

La cloison interatriale dans tous ses états



F Levy

Prise en charge du fop



collaboration neuro/ cardio

WANTED

dead or alive

	FOP
AVC	+
Hypoxémie posturale	+
Migraine	?
Plongée	+

REWARD
\$50000⁰⁰



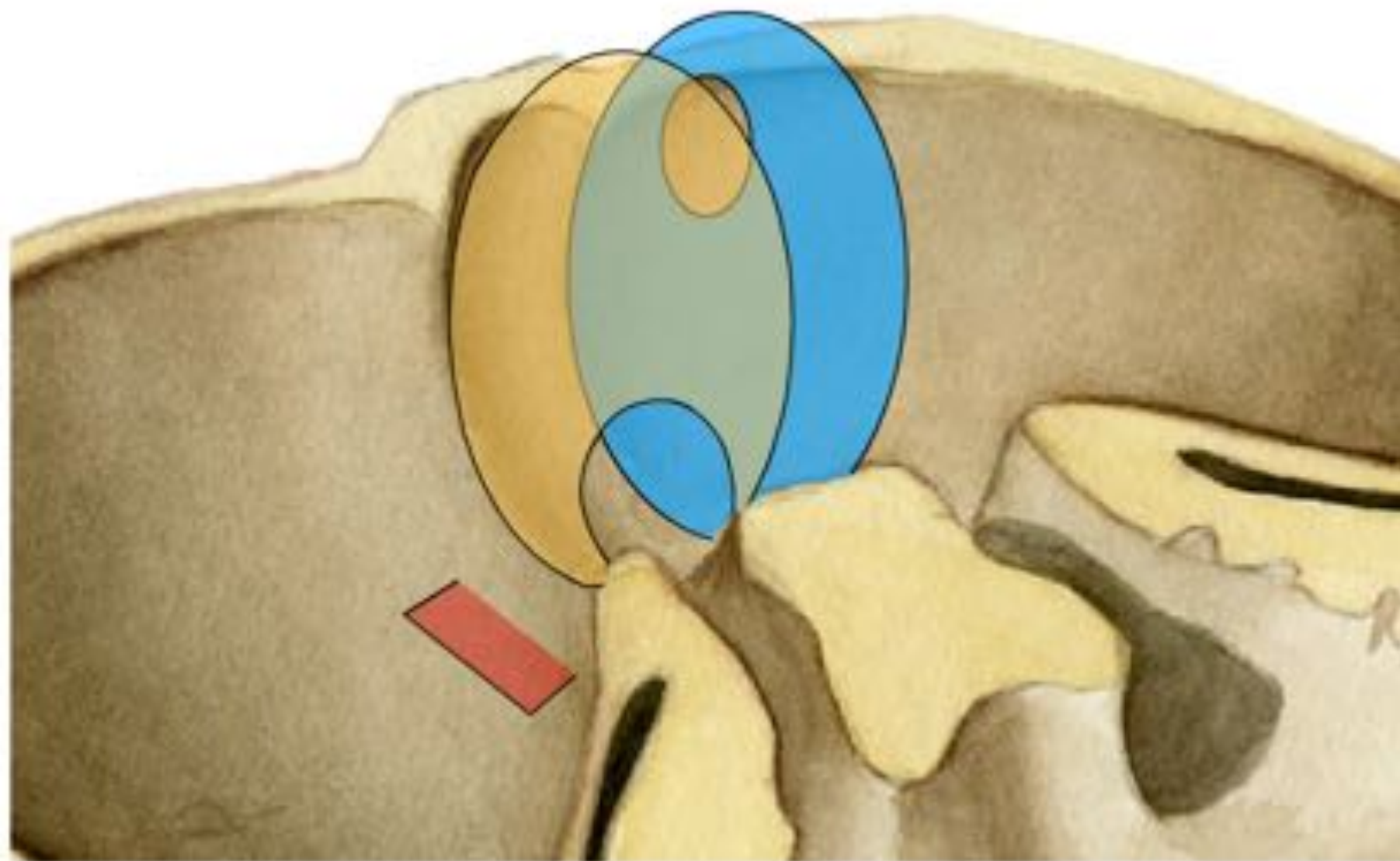
- Anatomie (pathologique)
- Diagnostic de FOP et ASIA
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 - Manœuvres de sensibilisation
- Sévérité du shunt
- Pièges

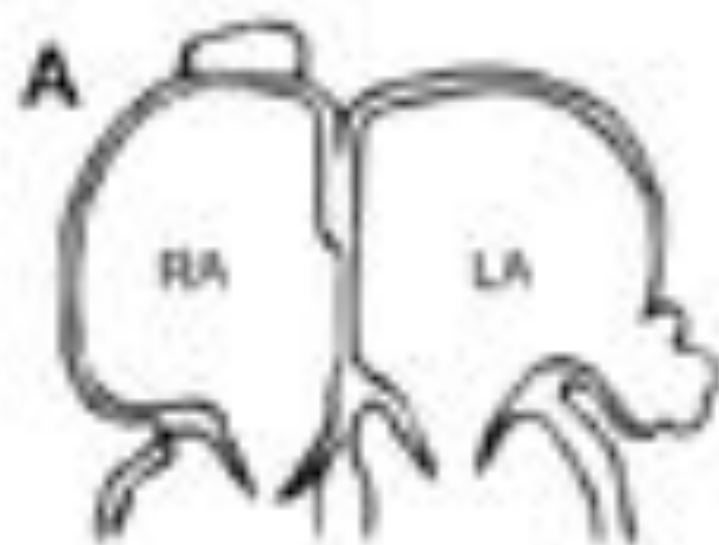
Vestige du canal de Botal

Maggie Tintignac



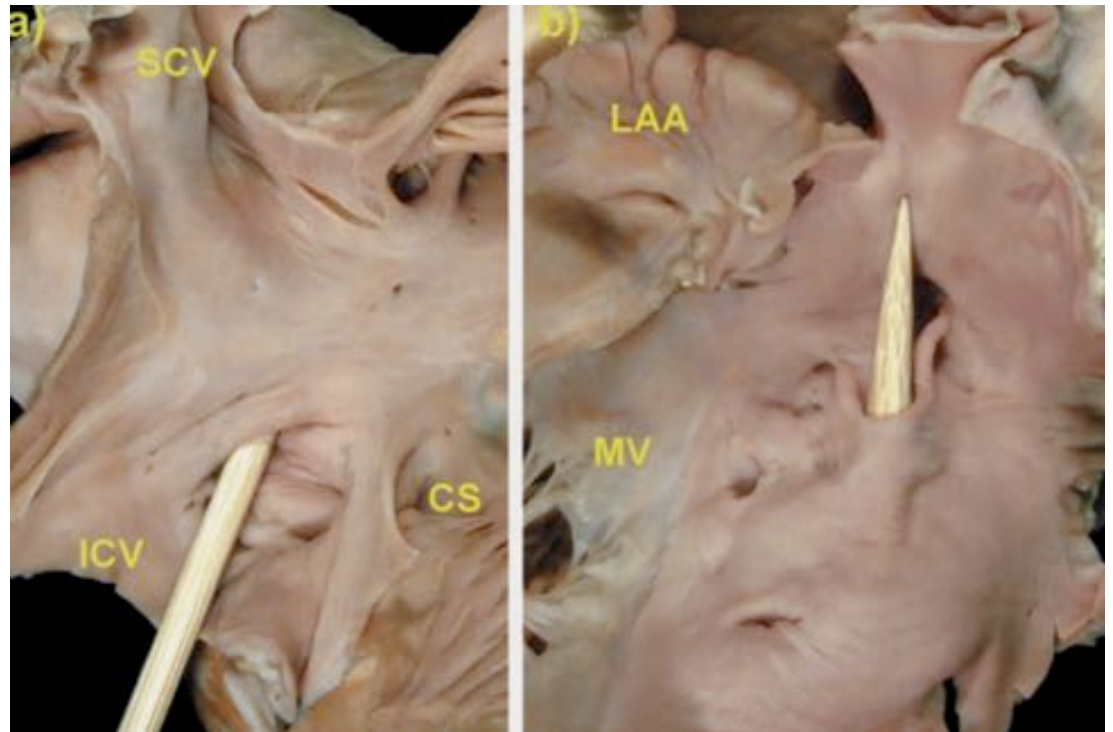
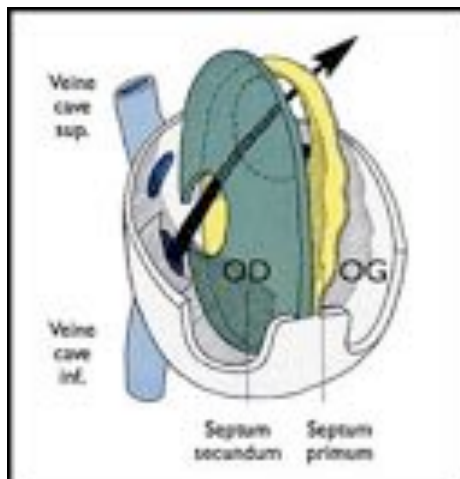
Maggie Tintignae



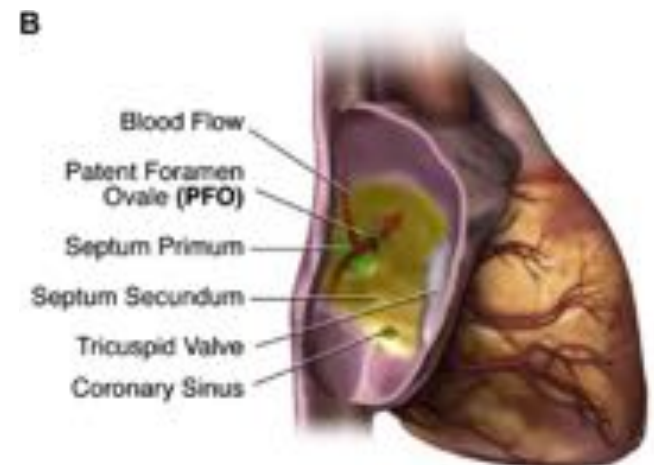
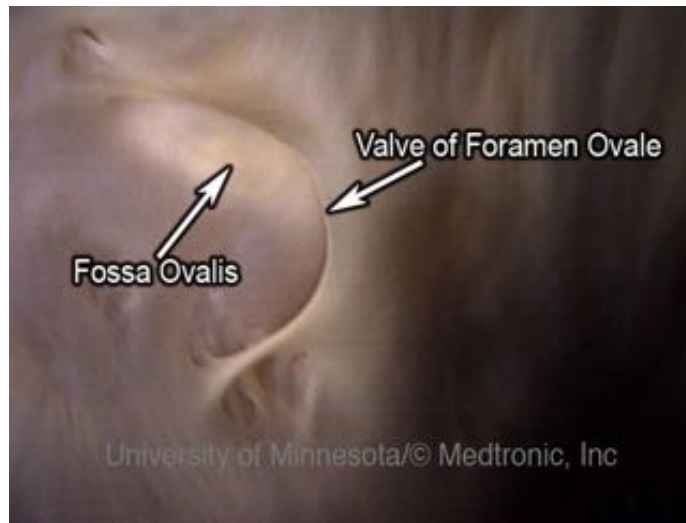


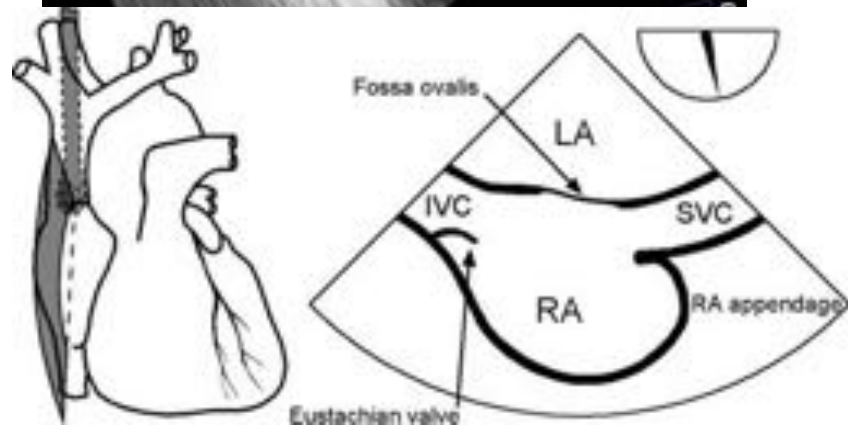
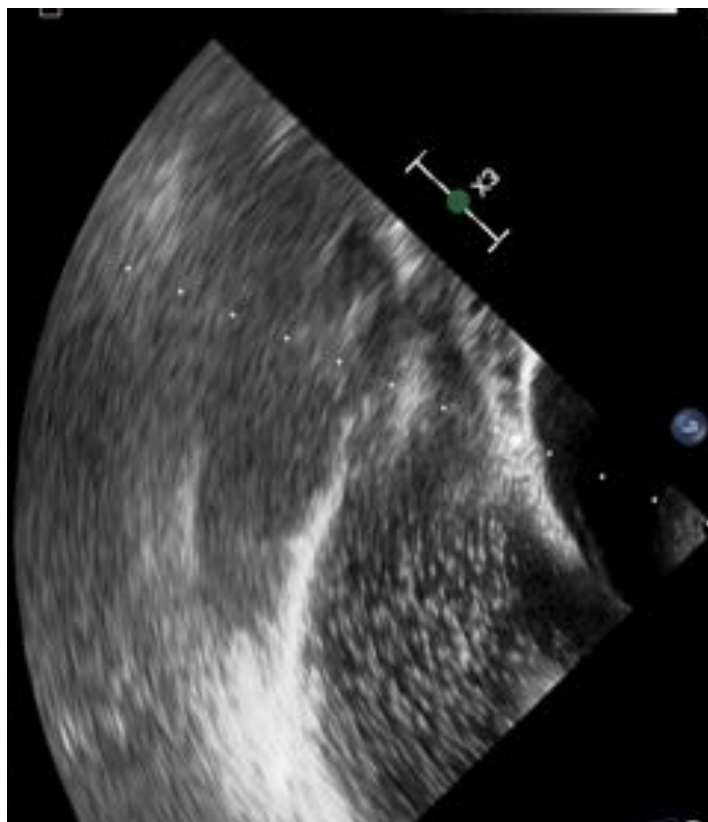
FOP

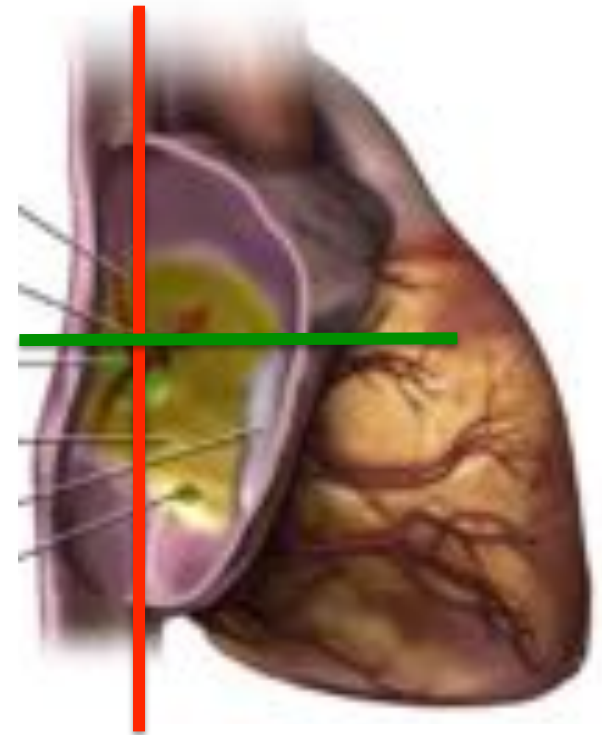
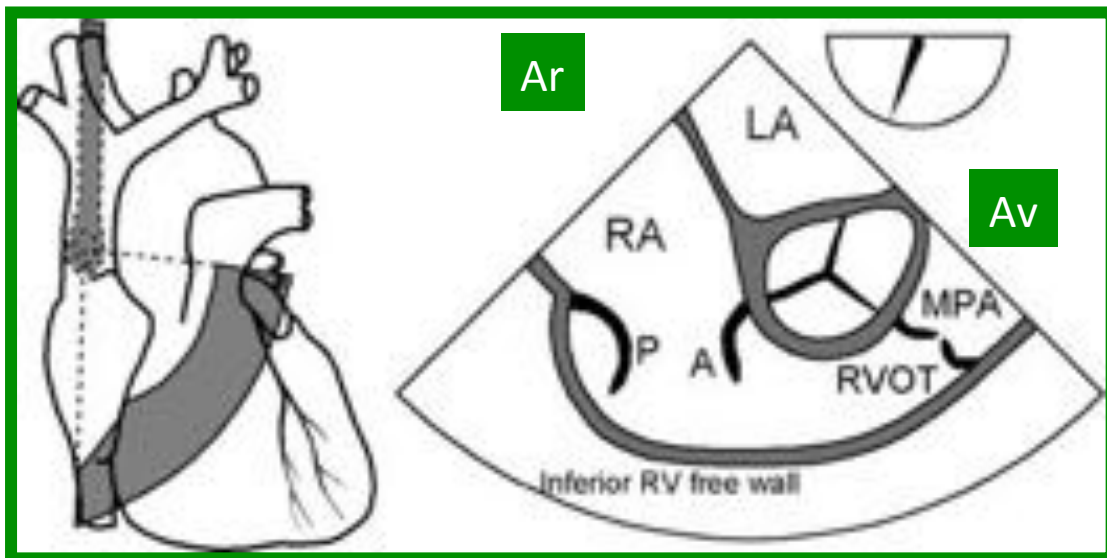
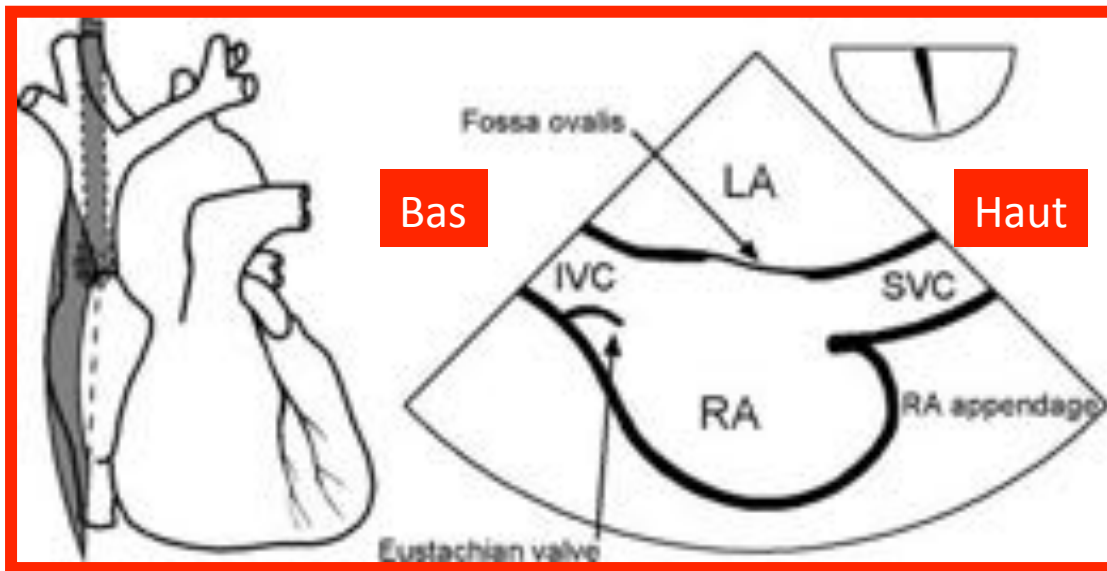
Fréquence : 14-25% selon les études anatomiques et
25% selon les études échographiques

