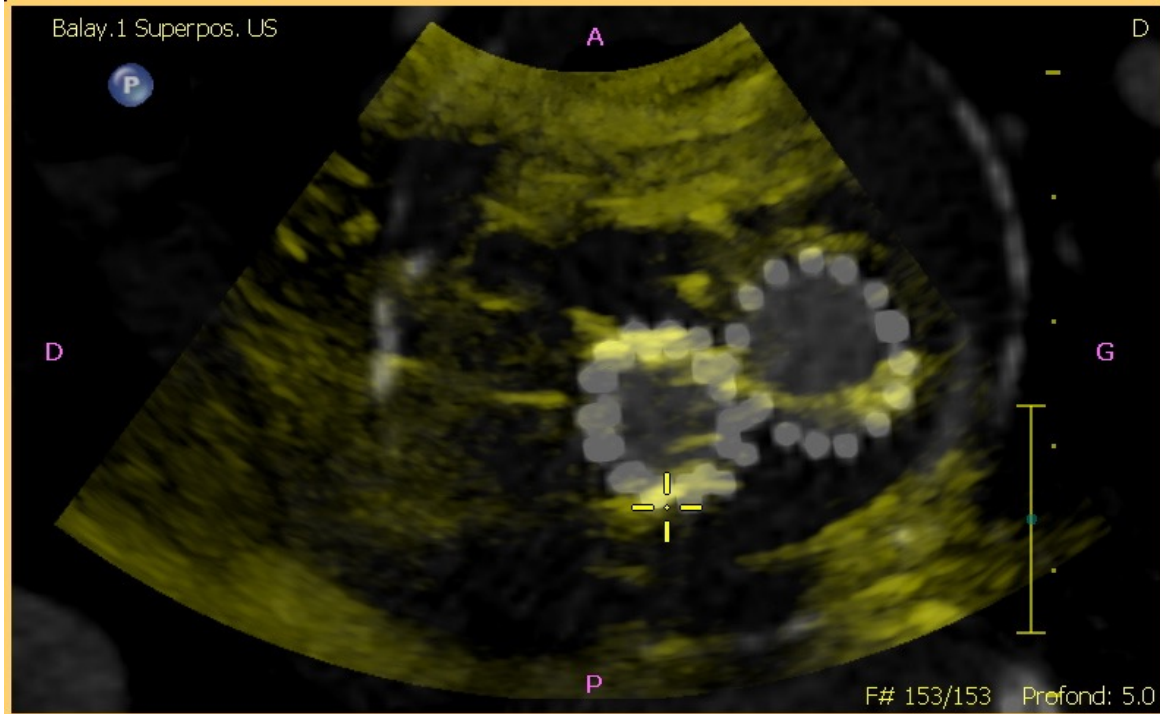
Principe : Imagerie de Fusion

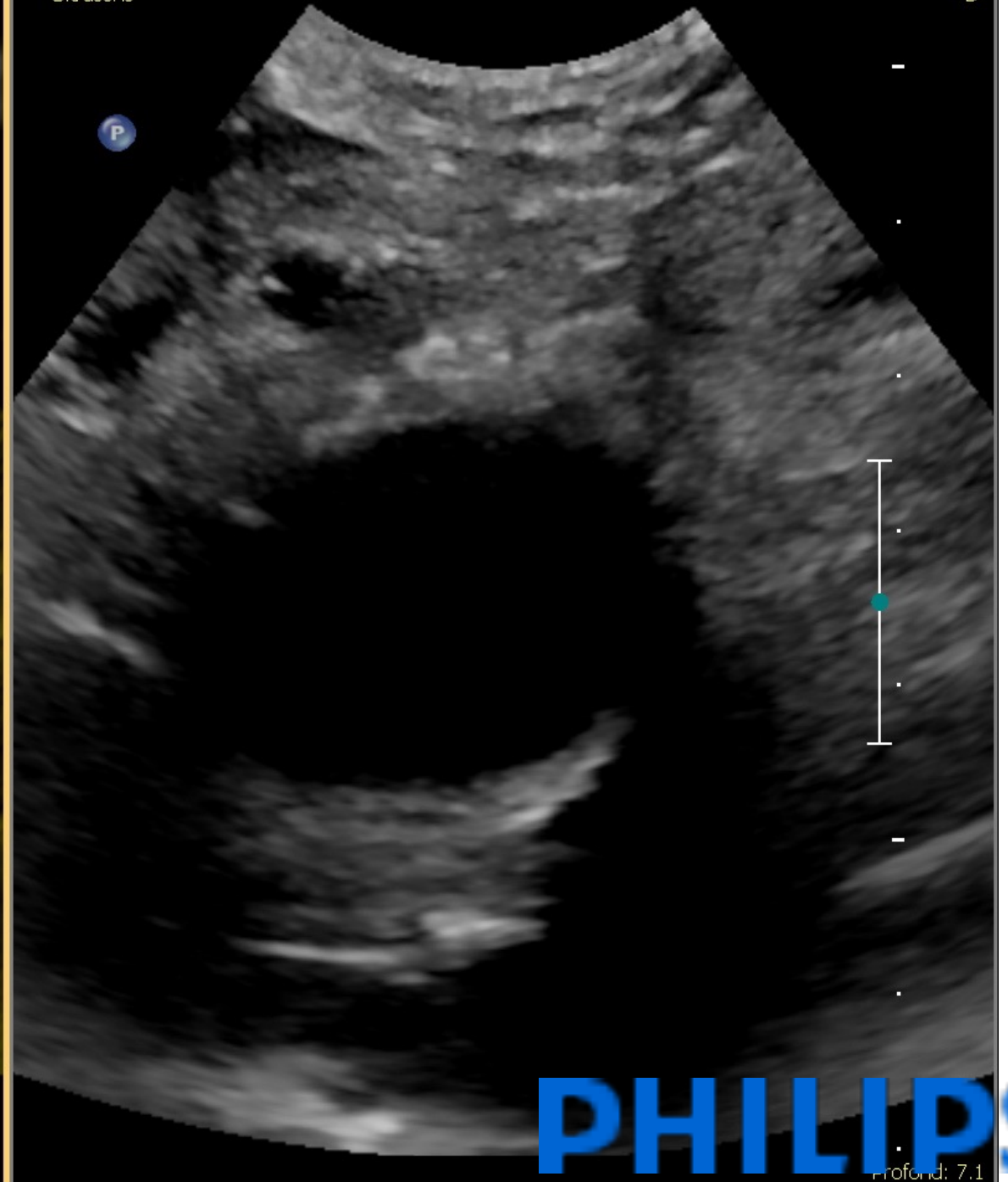
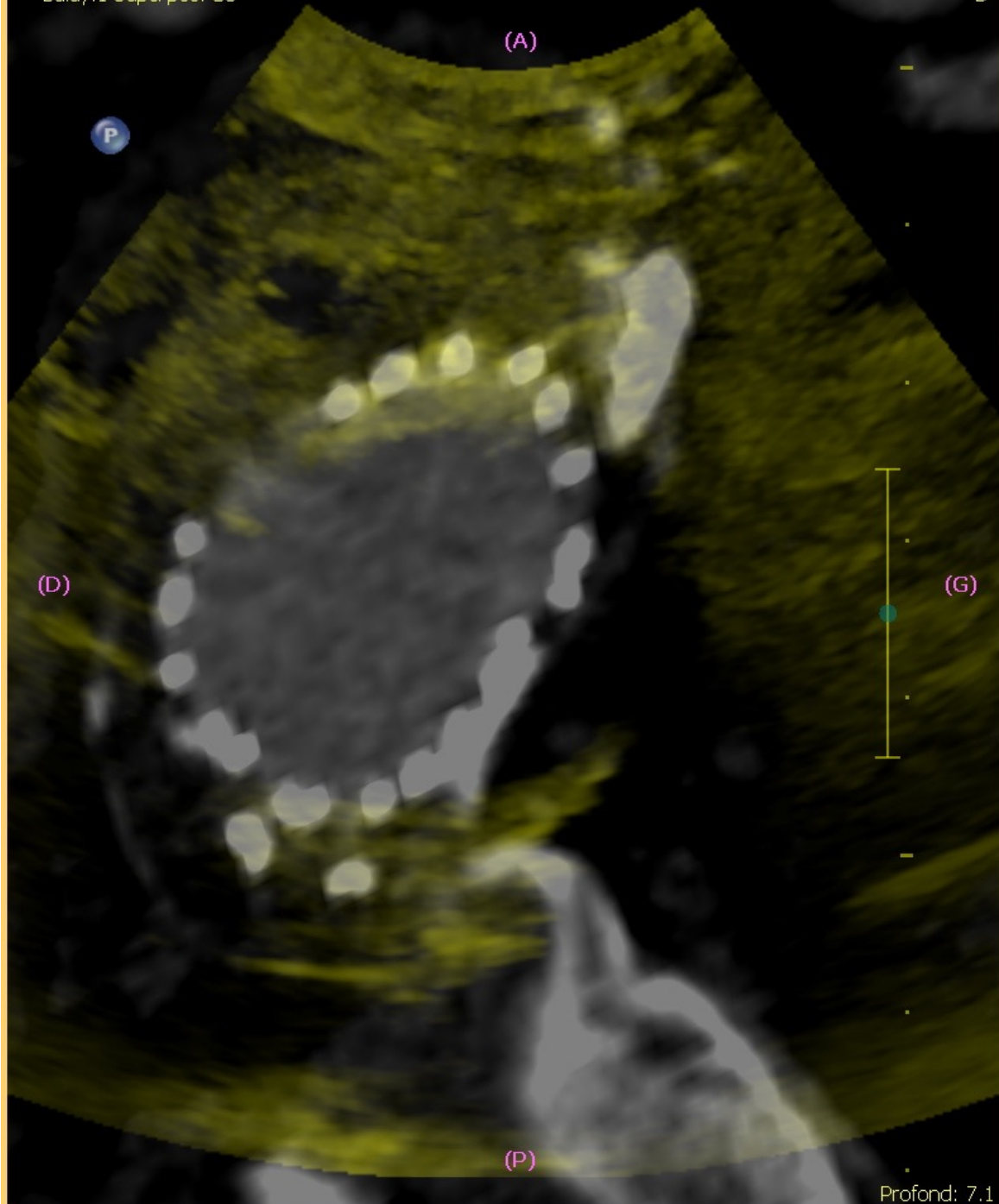
- Les différents plans d'exploration produits lors de l'échographie sont, en temps réel, synchronisés aux plans reconstruits dans les volumes scanner ou IRM d'examens antérieurs.
- La représentation peut être faite sur l'écran séparé avec d'un côté l'image échographique et de l'autre l'image scanographique ou IRM,
- ou avec une superposition des deux images grâce à un effet de transparence.
- Une lésion visible en scanner ou IRM, sera alors visible à l'échographie grâce à la fusion des deux examens.