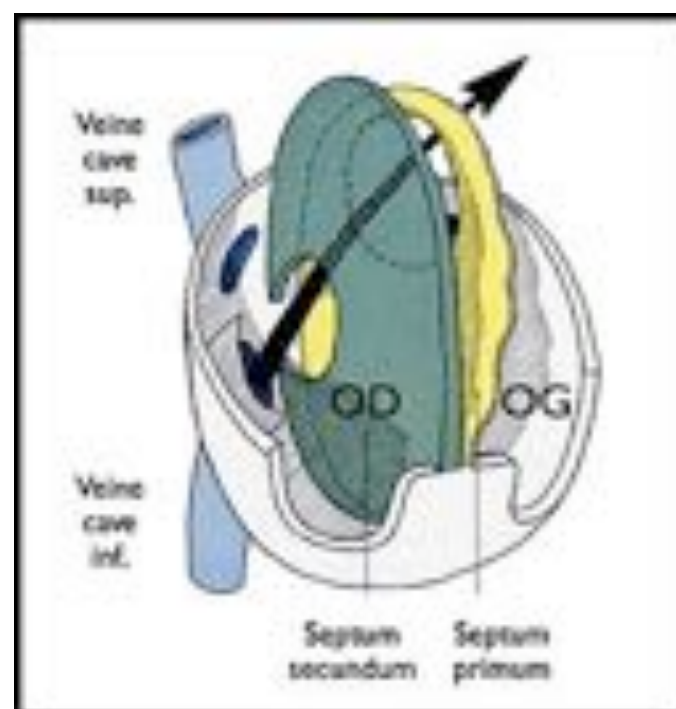


FOP





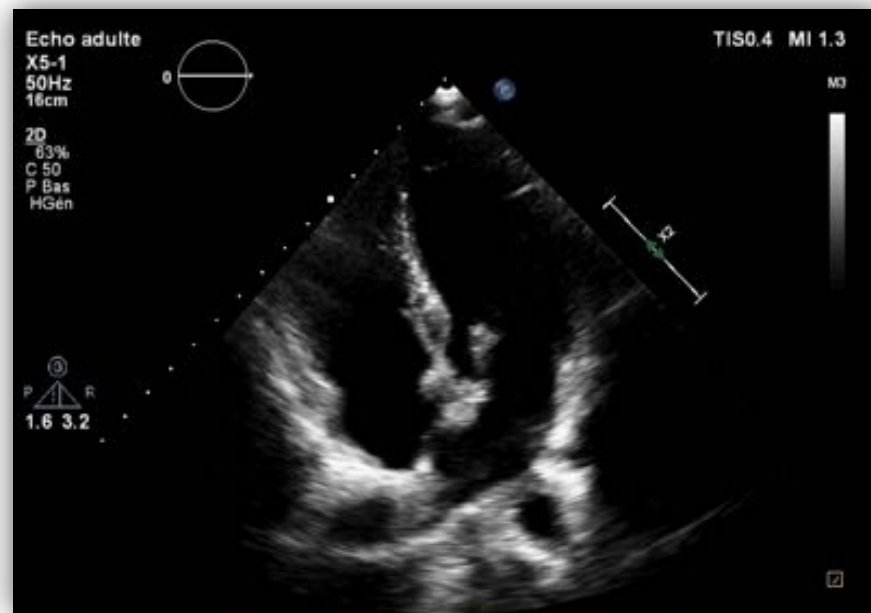




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ASIA en ETT



Epreuve de contraste ETT

Which Technique Is Better for Detection of Right-to-Left Shunt in Patients with Patent Foramen Ovale: Comparing Contrast Transthoracic Echocardiography with Contrast Transesophageal Echocardiography

Tian Li, M.D., Zhai Ya-nan, M.D. and Wei Li-qun, M.D.

L'ETT est plus performante pour détecter un shunt D/G lors de l'épreuve de contraste mais résolution spatiale < ETO

l'ETO apporte une meilleure évaluation de l'anatomie et de l'ASIA

Meilleure qualité du valsalva en ETT

ETT

Epreuve de contraste

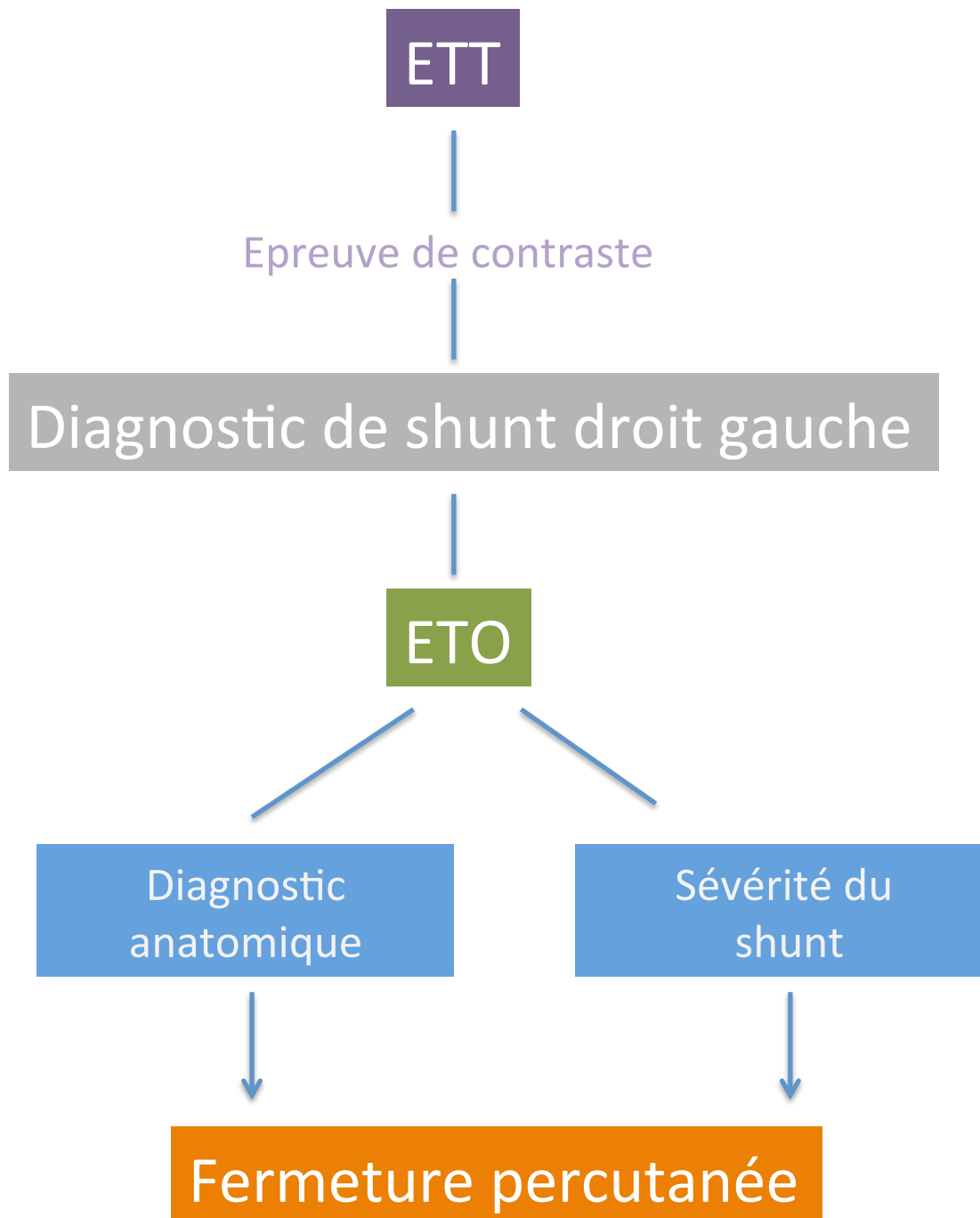
Diagnostic de shunt droit gauche

ETO

Diagnostic
anatomique

Sévérité du
shunt

Fermeture percutanée



ETO ou ETT?

	ETT	ETO
CLOSE	-	+
RESPECT	-	+
Gore REDUCE	-	+
Defense-PFO	-	+

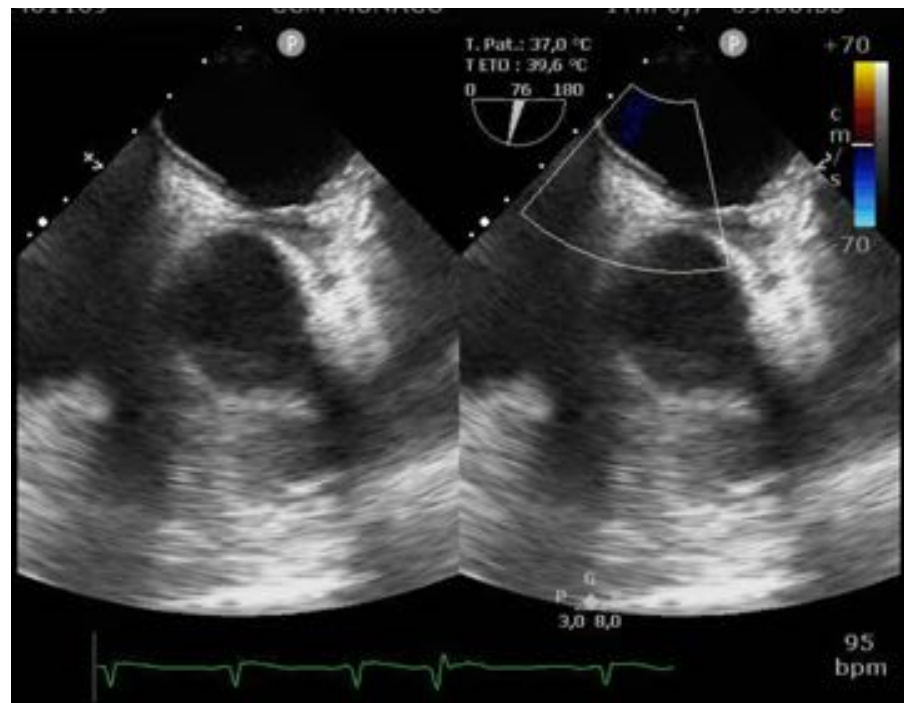
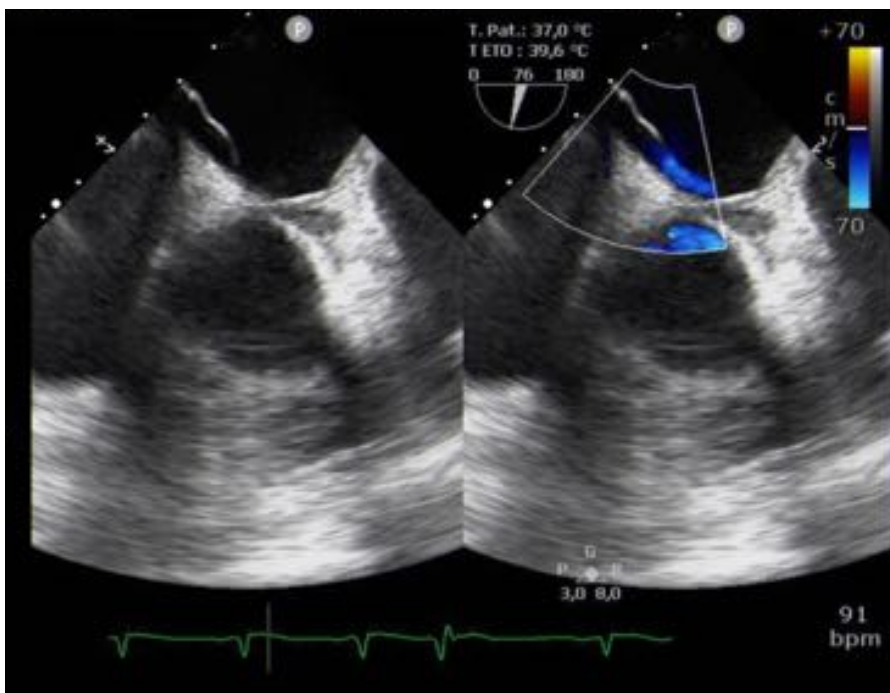
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Manœuvres de sensibilisation

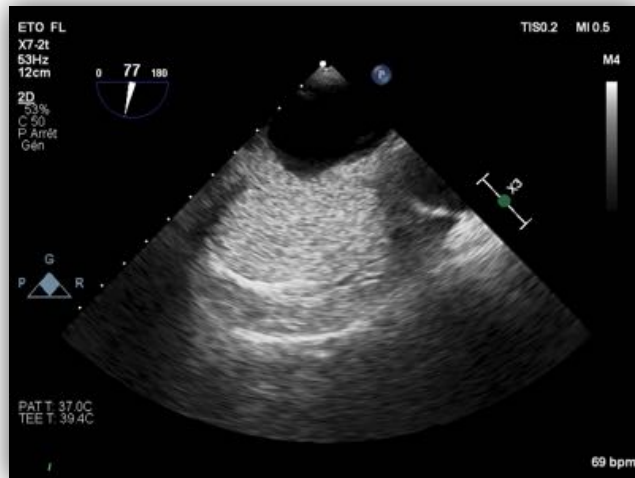
Visent à augmenter la POD



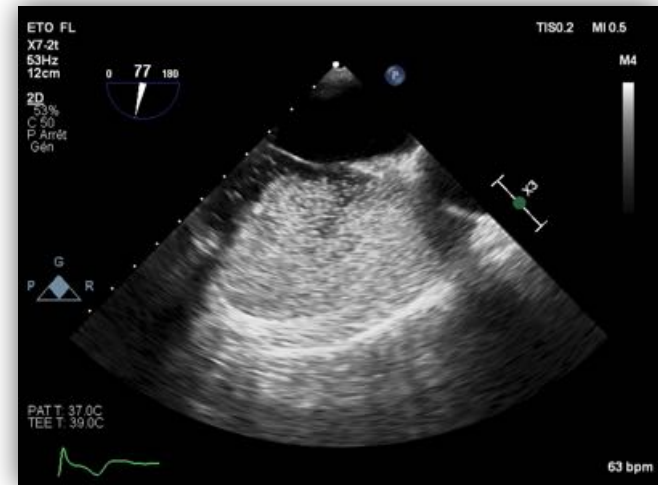
Shunt spontané en doppler couleur



Faut il faire une manœuvre de sensibilisation pour détecter le FOP?

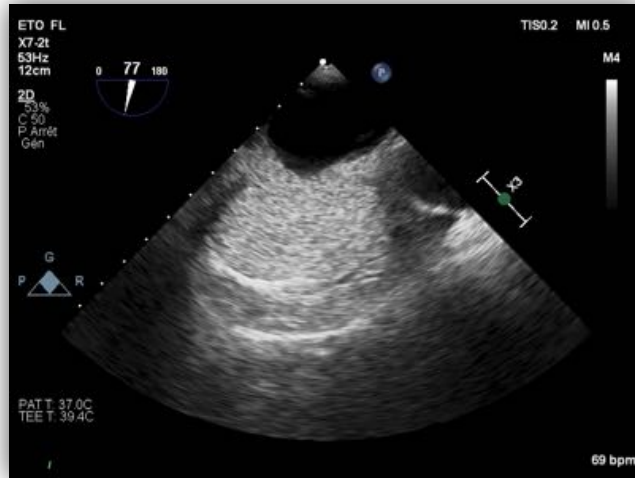


Sans manœuvre de sensibilisation
négatif

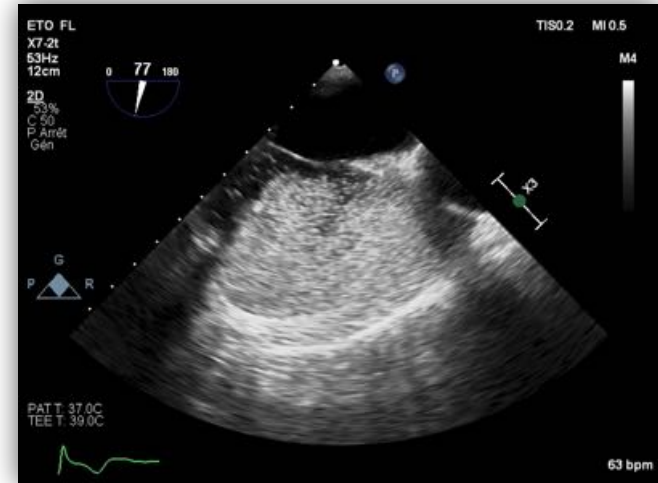


Contraste positif
après valsalva

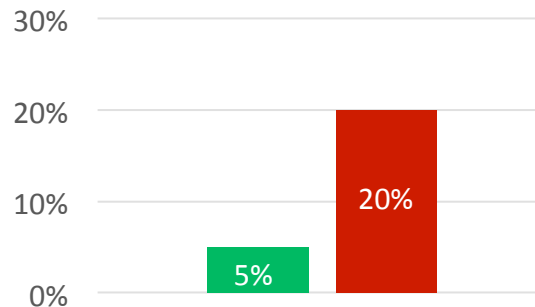
Faut il faire une manœuvre de sensibilisation pour détecter le FOP?