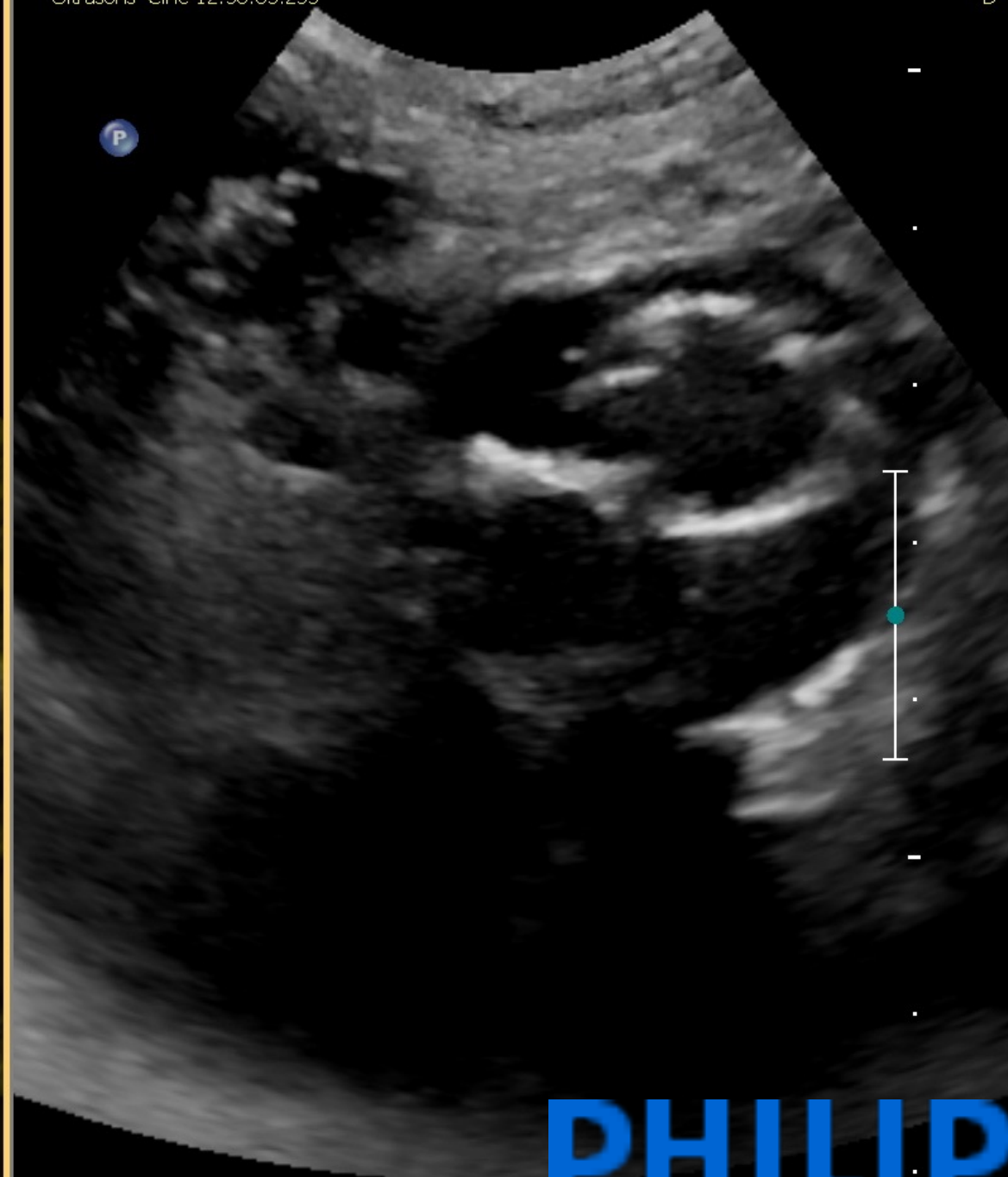