Sans manœuvre de sensibilisation
négatif



Contraste positif
après valsalva



N =290

Sans manœuvre 5% de pfo détectés vs 20% avec manœuvre! ($p < 0,0001$)

Manœuvre de Valsalva

en inspiration profonde et bloquée, en injectant les microbulles avant le relâchement du Valsalva



Gonflez

Bloquez

Poussez

Relâchez



Pression abd

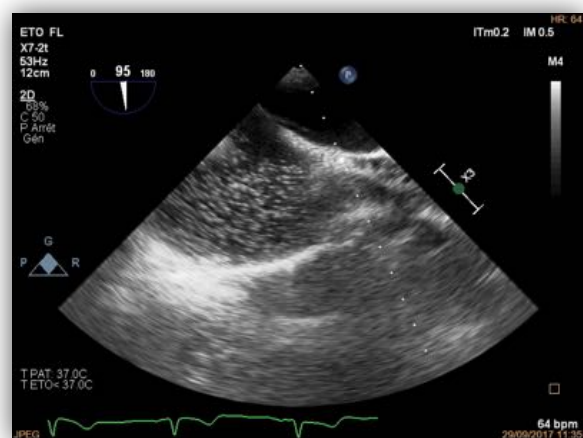
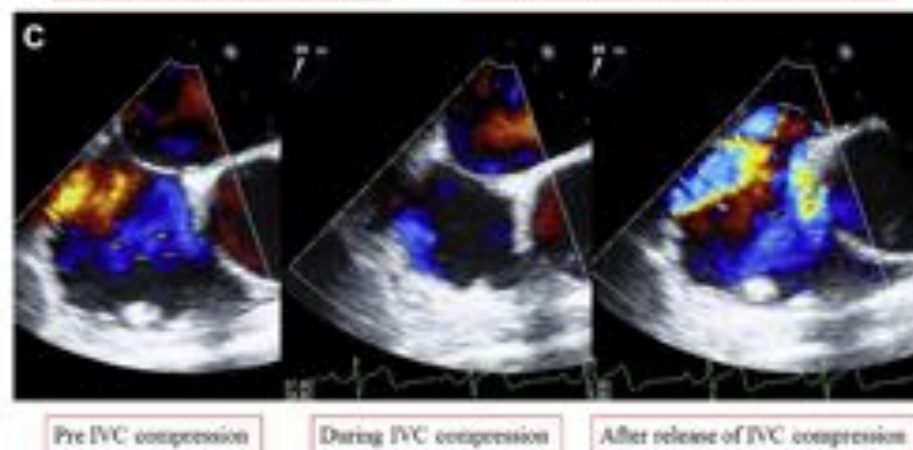
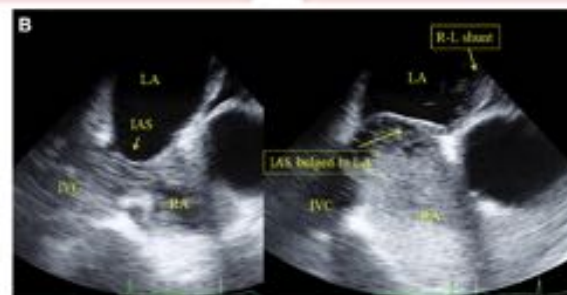
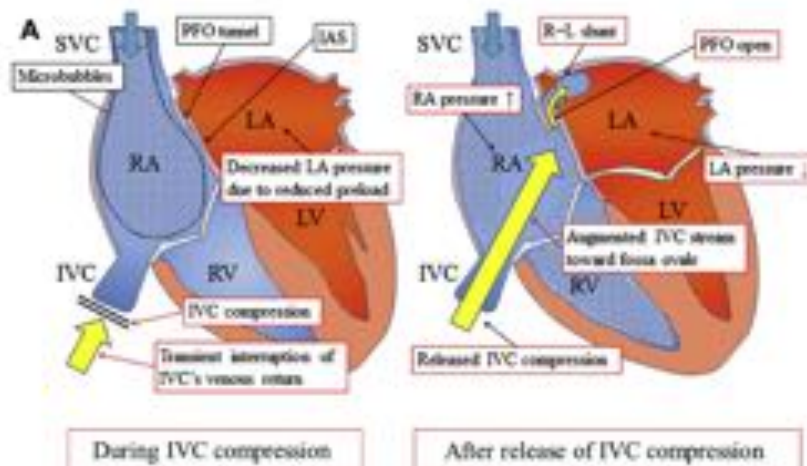


diminution retour vci



retour vci







N=290

No significant differences in PFO detection
between IVC compression and the Valsalva maneuver ($p=0.31$)

Anévrysme du septum interauriculaire

Touche 1% de la population

Excursion d'au moins 15mm par rapport au plan du sia et
base d'implantation d'au moins 15mm

Plusieurs types décrits

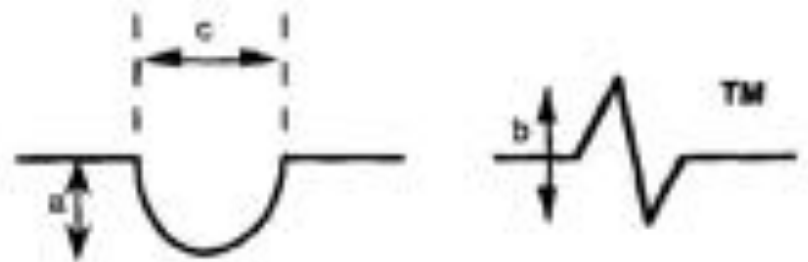


Fig. 1. (a) IASA protrusion into either atria. (b) IASA excursion. (c) Base of IASA.

International Journal of Cardiology 52 (1995) 59-65

Classification ASIA

NEW CLASSIFICATION OF ATRIAL SEPTAL ANEURYSM

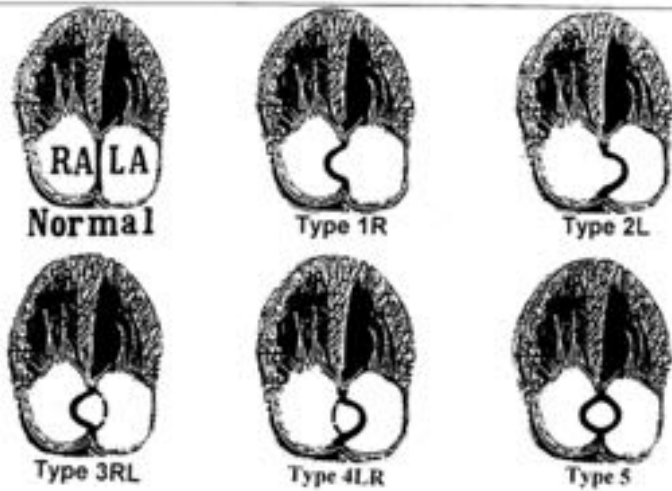
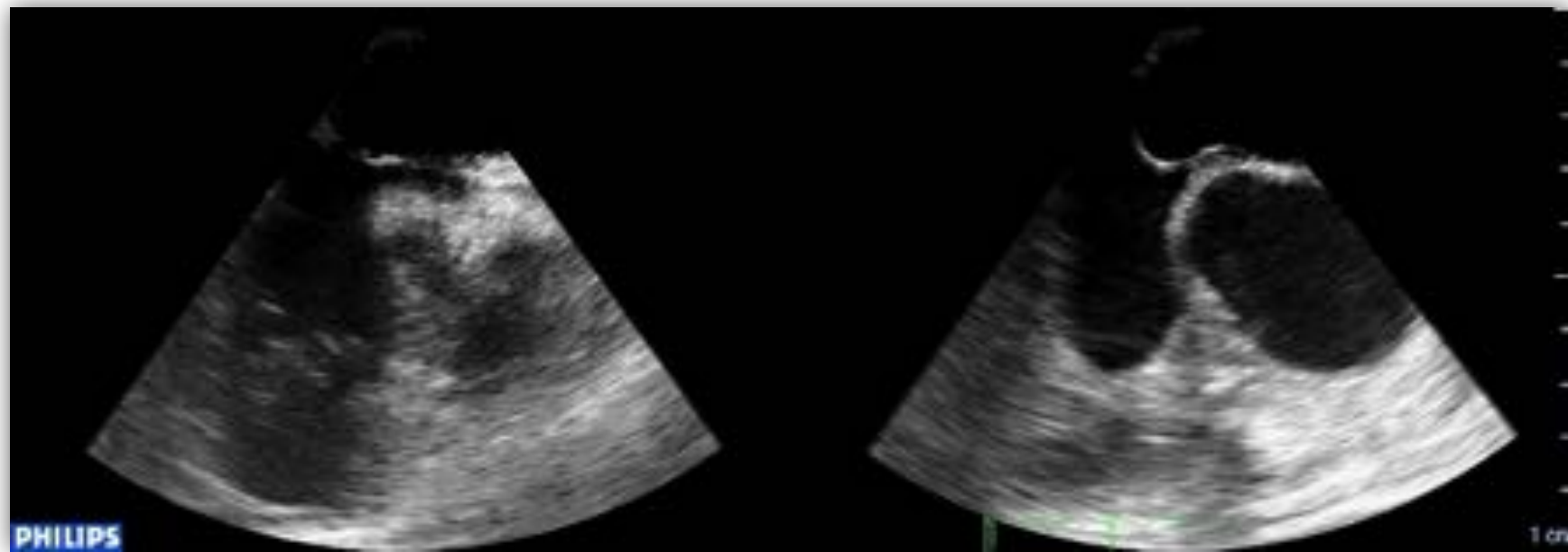
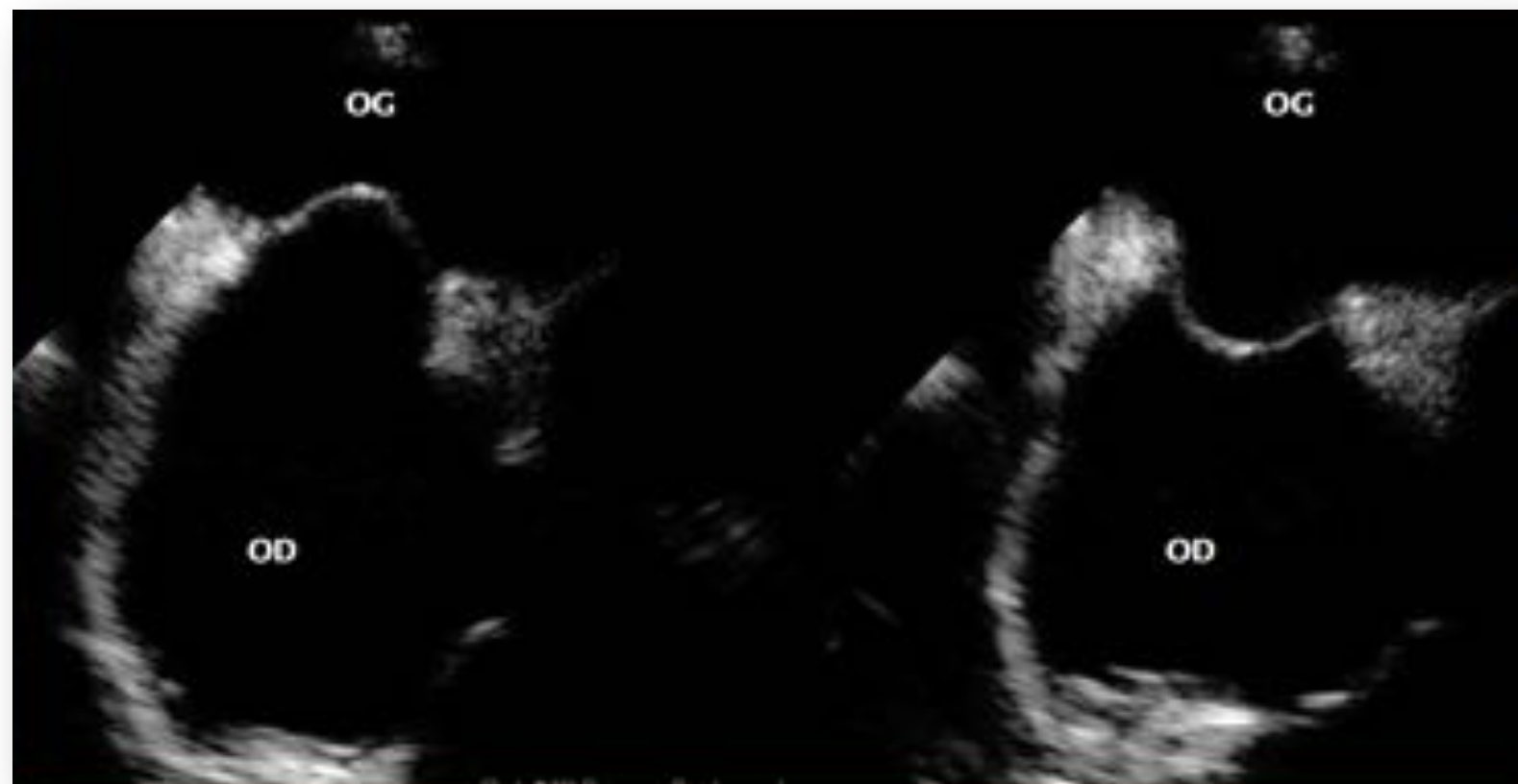


Figure 1 Echocardiographic four-chamber view, as well as the different bulgings of the atrial septum with aneurysm, showing the new classification of atrial septal aneurysm and how normally the atrial septum is seen in a two-dimensional depiction.

ASA type	Description
Type 1R	Bulging of ASA into right atrium only
Type 2L	Bulging of ASA into left atrium only
Type 3RL	Major excursion bulges into the right atrium and the lesser excursion bulges towards the left
Type 4LR	Major excursion bulges into the left atrium and the lesser excursion bulges towards the right
Type 5	ASA movement is bidirectional and equidistant to both atria during the cardiorespiratory cycle







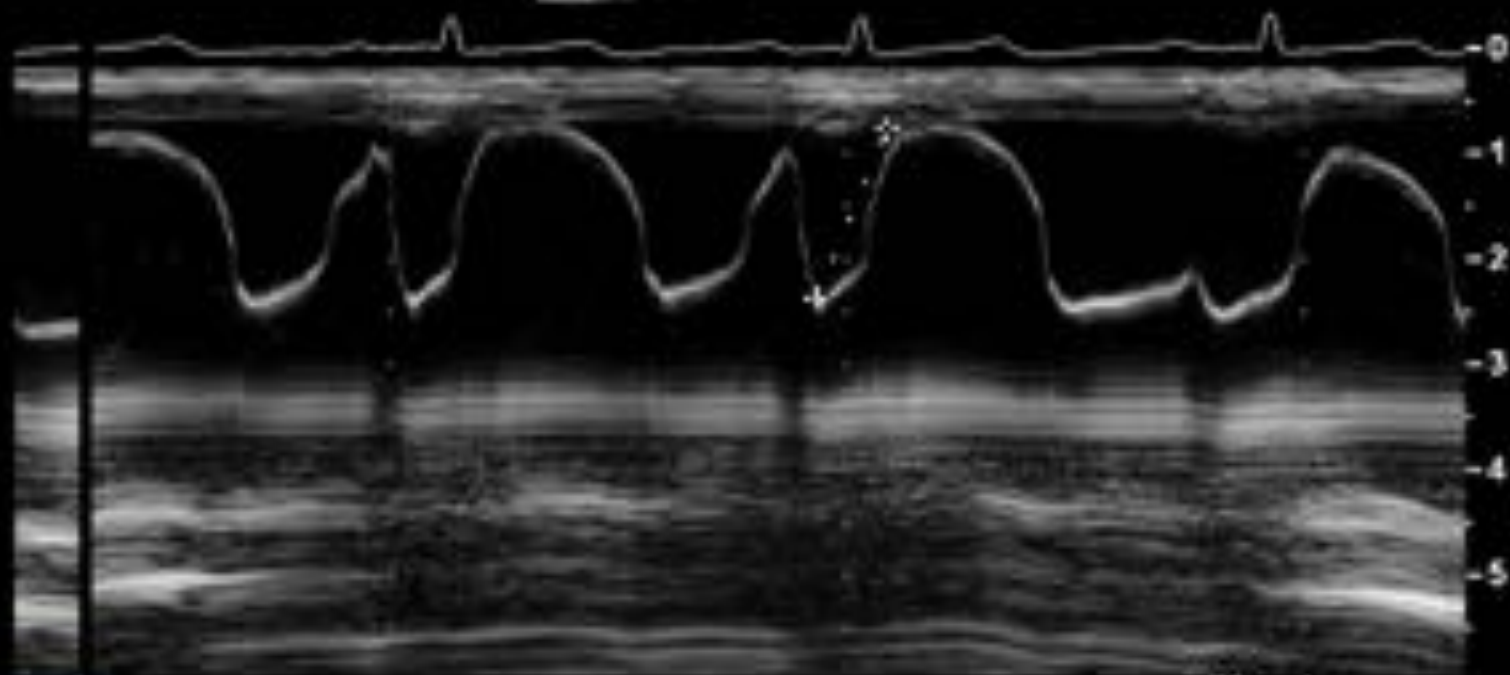
CI 31Hz
6.0cm

2D / TM
37% 37%
C 53
P Arrêt
Gén



+ Dist 1.60 cm
Temps 155 ms
Pente 10.3 cm/s

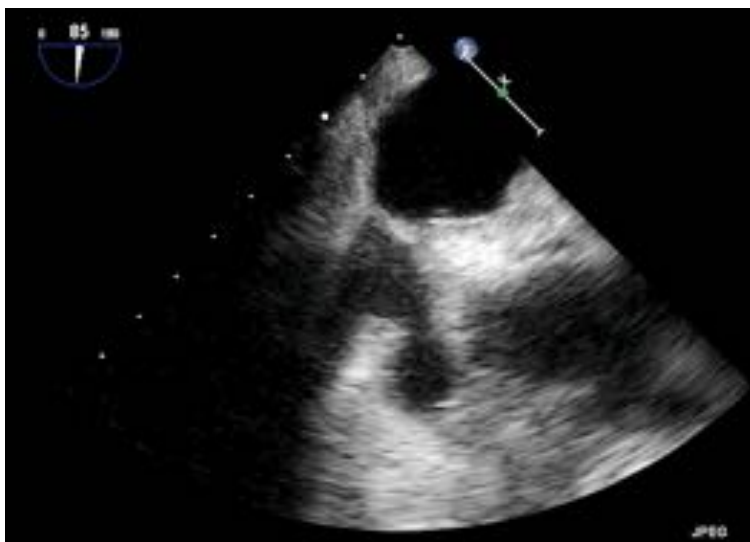
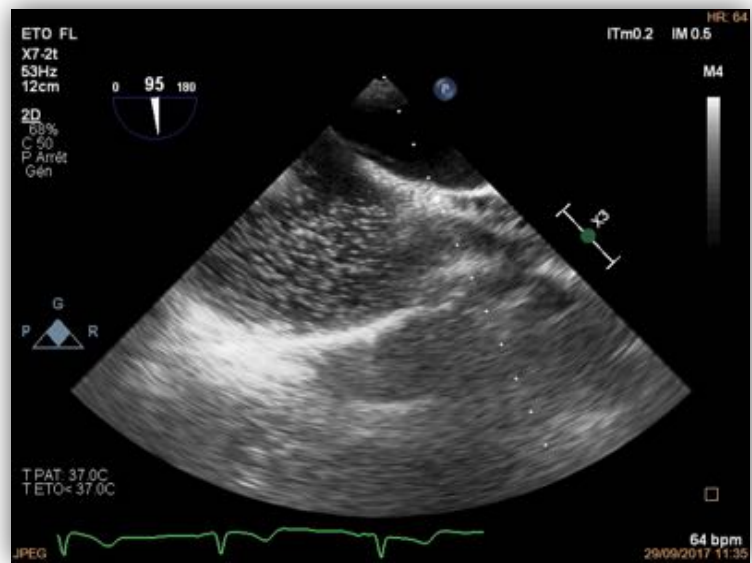
Q



PHILIPS

75mm/s

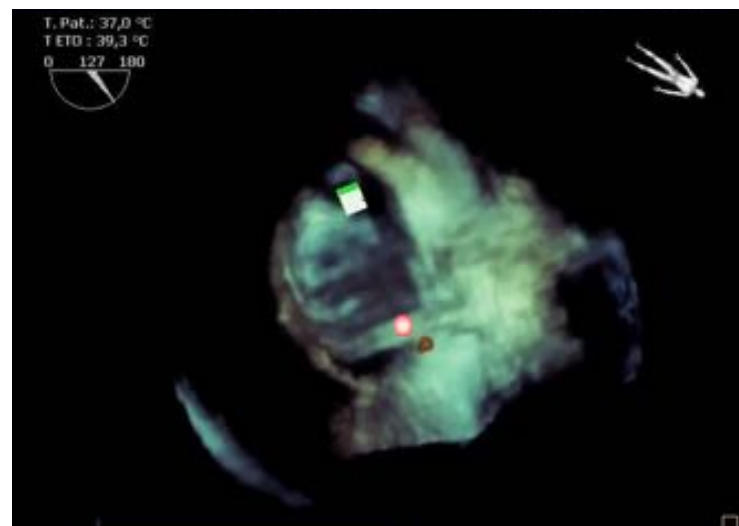
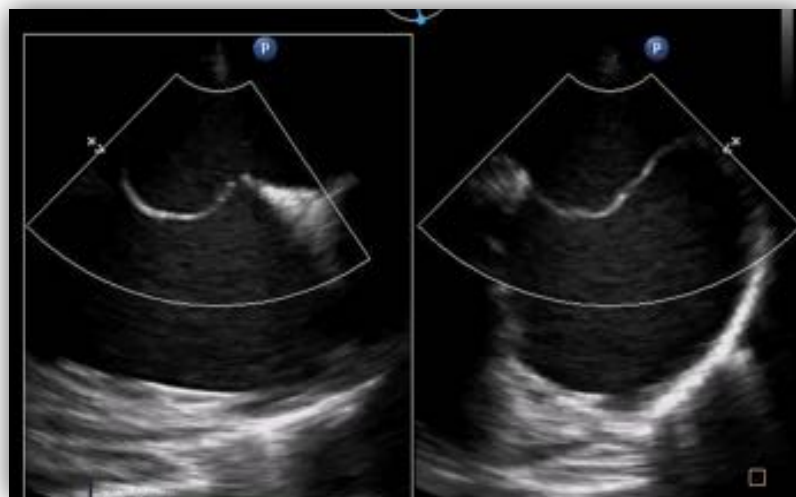
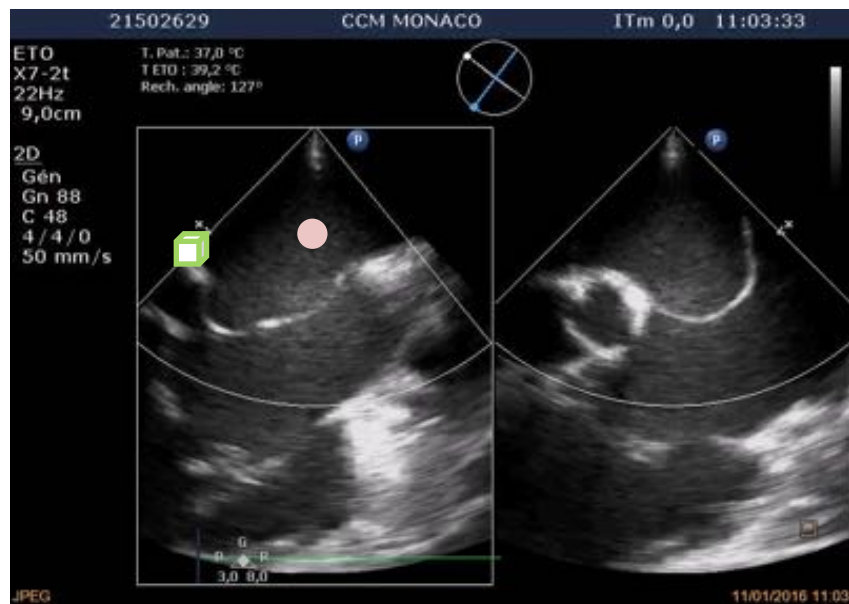
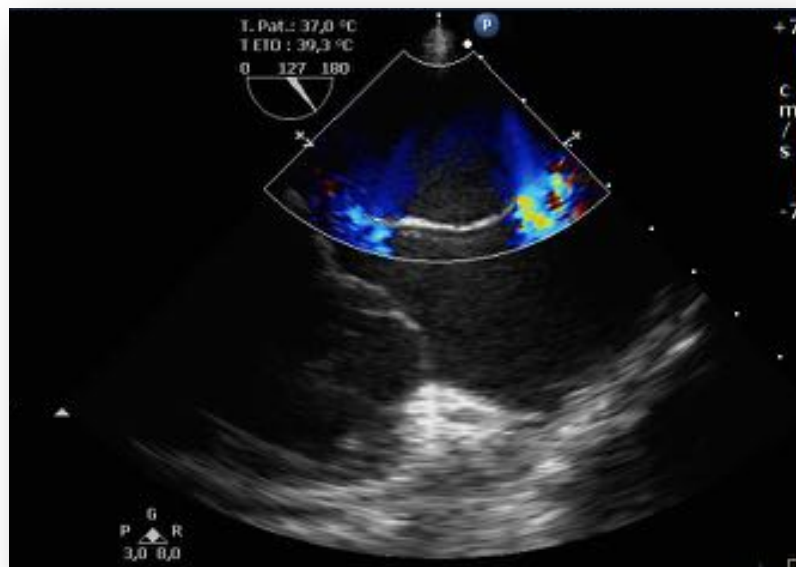
66bpm

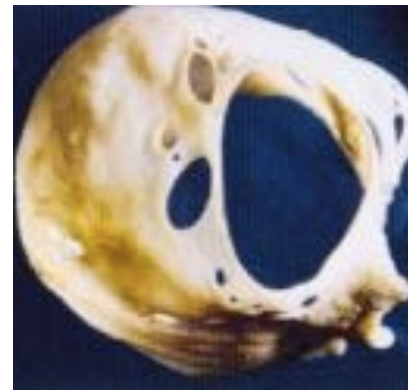
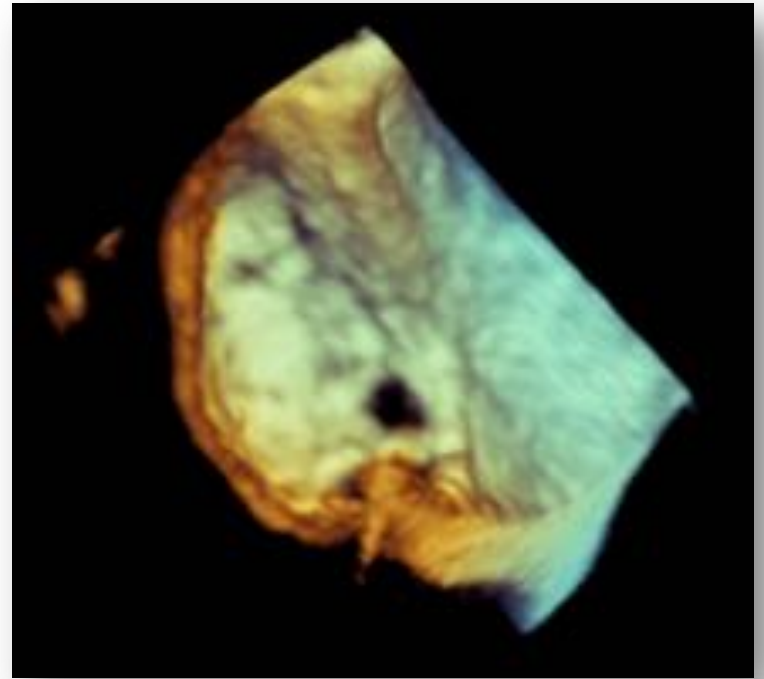
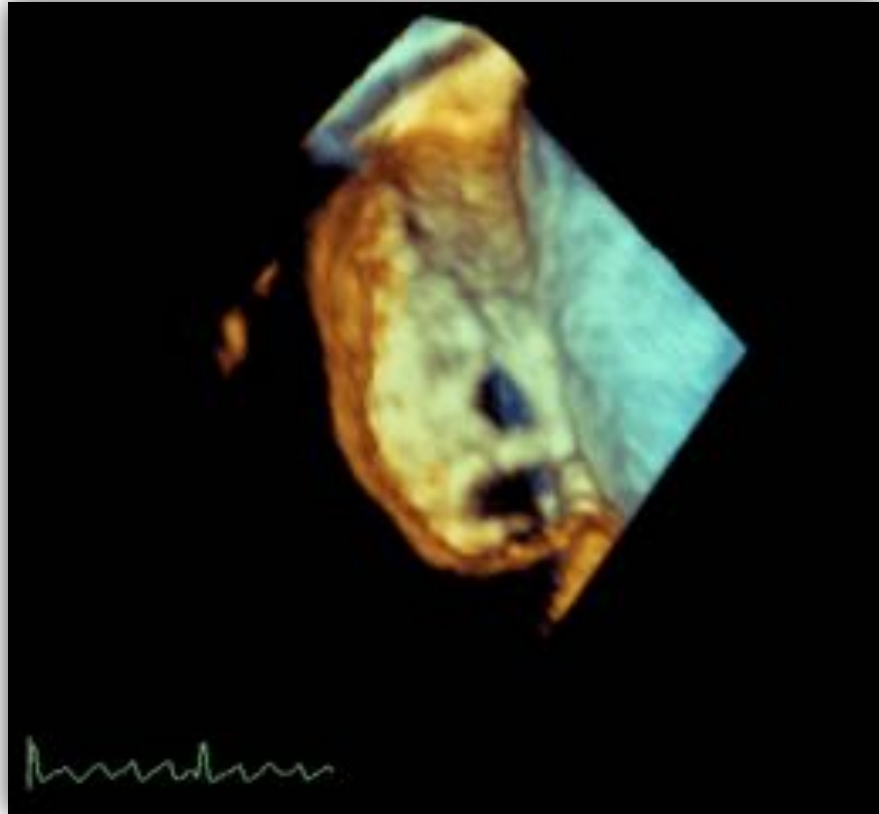


10:20:24

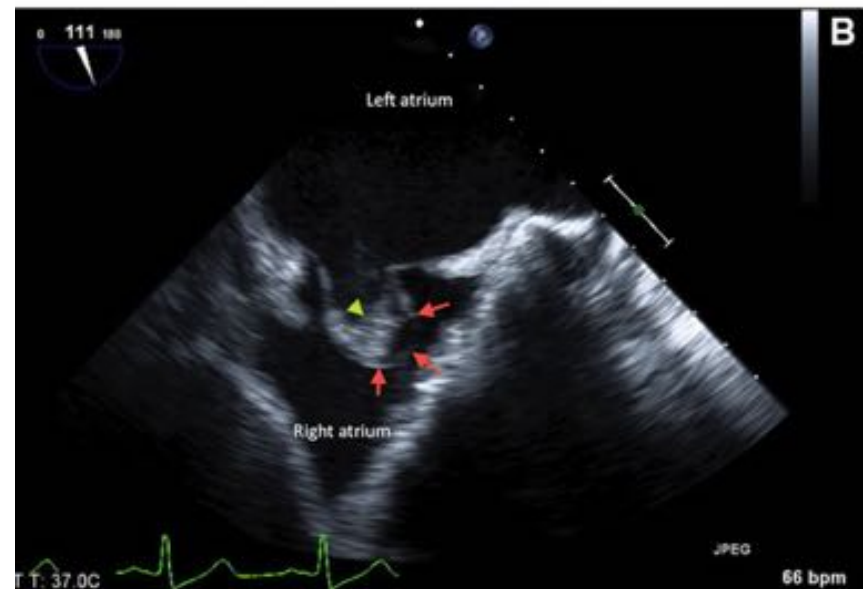
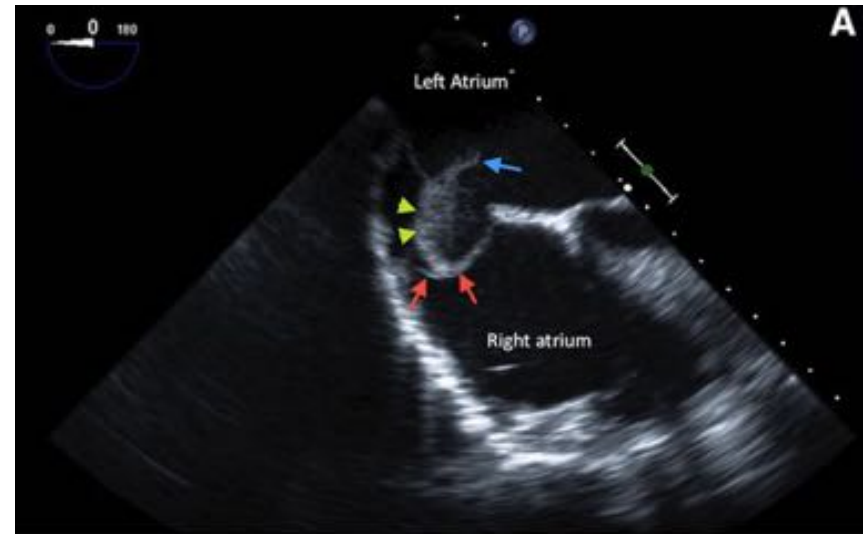


ASIA multiperforé

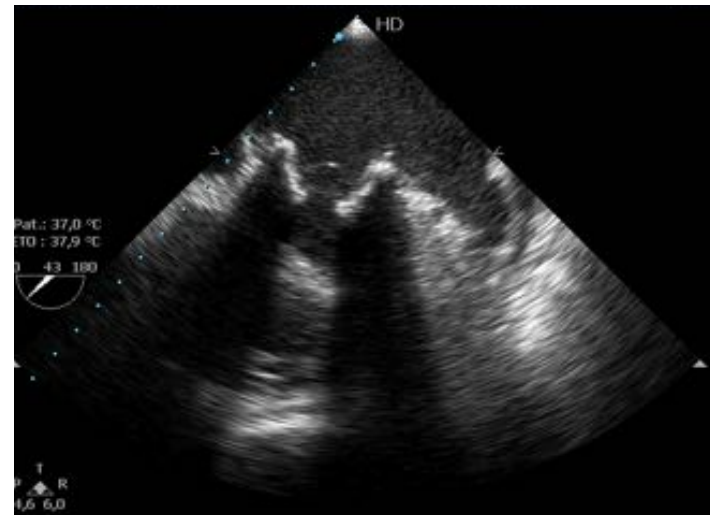
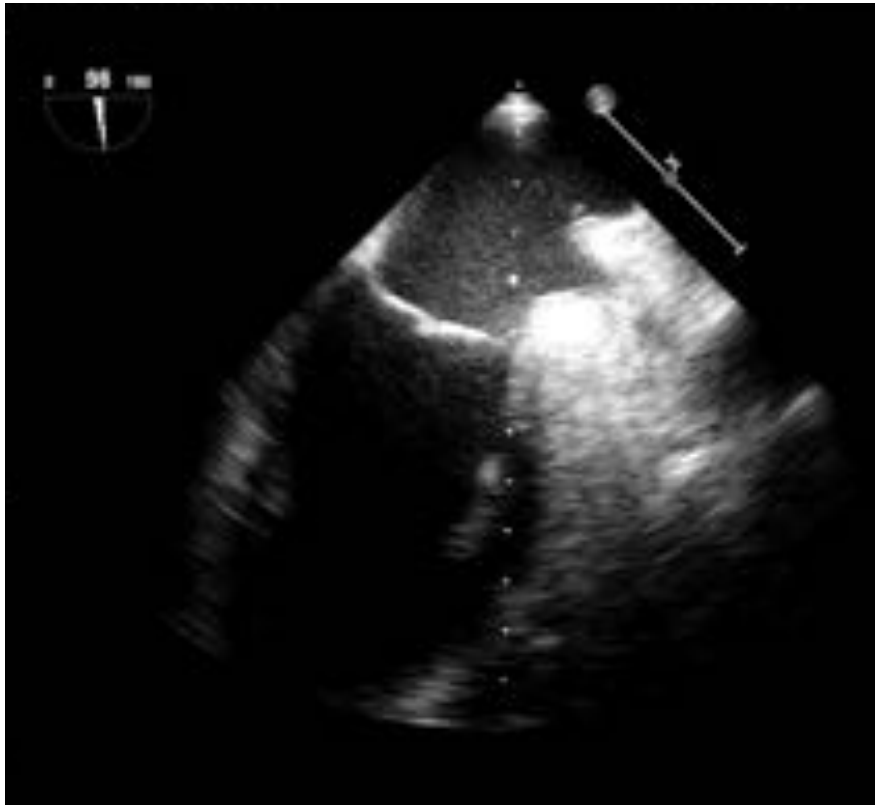




ASIA fixe et Thrombus



Les thrombi c'est pas QUE dans l'auricule...