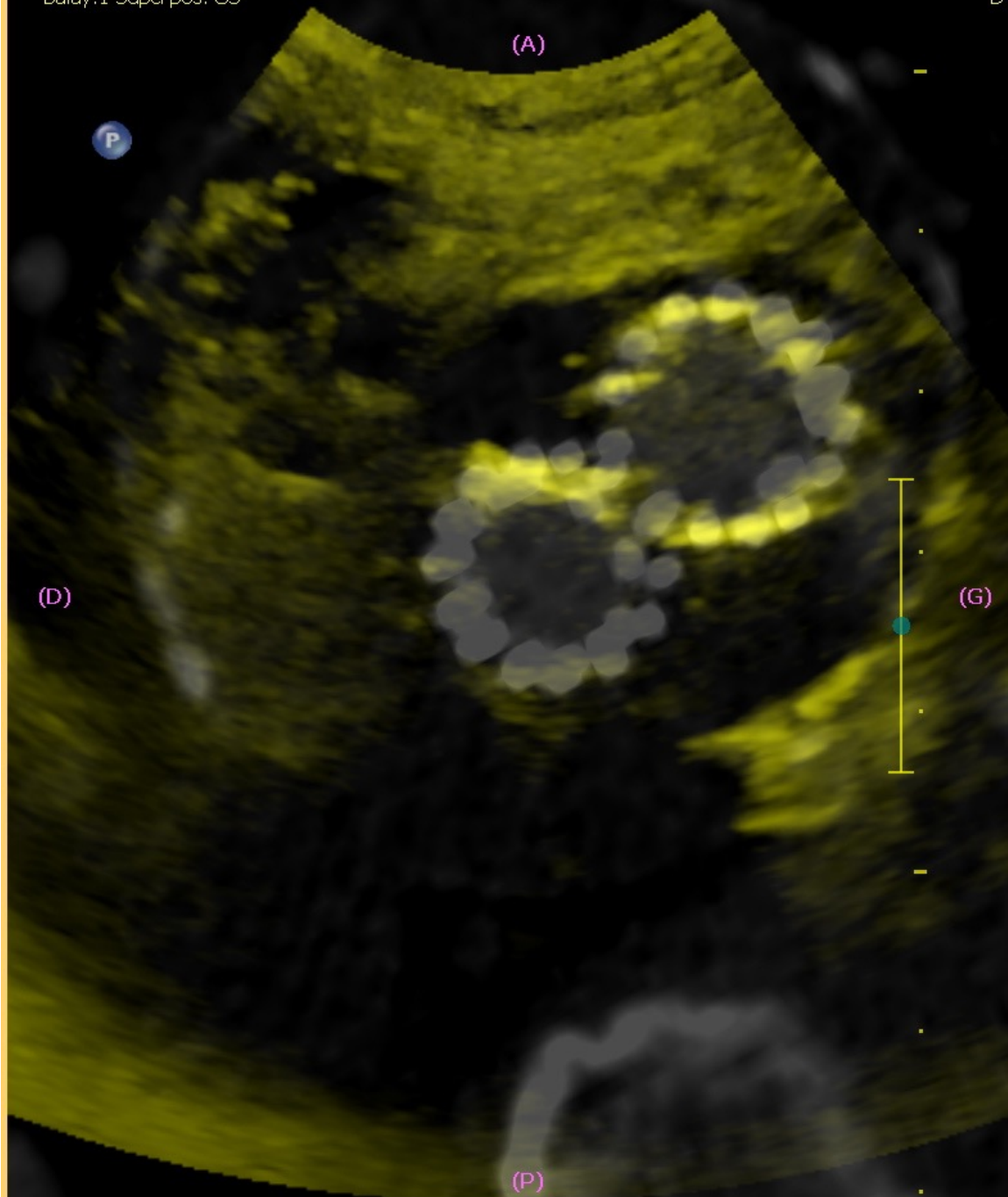
Principe : Imagerie de Fusion