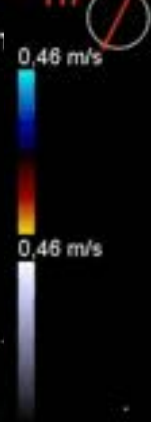
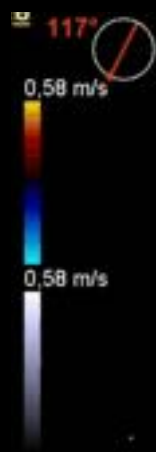
FOP



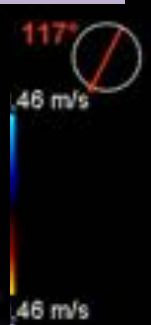
ASIA + FOP



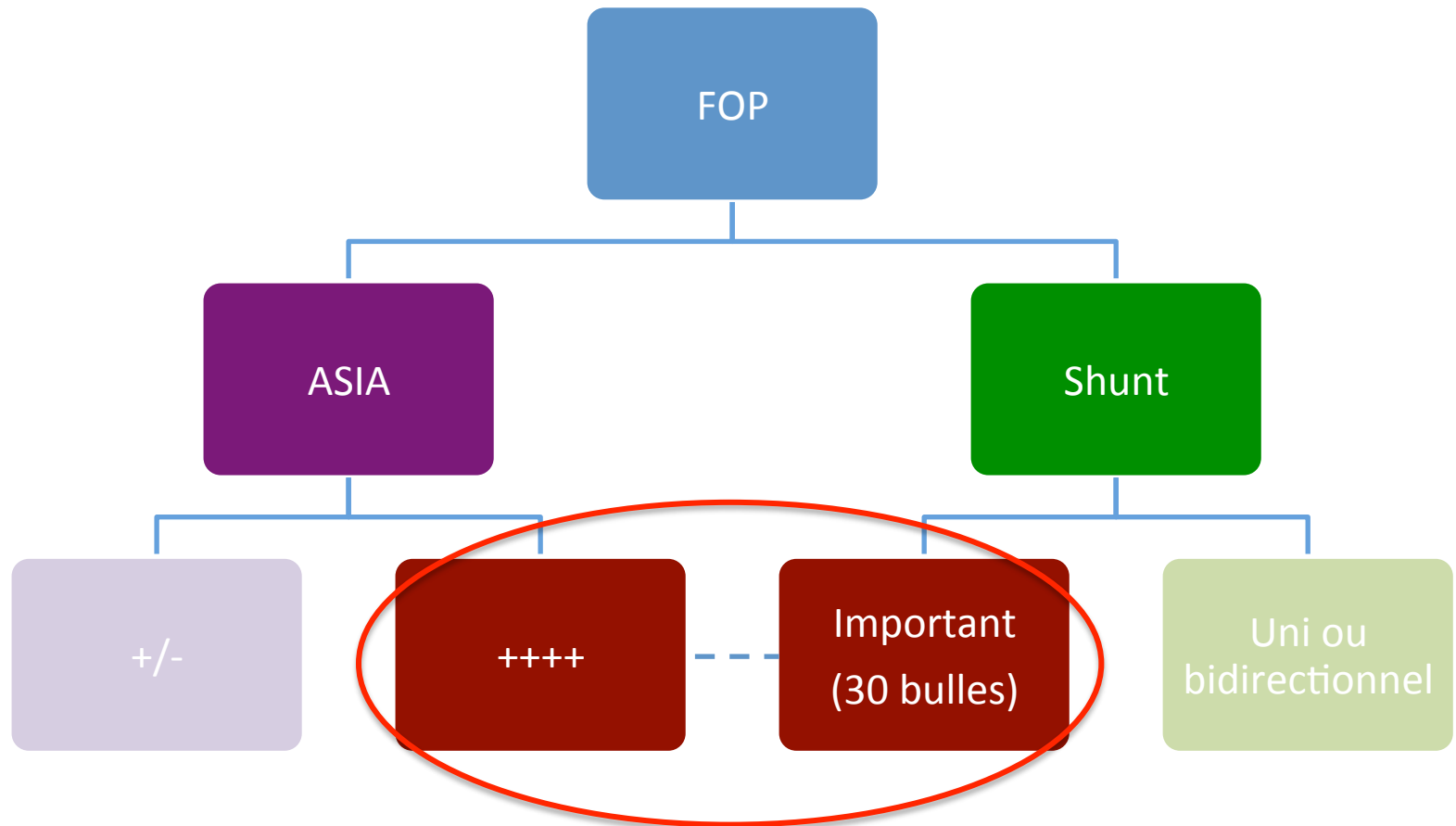
Tunnel



Tunnel



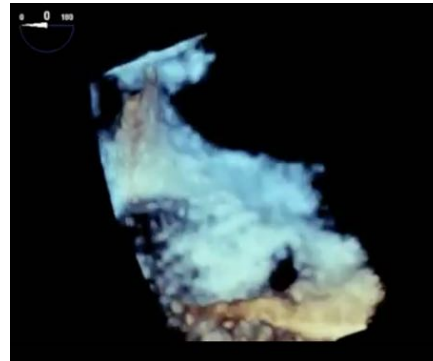
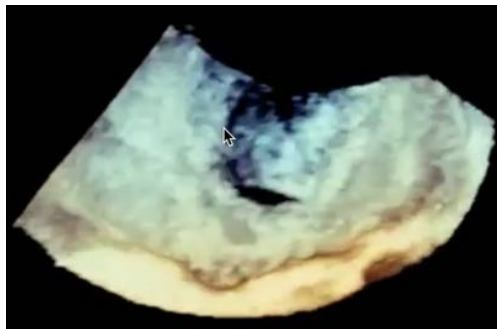
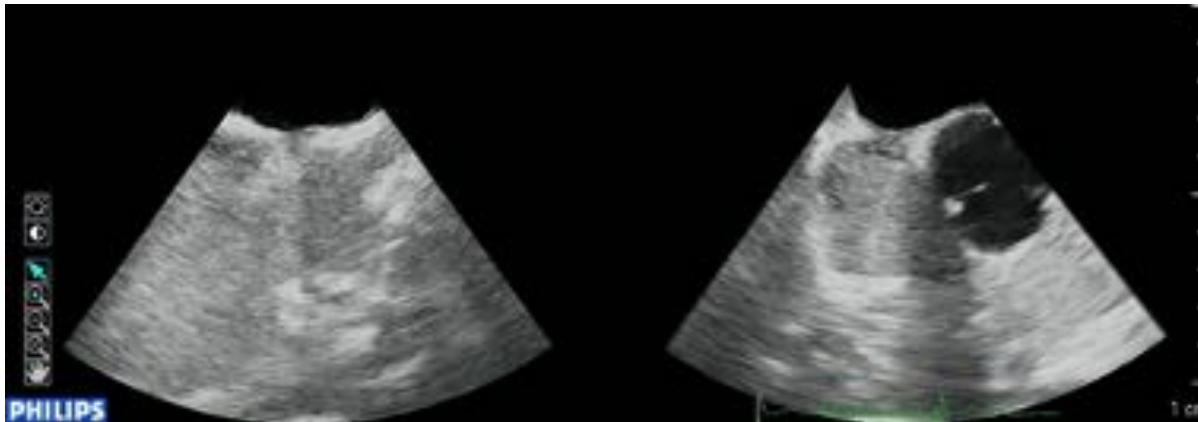
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Epreuve de contraste

Agitation serum salé ou macromolécules shunt droit gauche
Critères de positivité : apparition très précoce d'au moins 3 microbulles
Dans les 3 à 5 cycles qui suivent l'opacification complète de l'OD
Passage tardif = shunt intrapulmonaire
Manœuvres de provocation (valsalva)



Quantification arbitraire du shunt:

0: pas de shunt (<3 microbulles)

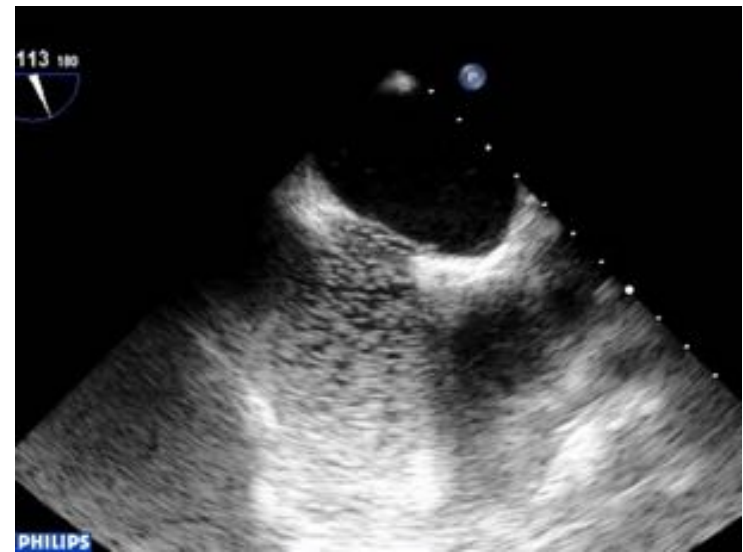
1: ~~petit shunt (<10)~~

2: shunt modéré (10 à 30)

3: shunt important (>30)



pas de shunt (<3)

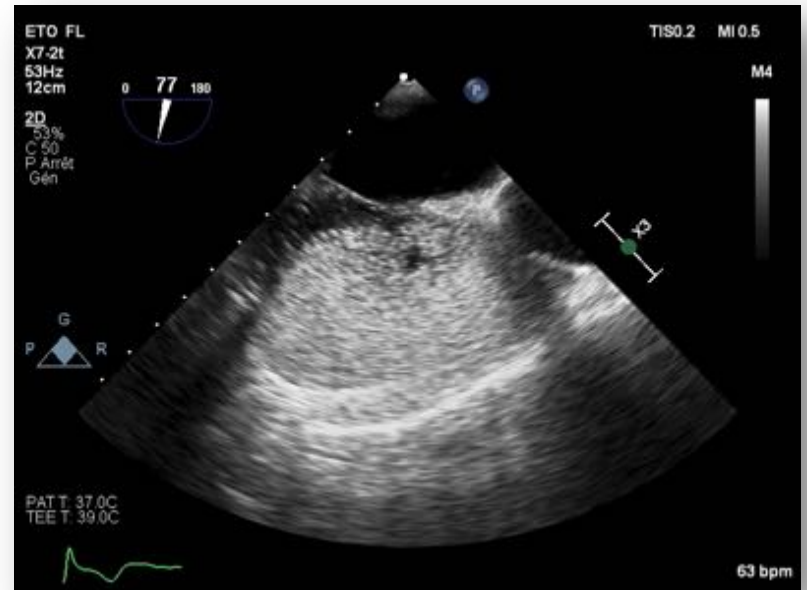
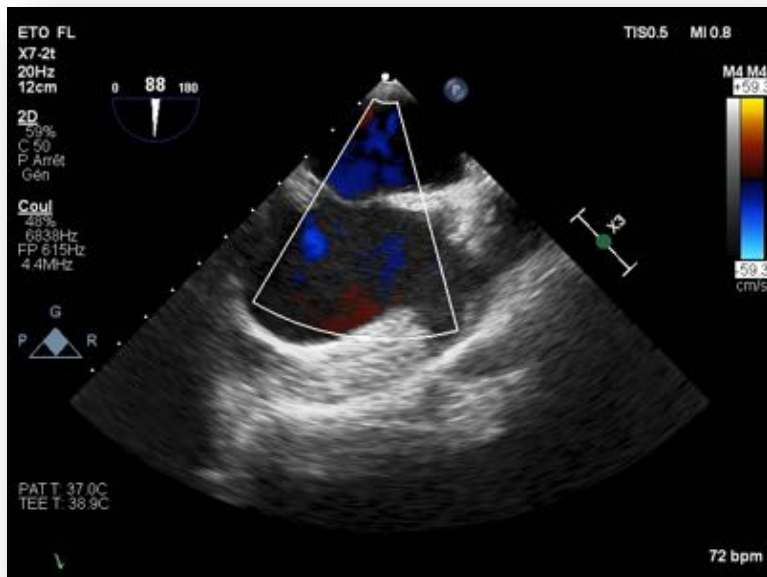


shunt modéré (10 à 30)



shunt large (>30)

Shunt bidirectionnel



Comment le FOP est-il défini dans les grandes études récentes?

CLOSE

« ...with no identifiable cause other than a PFO with an associated **atrial septal aneurysm** or **large interatrial shunt** »

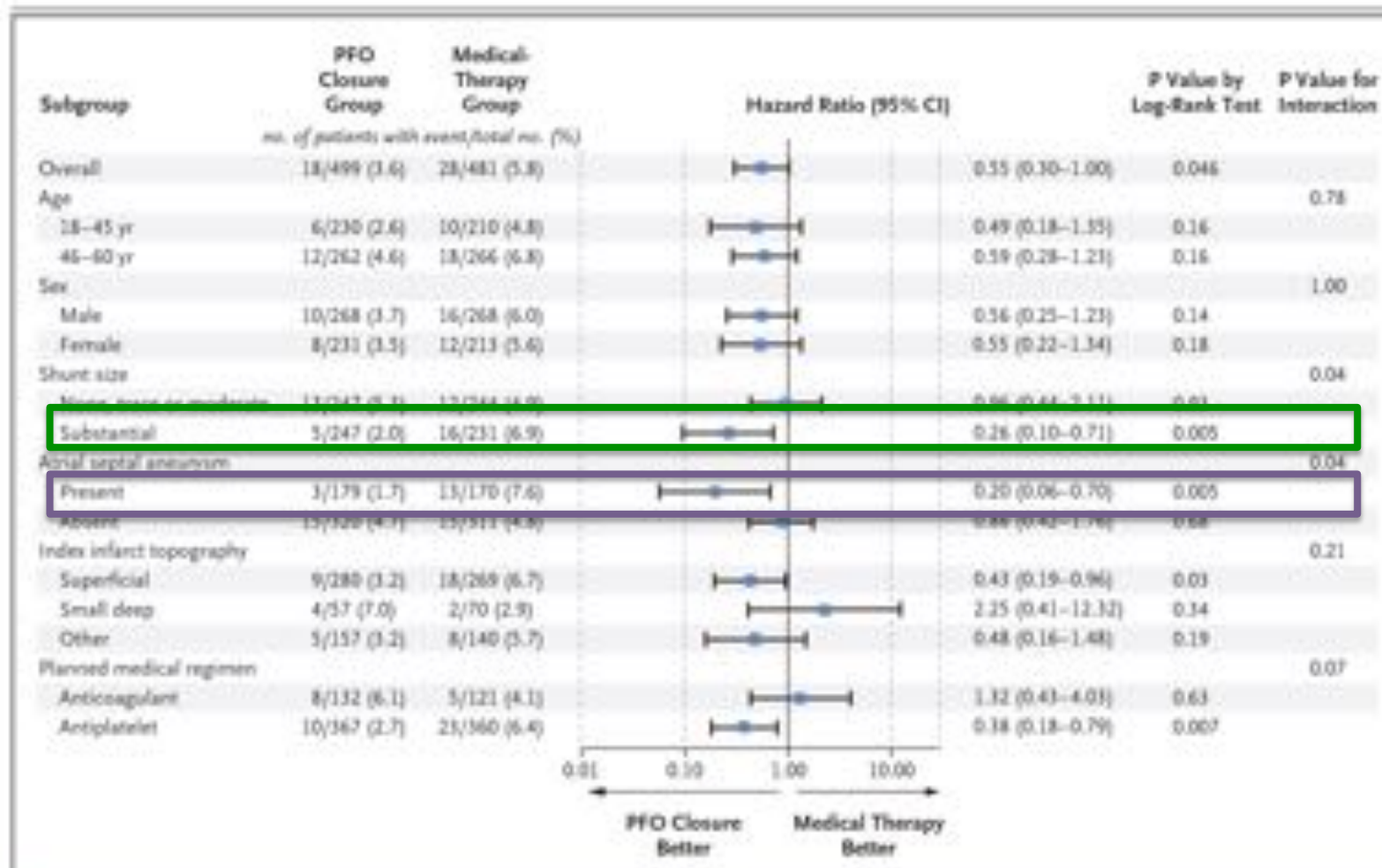
Atrial septal aneurysm was diagnosed on the basis of a septum primum excursion greater than 10 mm, as identified **on TEE** (core lab).

Large shunt was defined by the appearance of more than 30 microbubbles in the left atrium within three cardiac cycles after opacification of the RA

N Engl J Med 2017;377:1011-21.

RESPECT

PFO confirmé à l'ETO
ASIA ou non (pas de définition)



shunt

Asia

Gore REDUCE

TEE with agitated saline at rest or while a Valsalva maneuver

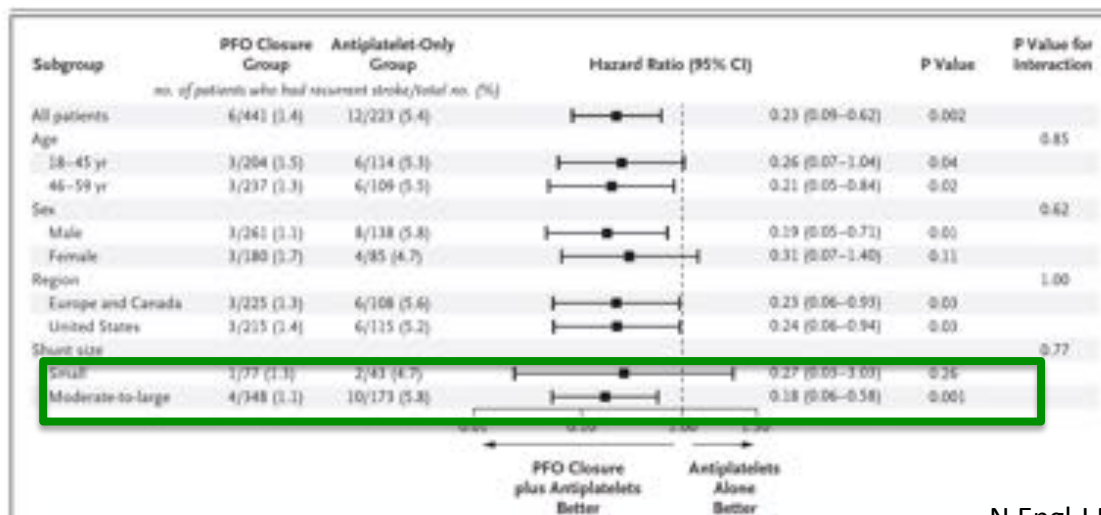
shunt size: 0 microbubble: occluded or no shunt

1 to 5: small

6 to 25 : moderate

> 25 : large

The presence of an atrial septal aneurysm was determined at the time of the PFO closure procedure (pas un critère d'inclusion)



N=120 randomisés PFO closure vs Medical T

What is high risk pfo?

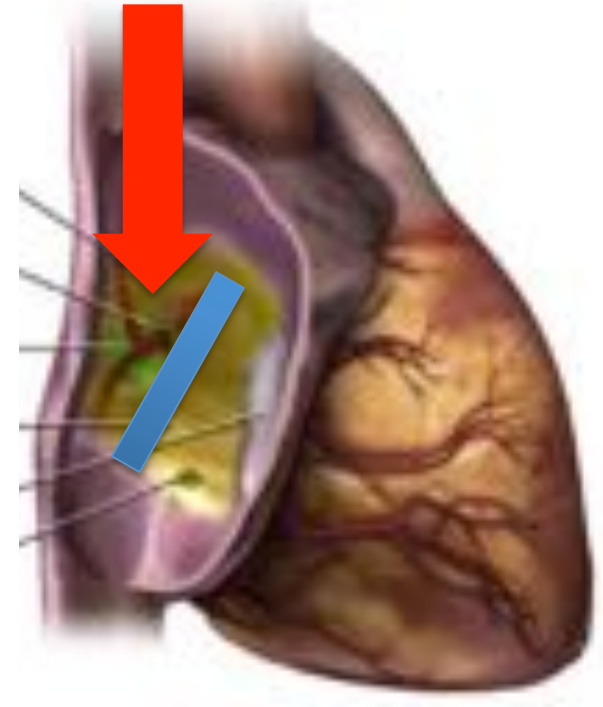
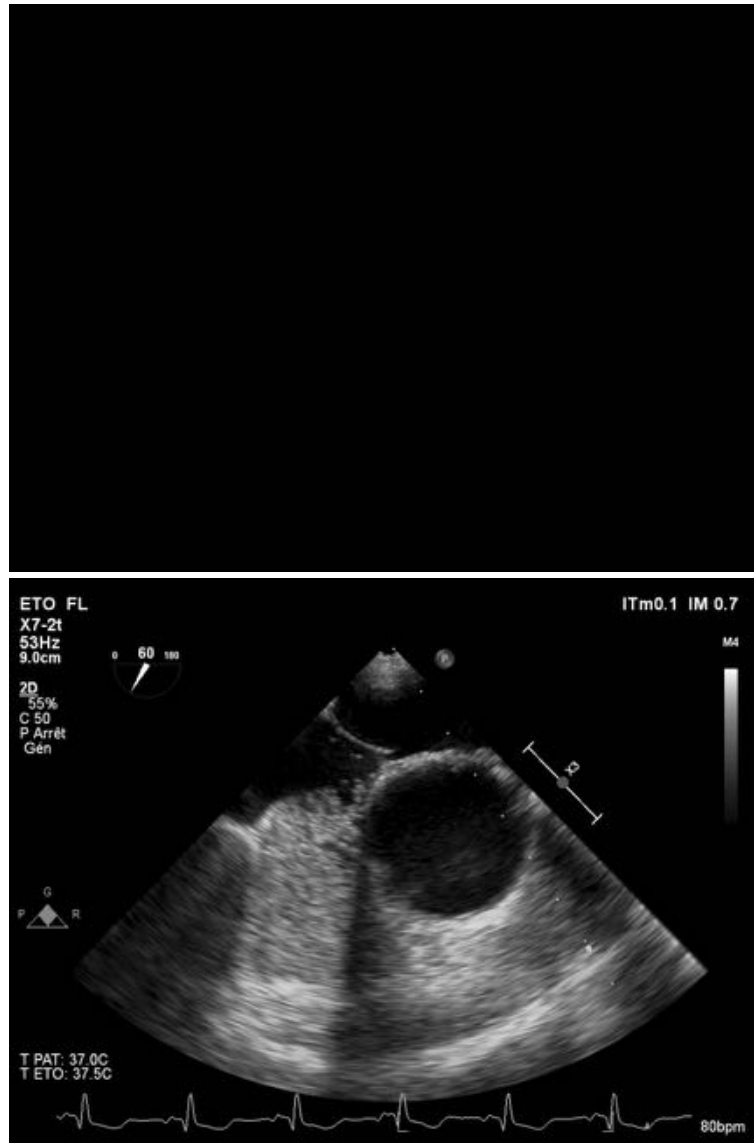
Large pfo size $\geq 2\text{mm}$

or

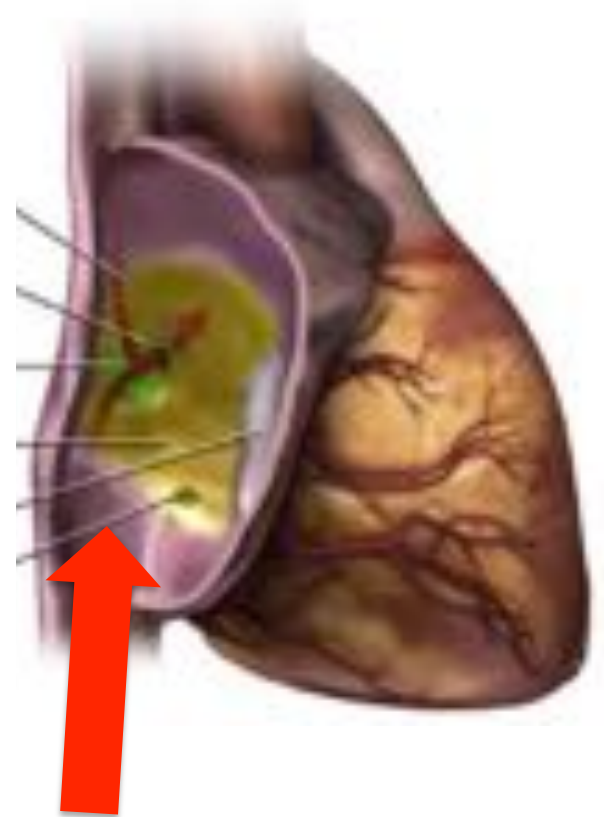
asia or hypermobility $\geq 10\text{mm}$