- Nécessité d'un examen TDM ou IRM stocké au format DICOM qui est importé dans l'échographe
- Sonde spécifique ou capteur installé sur la sonde
- Repérage spatial entre l'imagerie échographique temps réel et l'imagerie importée









Perspectives : Fusion

Improving the follow up after EVAR by using ultrasound image fusion of CEUS and MS-CT

- 35 patients
- Siemens ACUSON S2000™, Siemens Healthcare
- Logic E9, GE Healthcare

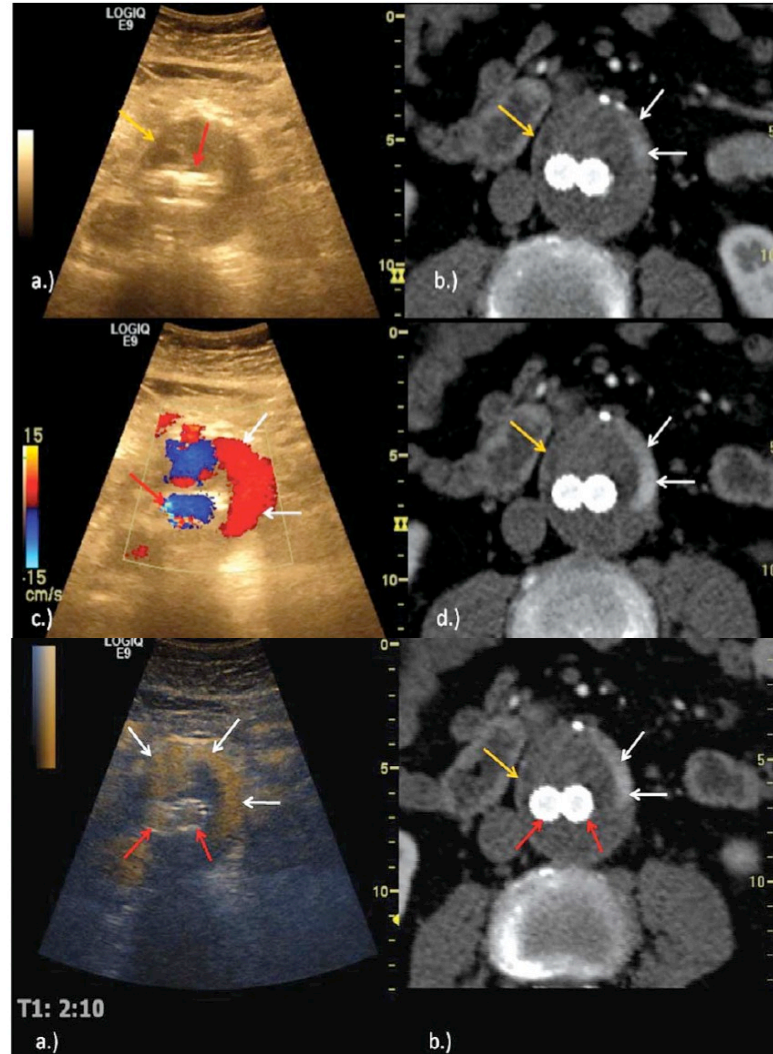


Table 2

Evaluation of detectability of stentgraft flow artifacts in colour-coded duplex sonography, CEUS and image fusion

Examination	CCDS	CEUS	Image fusion
Total score for 35 patients	48	66	65
Mean score	1.37	1.88	1.86

Score 0 = incomplete flow detection with pronounced overwriting artifacts, score 1 = partial artifacts due to flow overwriting, score 2 = no artifacts with optimal flow detection.