L'eustachi arrête les bulles



Epreuve de contraste par la VCI



When to use femoral vein injection for diagnosis of patent foramen ovale—Effect of a persistent eustachian valve on right atrial flow patterns during contrast transesophageal echocardiography

Tat W. Koh MD, FRCP, FACC, FESC, FASE 

VCS

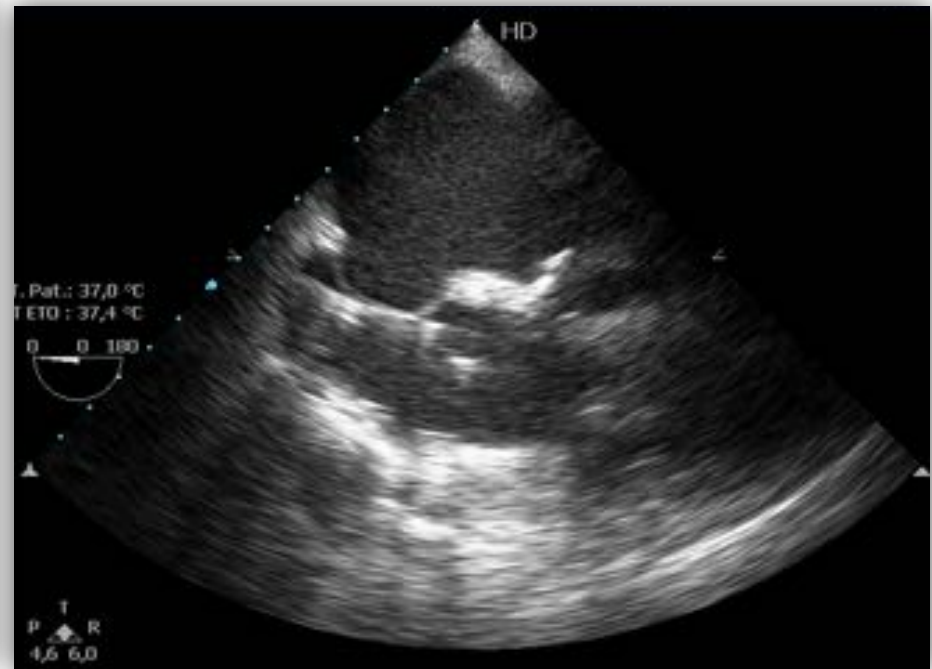


VCI



Exemples de situations cliniques

Endocardite sur PM et FOP



- Patiente de 81ans
- hospitalisée en rhumatologie pour tassement vertébral secondaire à une chute mécanique, pas de malaise, pas de PDC

Découverte d' une dyspnée avec hypoxémie et effet shunt

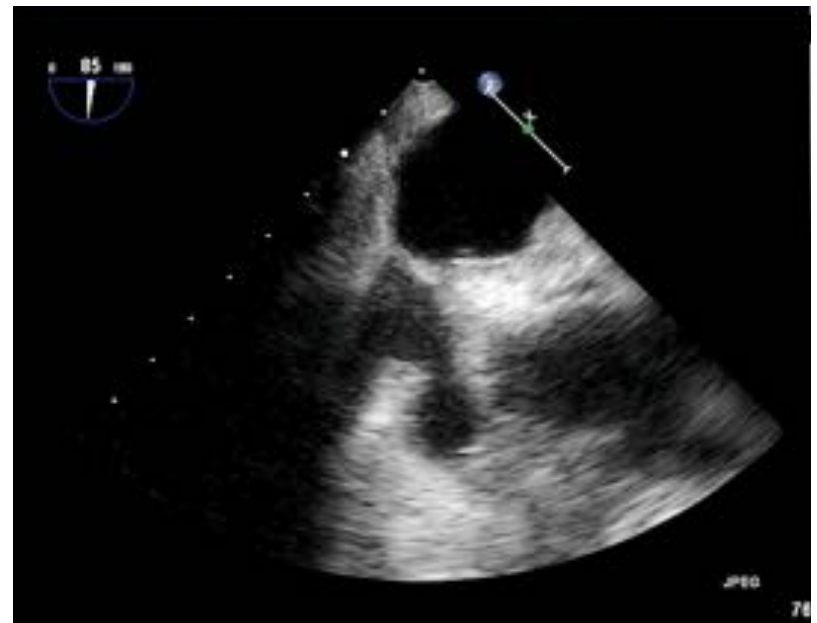
gaz du sang:

PO2: 56 pCO2: 31 Ph 7.45

SaO2: 90%



- Scintigraphie pulmonaire V/P: défaut basal G?
- Angioscanner: pas d' EP, pas d' atteinte parenchymateuse pulmonaire
- Hypoxémie réfractaire avec SaO₂ à 90% malgré optiflow (oxygenation à haut débit)



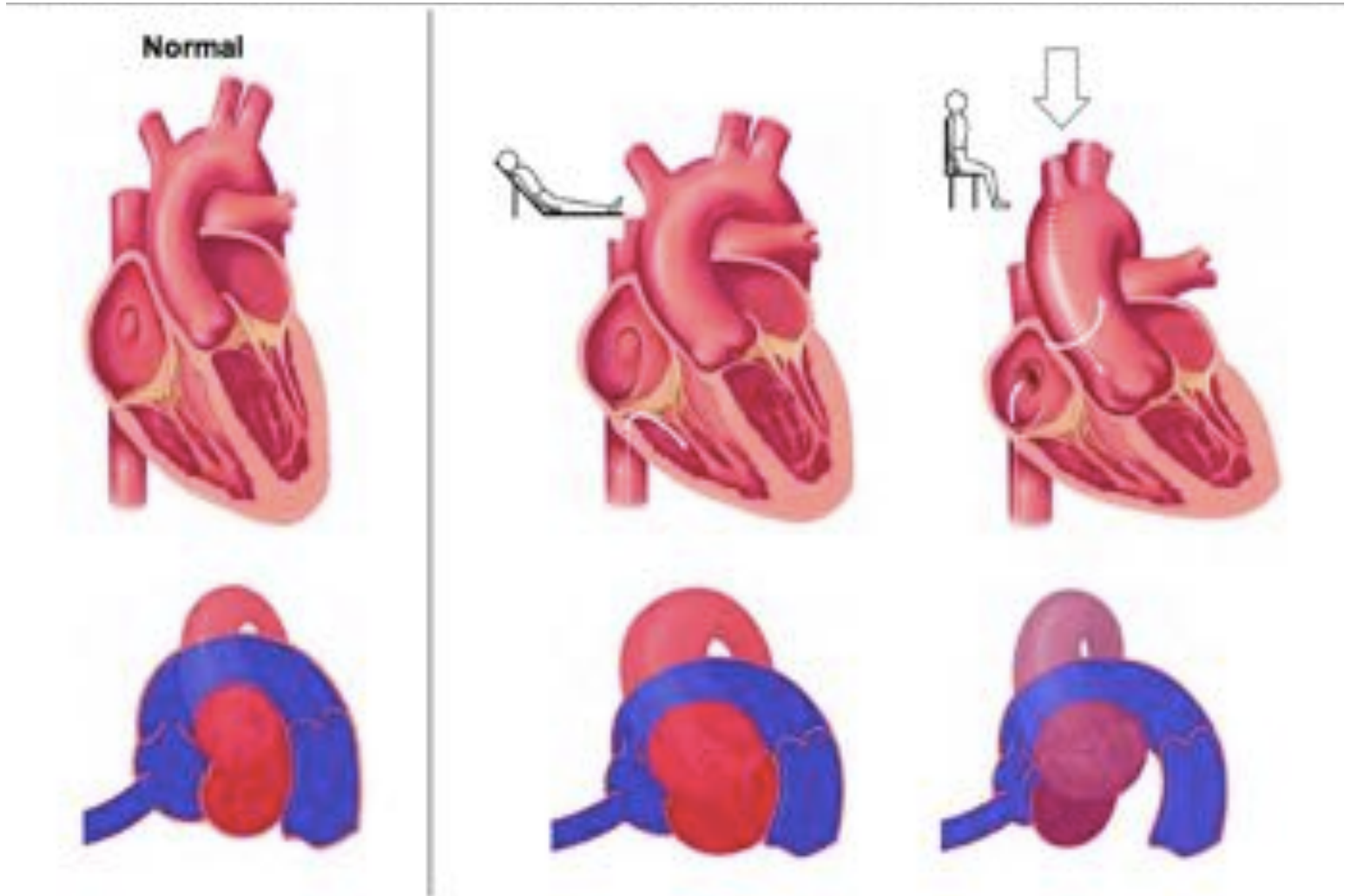
Saturation à 95% en air ambiant !!!!

Contrôle



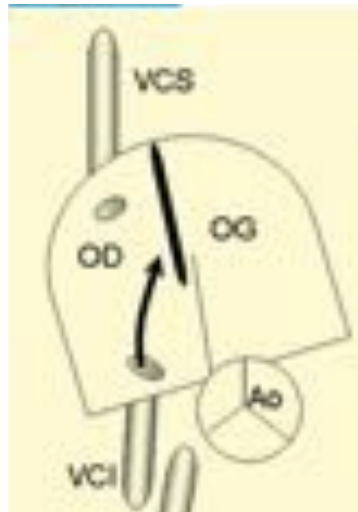
- Hypoxemie réfractaire liée à la réouverture d'un large FOP
- Habituellement, liée à élévation des pressions droites (EP, IDM VD, pneumopathie...)
- Mais aussi à des modifications du retour veineux cave soulevant la fosse ovale sans élévation majeure de la pod.

Platypnée orthodeoxie



- (*platys* : couché ; *pnoe* : respiration ; *orthos* : droit ; *de oxia* : sans air), signifie que la dyspnée observée en orthostatisme s'amende en décubitus,

- Shunt droite-gauche auriculaire à pressions pulmonaires normales par désorientation du septum interauriculaire



Platypnée orthodéoxie:

Post pneumonectomie, atélectasie, paralysie
diaphragmatique

Dilatation de l'aorte ascendante

Anévrisme de l'aorte

Pectus excavatum

- Mais aussi:

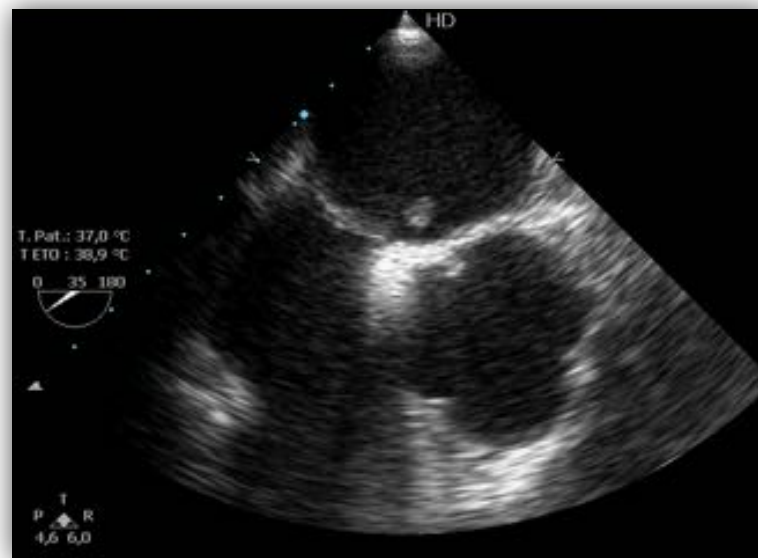
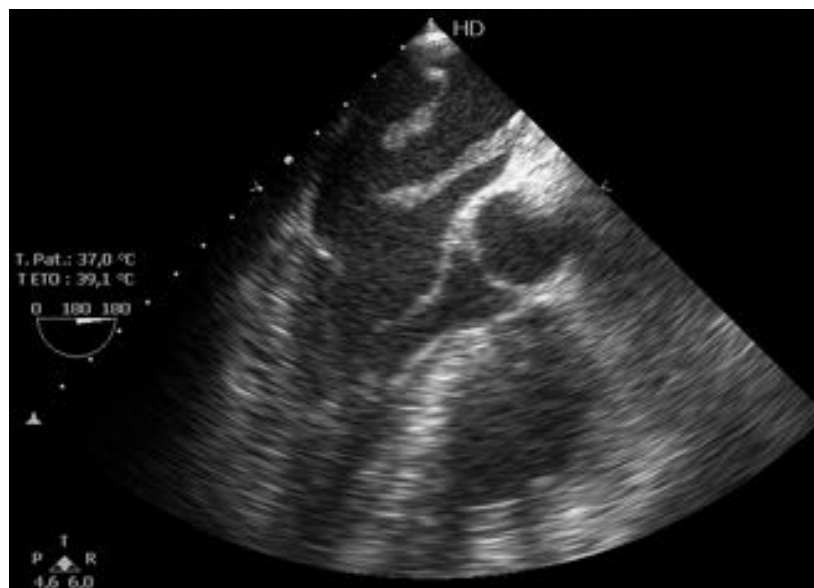
- Cyphoscoliose

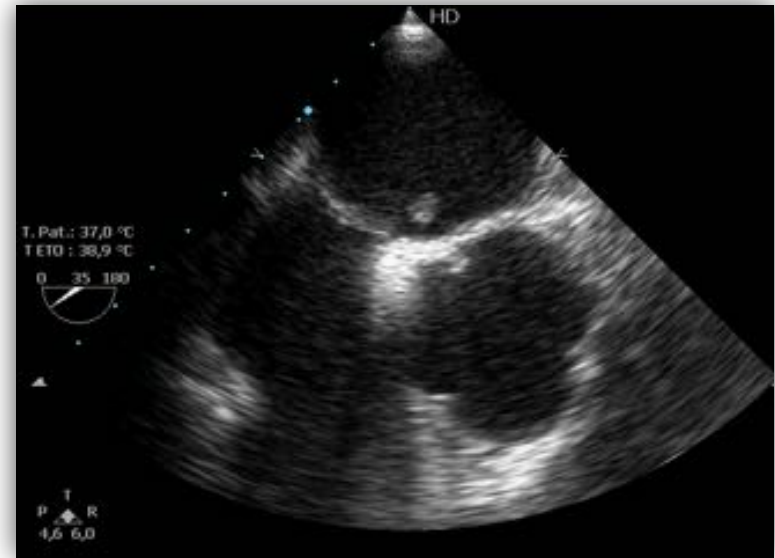
- Tassements vertébraux

- Donnant une horizontalisation du SIA

Patient ayant présenté une TVP mb inf G suivie d'un AVC

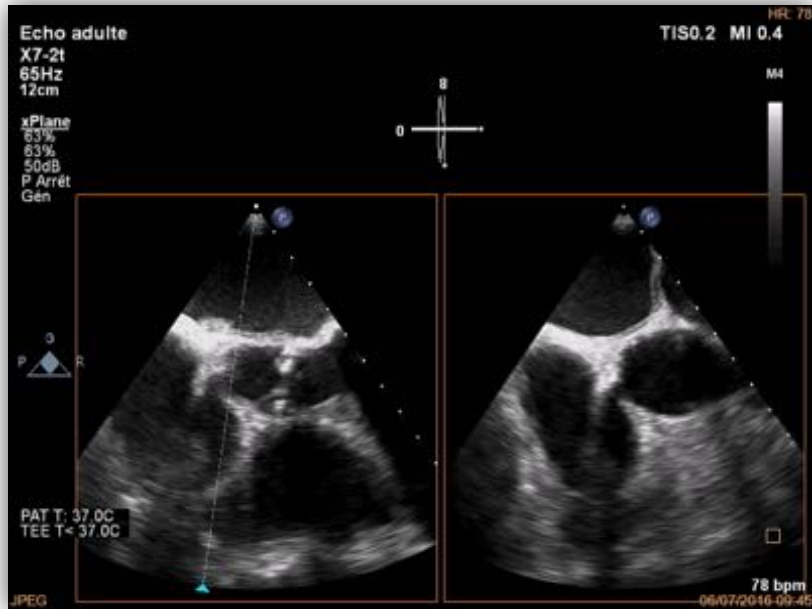








Ischémie de membre et AIT à 83 ans

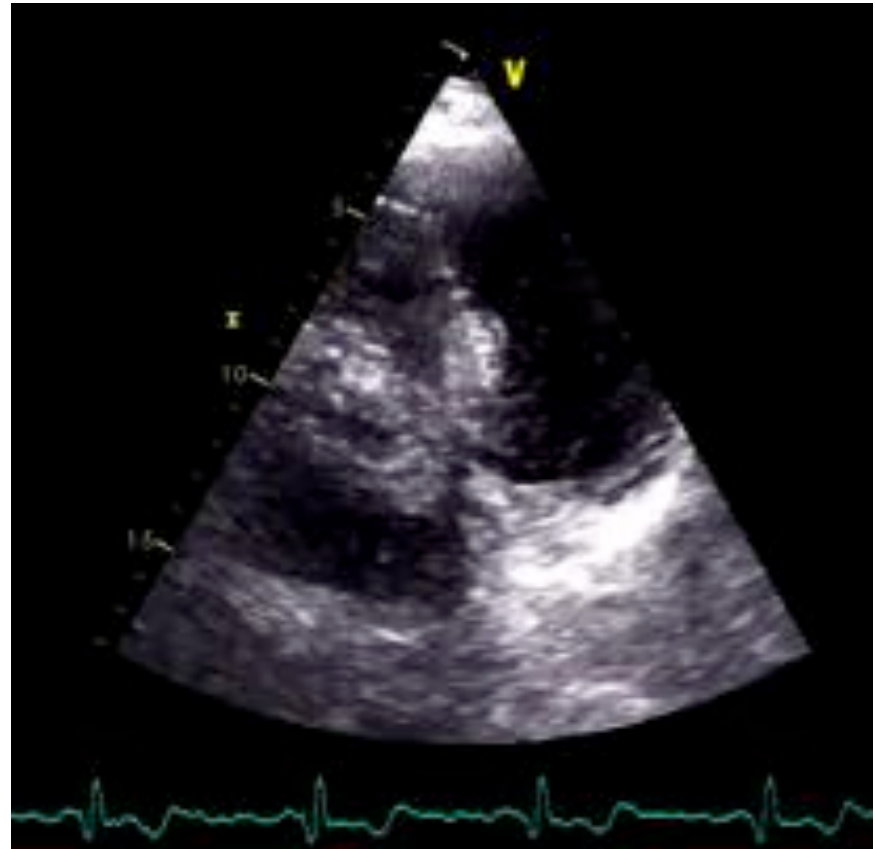


CENTRE CARDIO-THORACIQUE DE MONACO

Pièges à échographiste

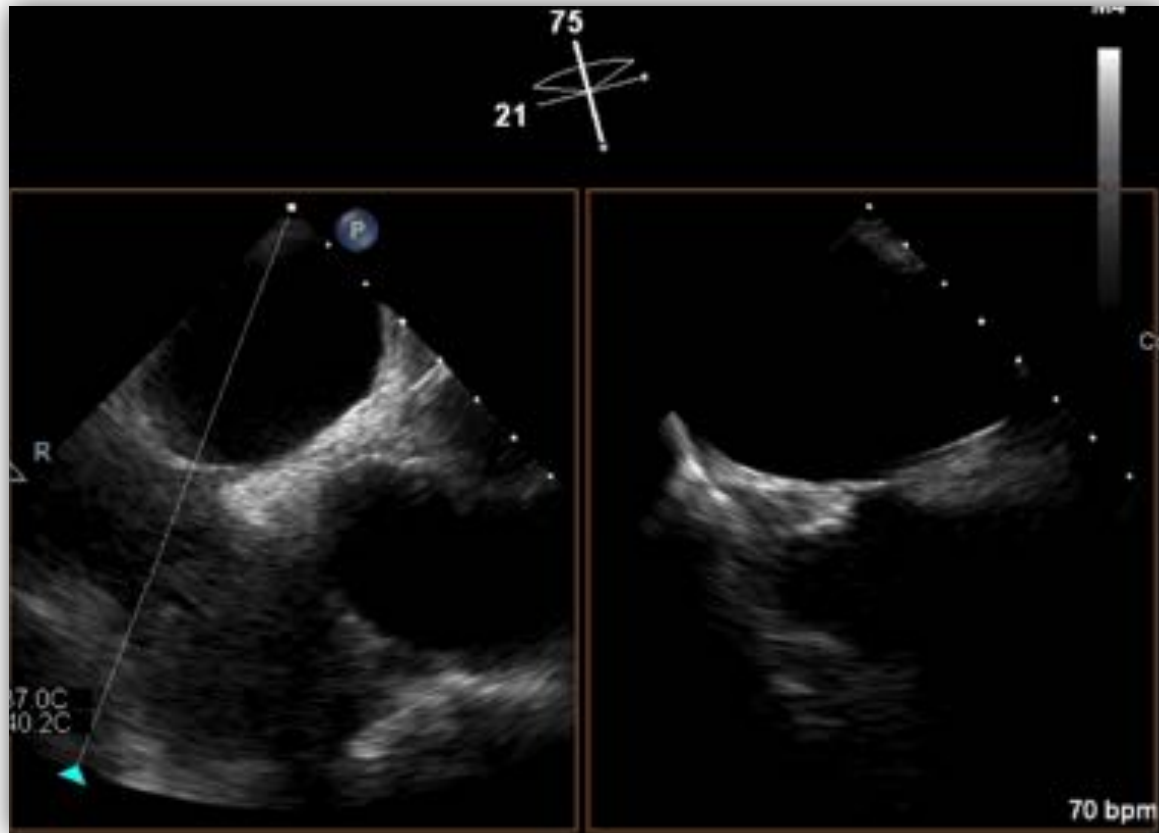


Passage tardif



Dans les 3 à 5 cycles qui suivent l'opacification complète de l'OD

Hypertrophie lipomateuse du SIA

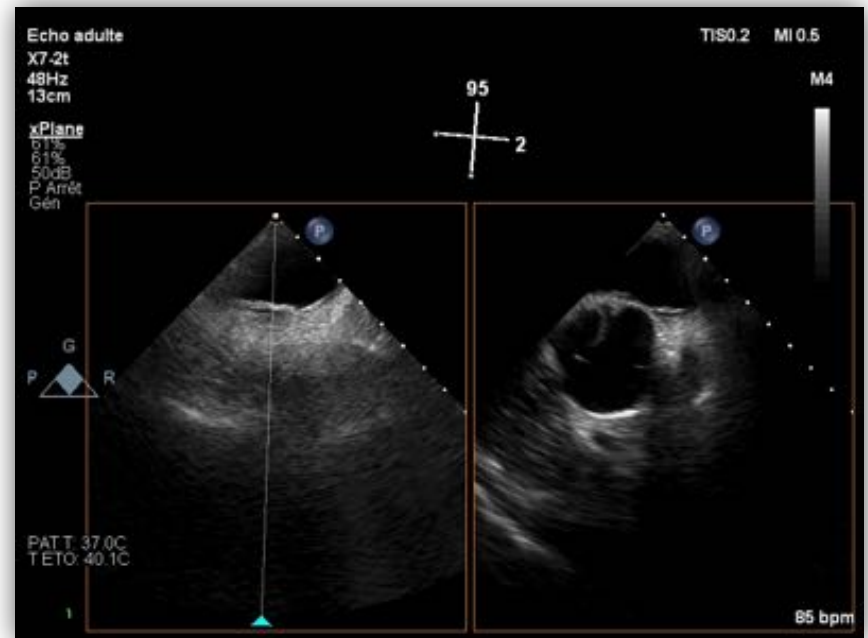
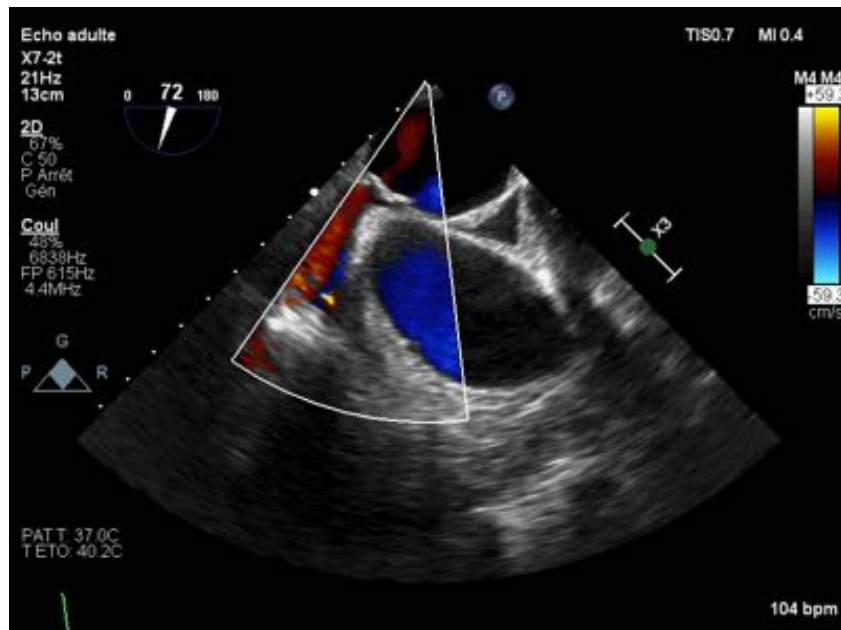


Hypertrophie lipomateuse du SIA



In the pocket....

Eto : Bilan d'ait



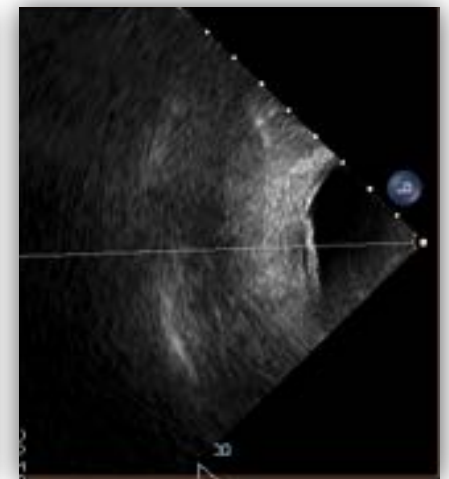


ASIA mais pas de fop.....



FOP

Right Septal pouch



- La poche septale est formée par une fusion incomplète du septum primum et du septum secundum
- La poche gauche peut être un site favorisant la thrombose mais pas de liens significatif avec les AVC cryptogéniques dans les quelques études publiées



Right Septal pouch



Left Septal pouch



Left Septal pouch



Right Septal pouch



Double Septal pouch

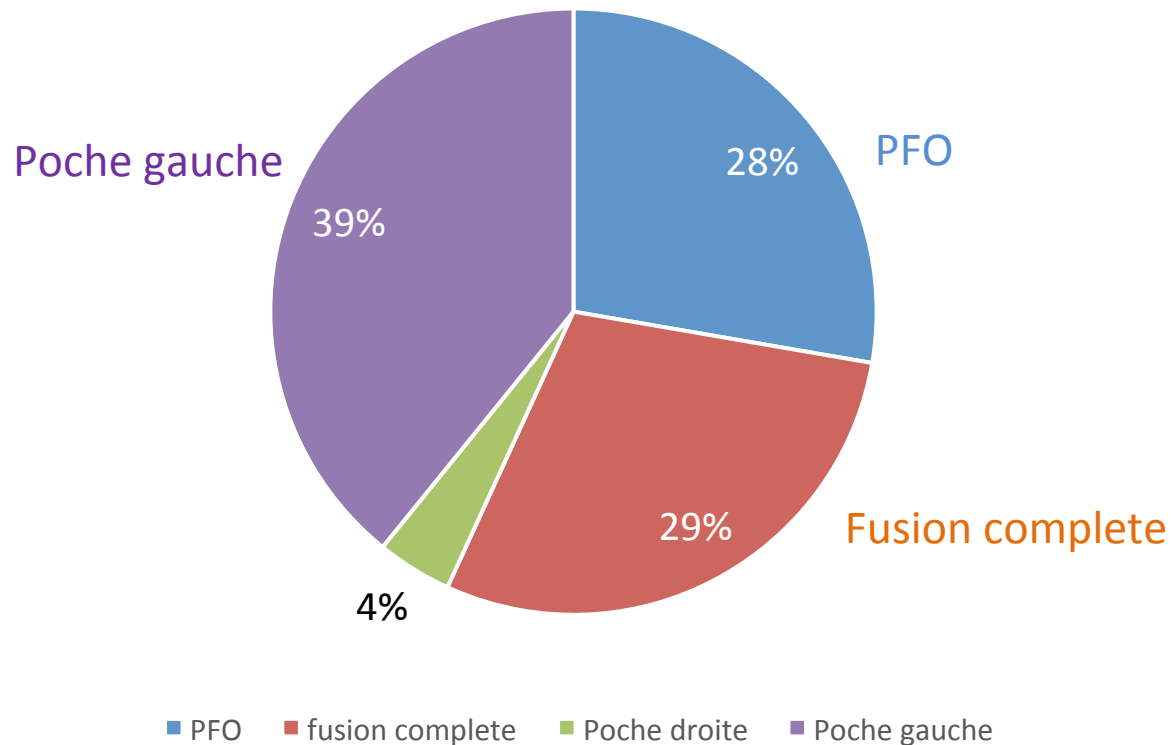
Septal Pouch in the Left Atrium

A New Anatomical Entity With Potential for Embolic Complications

Subramaniam C. Krishnan, MD, Miguel Salazar, MD

Orange, California

94 randomly selected autopsied hearts





Atrial septal pouch – Morphological features and clinical considerations



Mateusz K. Holka ^{*,†}, Mateusz Kuciej [†], Jakub Holka [†], Katarzyna Piętek [†], Karol Tyrak [†], Weronika Cholepak [†], Filip Bolechala [†], Jerzy A. Walocho [†], Wiesława Elżbieta Potemienko [†]



Fig. 1. The chart showing the prevalence of observed intratrial septum variations ($n = 200$). PFO = patent foramen ovale; SP = septal pouch.

Left septal pouch

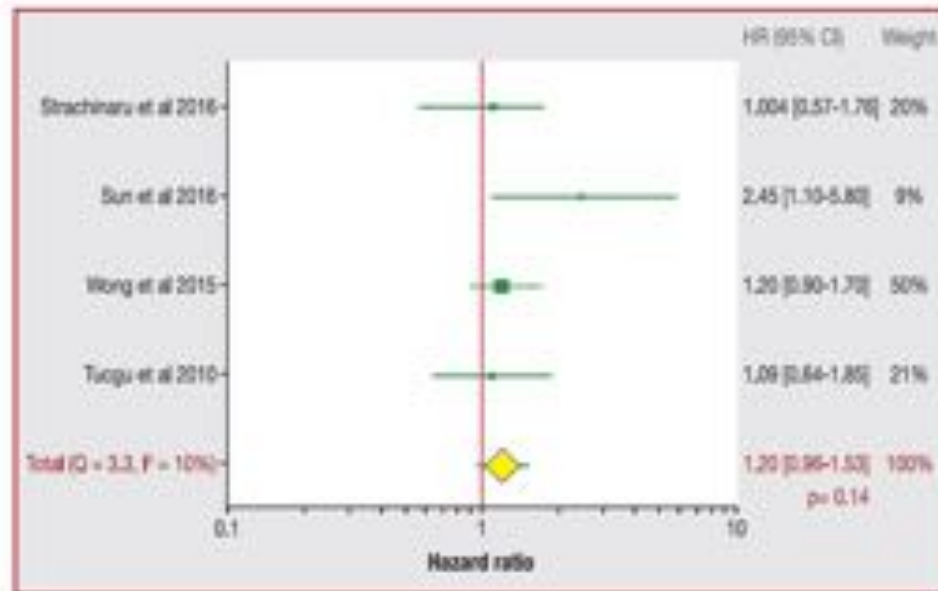
- Présent chez 40-47% des patients !
- Soit 2x plus souvent que le FOP!!
- Stase à ce niveau = risque d'avc?... Ça reste à prouver....

The left atrial septal pouch as a risk factor for stroke: A systematic review

La poche septale atriale gauche comme facteur de risque embolique : une revue systématique

Mihai Strachinaru ^{a,*}, Jose Castro-Rodriguez ^b,
Thierry Verbeet ^b, Marie-Dominique Gazagnes ^c