D.A. Clevert^{a,*}, A. Helck^a, M. D'Anastasi^a, V. Gürtler^a, W.H. Sommer^a, G. Meimarakis^b, R. Weidenhagen^b and M. Reiser^a

^aDepartment of Clinical Radiology, University of Munich-Grosshadern Campus, Munich, Germany

^bDepartment of Surgery, University of Munich-Grosshadern Campus, Munich, Germany



Perspectives : 3D

Three-dimensional Ultrasound Improves the Accuracy of Diameter Measurement of the Residual Sac in EVAR Patients

K. Bredahl^{a,*}, M. Taudorf^b, A. Long^c, L. Lönn^{a,b}, L. Rouet^d, R. Ardon^d, H. Sillesen^a, J.P. Eiberg^a

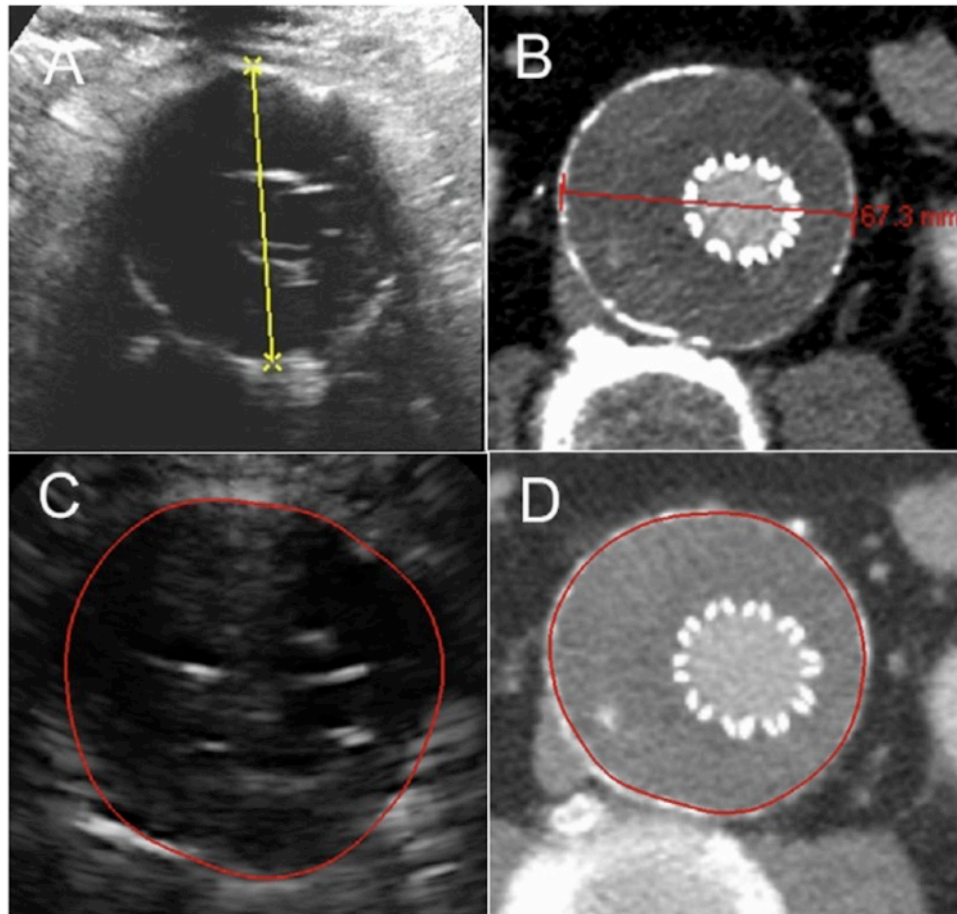
^a Department of Vascular Surgery, Rigshospitalet and University of Copenhagen, Denmark

^b Department of Interventional Radiology, Rigshospitalet and University of Copenhagen, Denmark

^c Department of Internal Medicine and Vascular Medicine, Hospices Civils de Lyon, University Hospital Edouard Herriot, Claude Bernard Lyon 1 University, Lyon, France

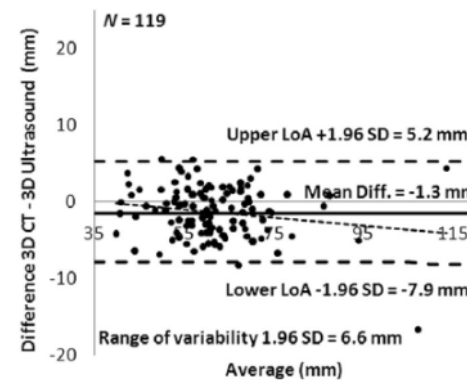
^d Medisys, Philips Research, Suresnes, France

© 2013 European Society for Vascular Surgery.

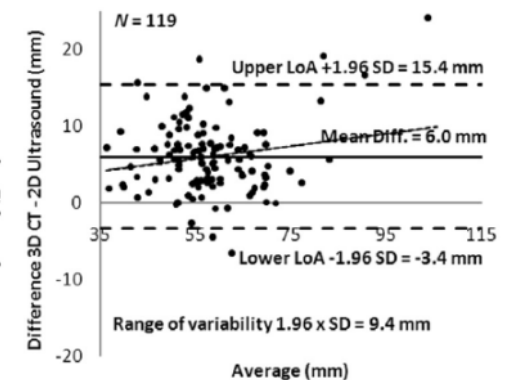


Imaging method	Mean diameter (mm)	Mean difference \pm range of variability from 3D CT (mm)	p^*
3D CT	60.8 (38.9–82.7)	0 \pm 0	NA
2D CT	61.5 (39.9–83.1)	-0.7 \pm 6.0	.623
3D ultrasound	62.2 (39.1–85.2)	-1.3 \pm 6.6	.368
2D ultrasound	54.8 (34.6–75.1)	6.0 \pm 9.4	.002

A Maximum Residual Sac Diameter 3D CT and 3D Ultrasound



B Maximum Residual Sac Diameter 3D CT and 2D Ultrasound



Philips iU22, Ultrasound System, Philips Healthcare X6-1, xMATRIX transducer

Perspectives : 3D - fusion

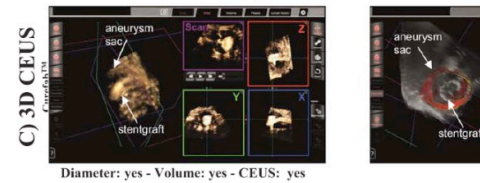
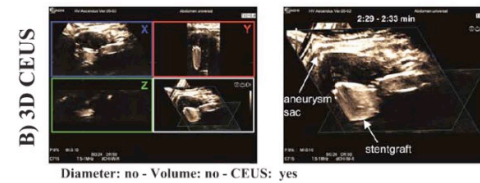
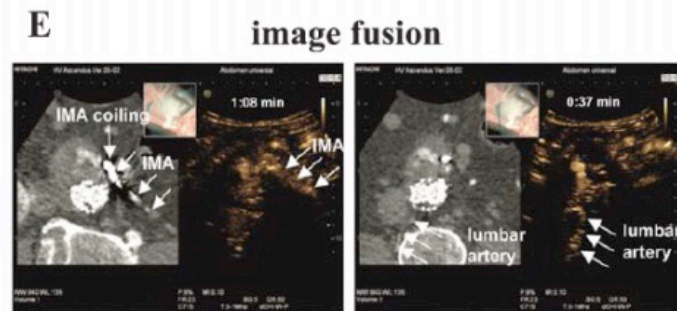
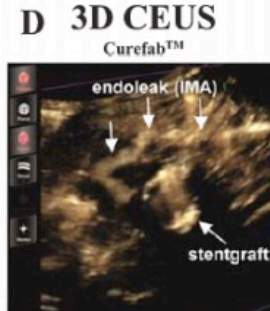
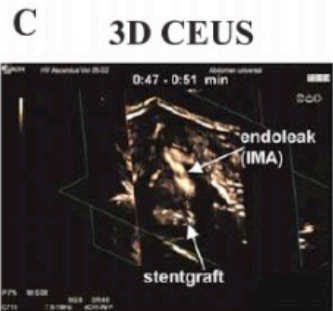
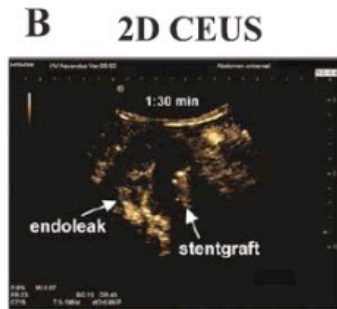
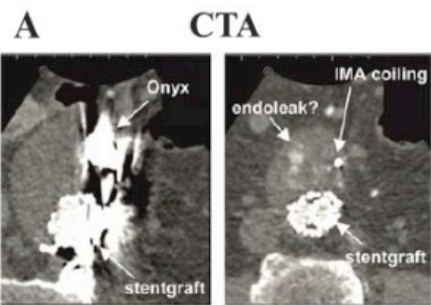
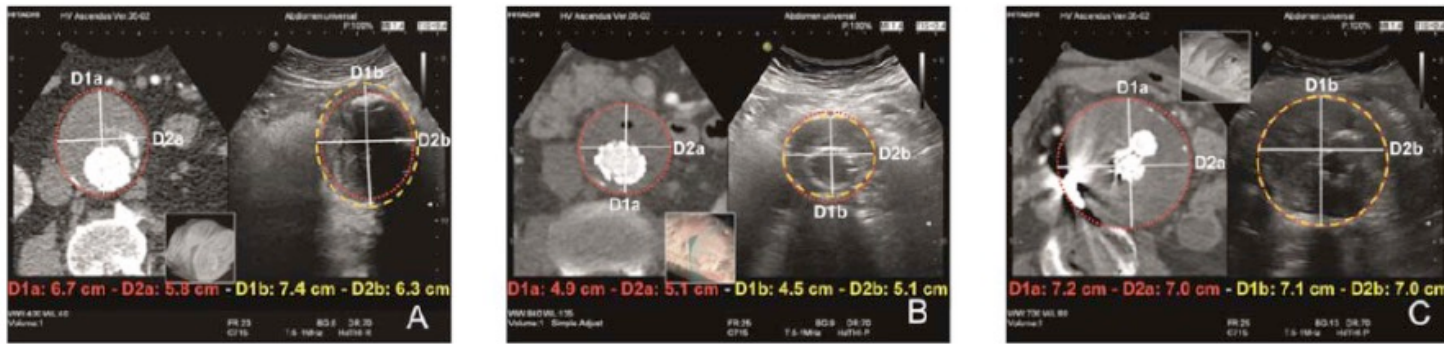
Standardized 2D ultrasound versus 3D/4D ultrasound and image fusion for measurement of aortic aneurysm diameter in follow-up after EVAR

Karin Pfister^{a,*}, Wilma Schierling^a, Ernst Michael Jung^b, Hanna Apfelbeck^a, Christoph Hennesperger^c and Piotr M. Kasprzak^a

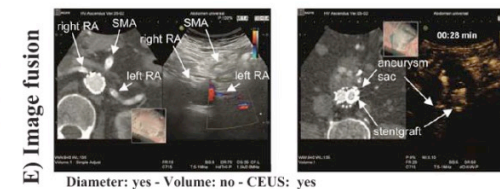
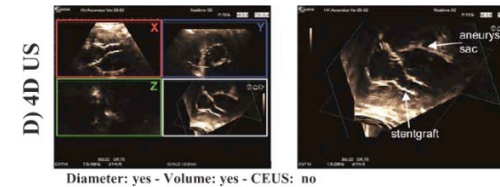
^aDivision of Vascular and Endovascular Surgery, University Medical Center Regensburg, Regensburg, Germany

^bInstitute of Diagnostic Radiology, University Medical Center Regensburg, Regensburg, Germany

^cComputer Aided Medical Procedures (CAMP), Technische Universität München, Garching, Germany



- 20 patients
- Hitachi HI VISION Ascendus



Applications en vasculaire ?

- Imagerie non échographique disponible
- Deux situations :
 1. Lésions artérielles difficiles à caractériser ou quantifier
 2. Lésions artérielles justifiant un suivi pour lequel l'exposition aux radiations veut être réduite

Applications en vasculaire ?

- Aide au suivi écho-doppler des endoprothèses aortiques abdominales
- Aide à la caractérisation d'une lésion carotidienne atypique :
dissection, diaphragme, thrombus
- Aide à la quantification de lésions artérielles sténosantes calcifiées
- Aide au repérage et au suivi des lésions de dysplasie fibromusculaire
- Aide au suivi écho-doppler d'anévrisme des artères digestives ou rénales

Messages – Echo doppler des maladies aortiques

- Imagerie incontournable pour le diagnostic et le suivi des maladies de l'aorte abdominale
- Renseignements étiologique et de gravité
- Savoir utiliser le produit de contraste pour l'aide au diagnostic
- Perspectives : fusion, 3D, contraste/fusion/3D ...