Peu d'études, case reports.... Pas valable statistiquement



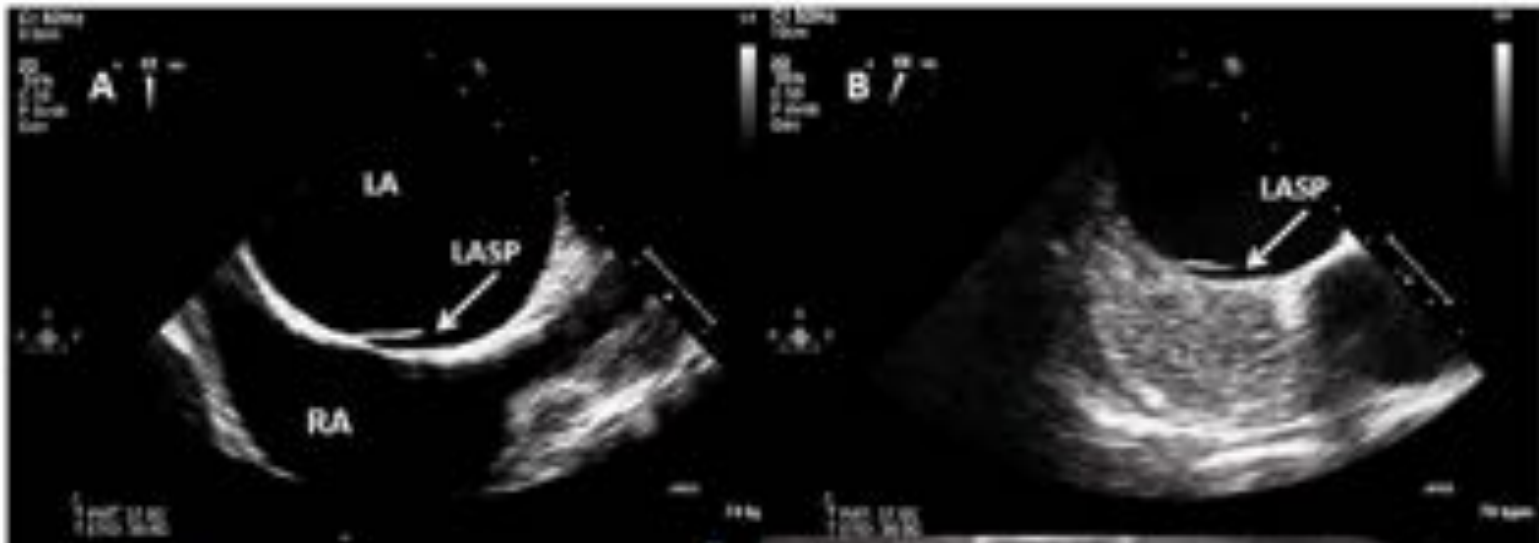
Left septal pouch

340

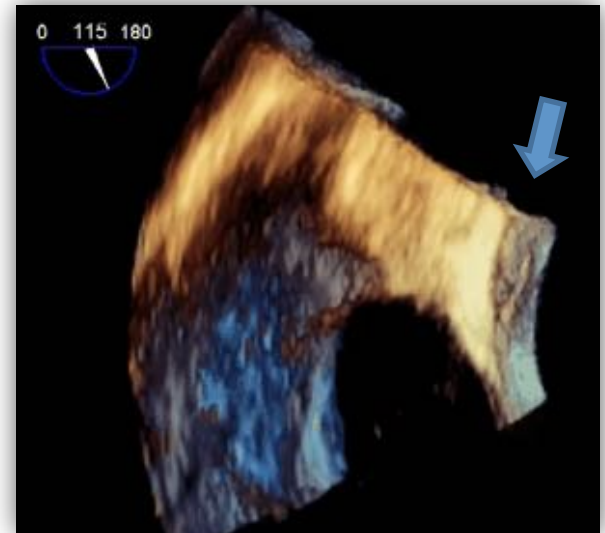
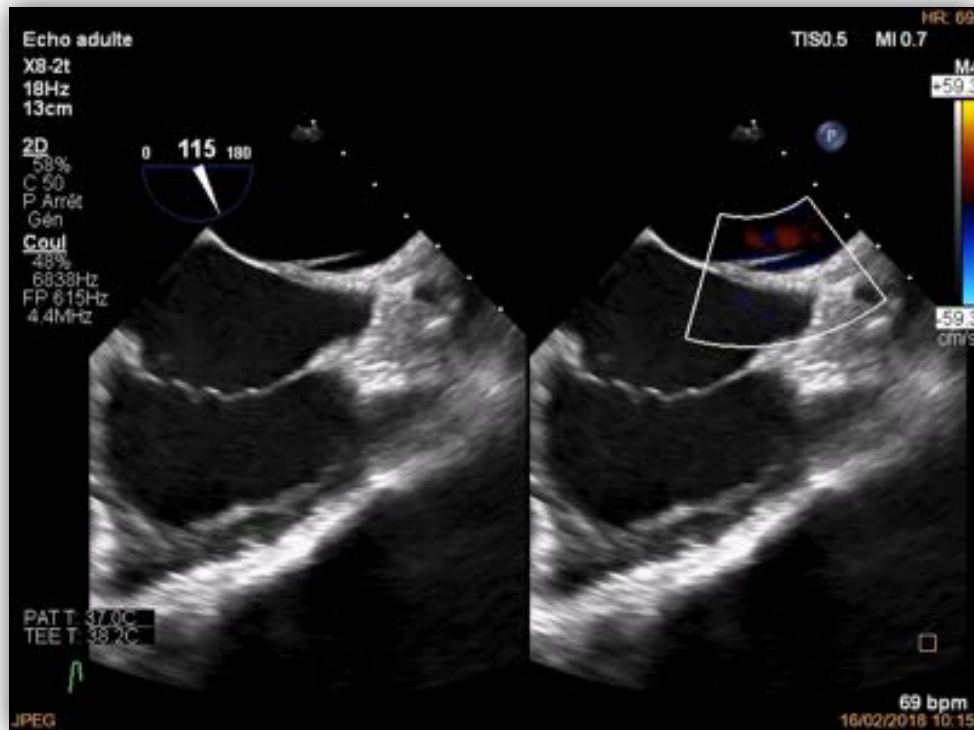
M.K. Hoidal et al. / International Journal



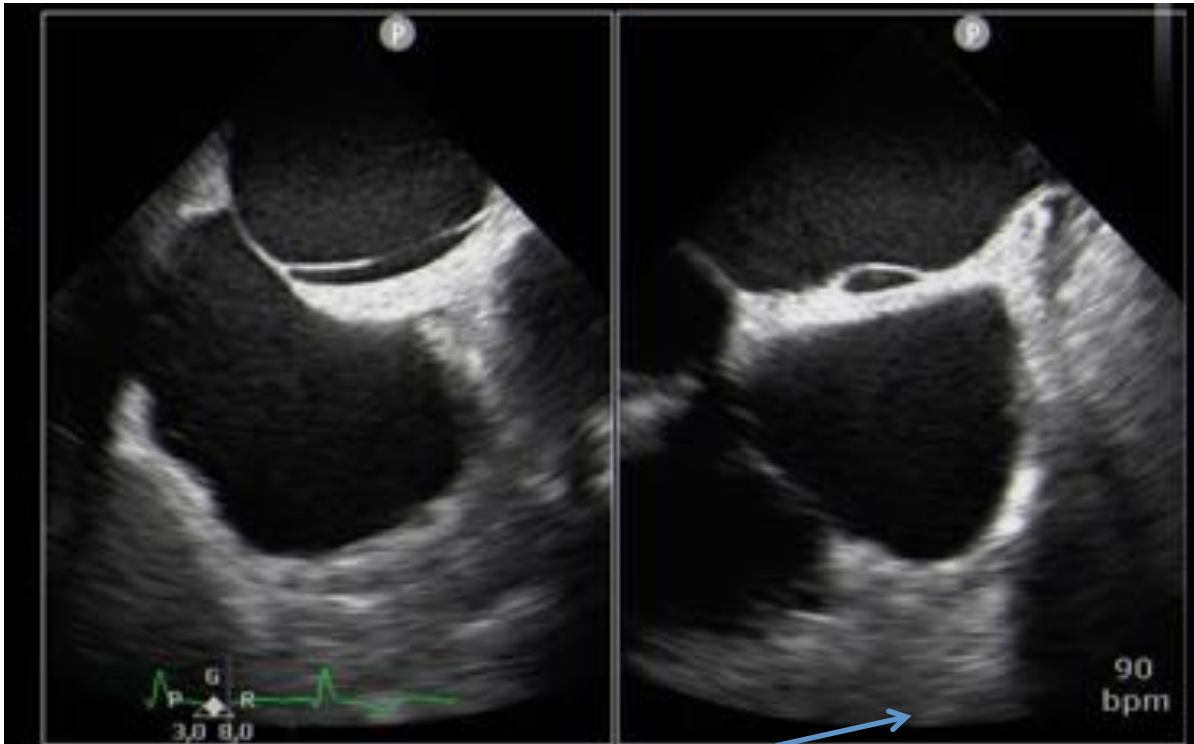
Aspect de poche coté OG
avec absence **obligatoire** de shunt et de bulles entre les S secundum et primum



Left septal pouch

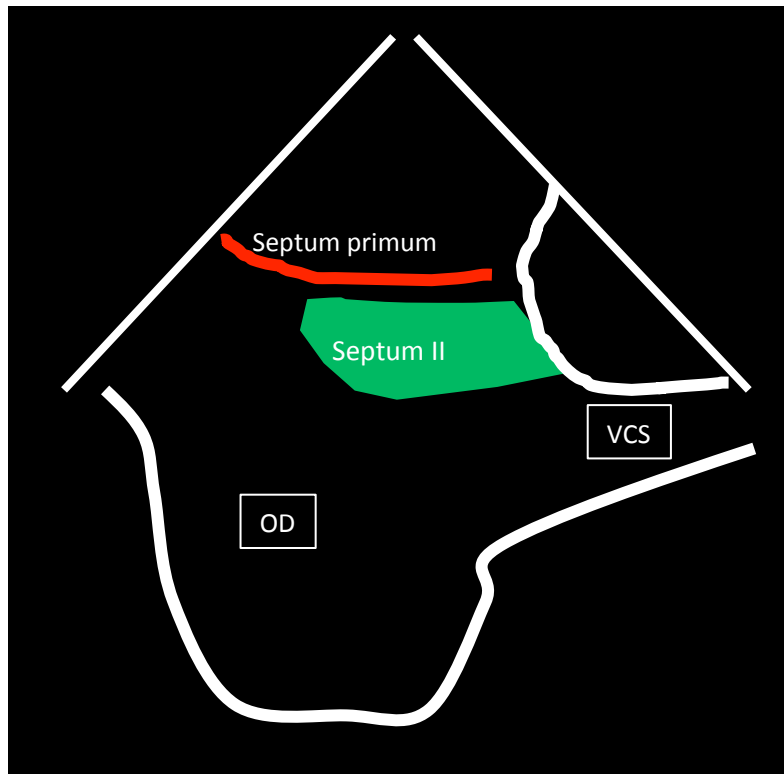


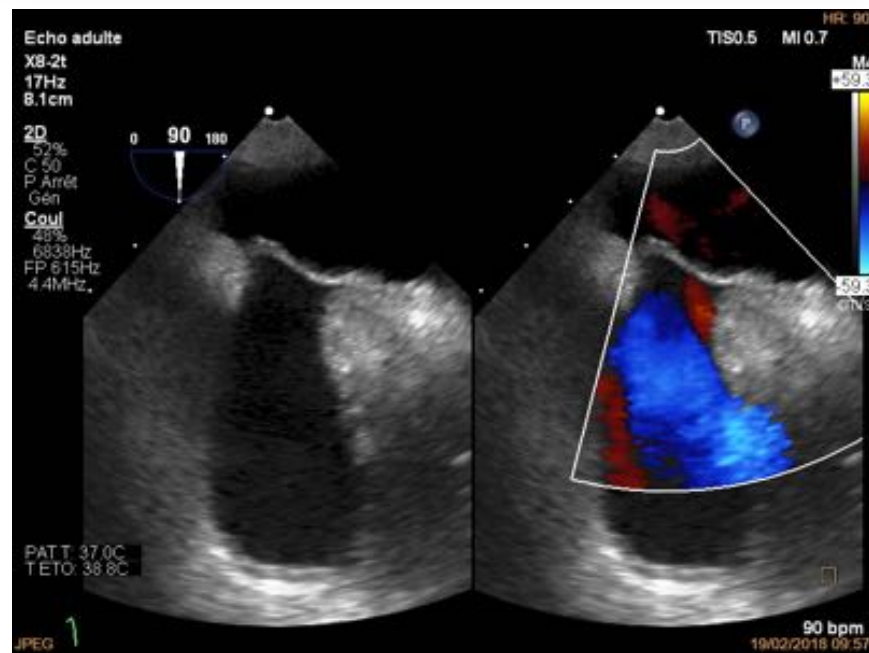
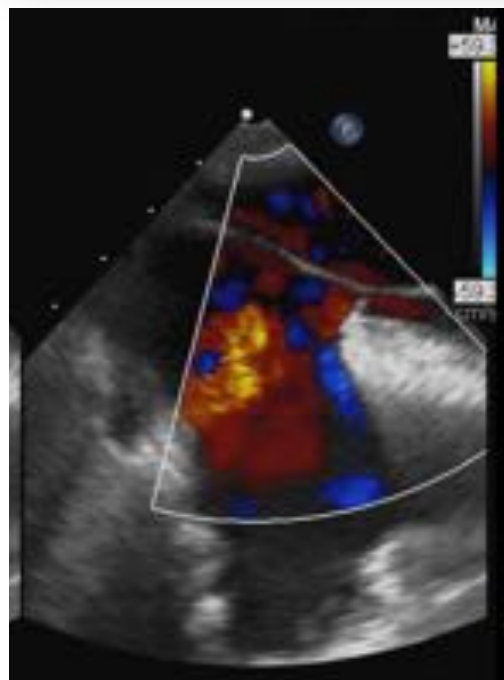
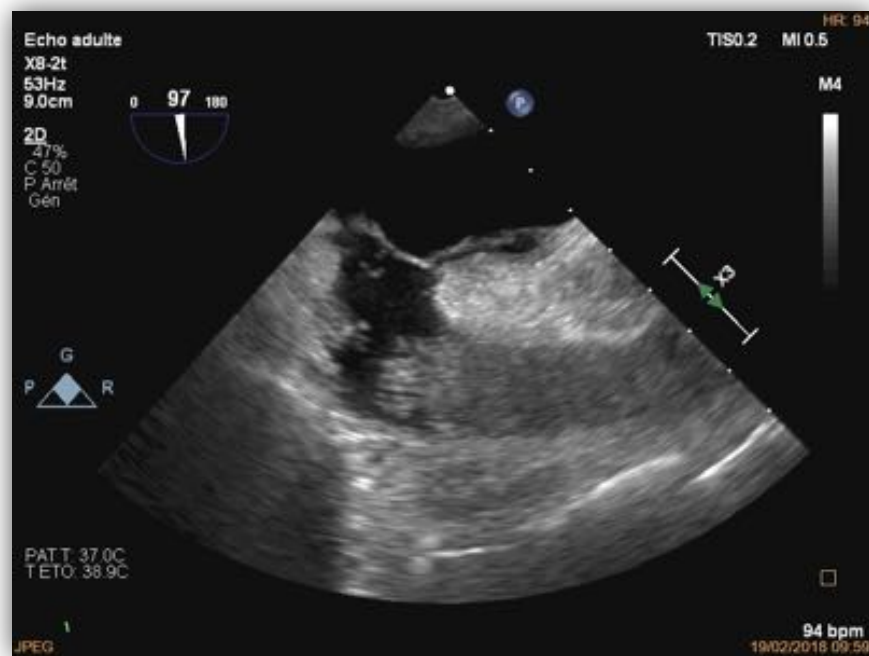
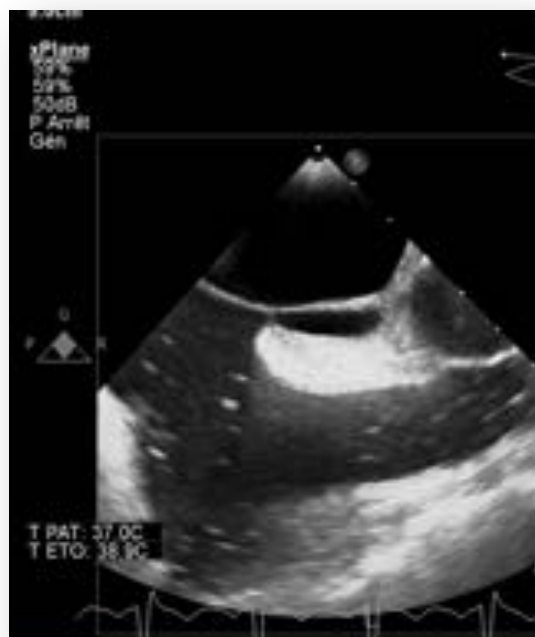
Left septal pouch



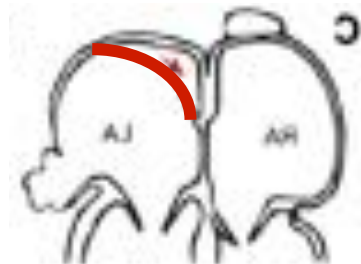
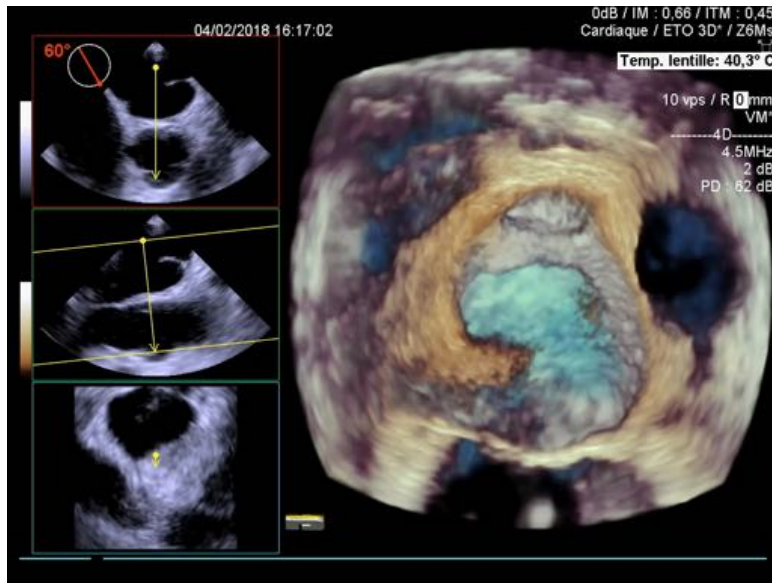
FOP ou poche?

Hypertrophie lipomateuse et tunnel

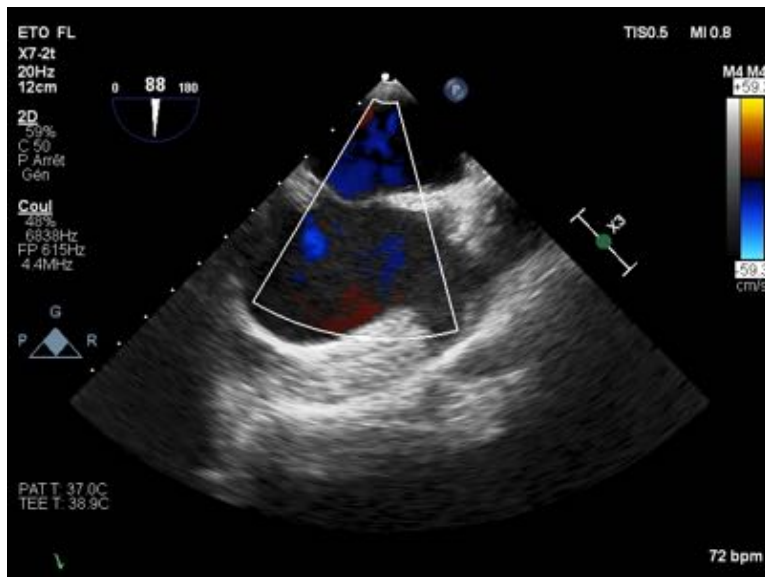




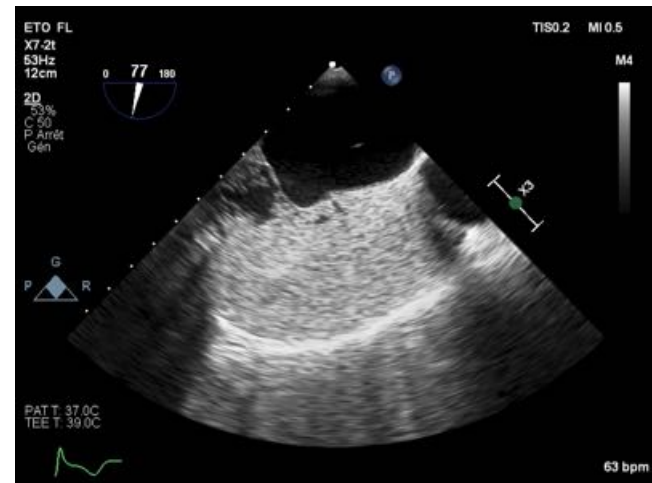
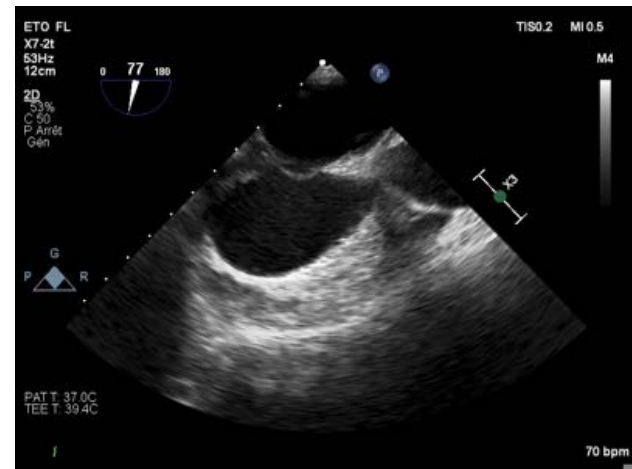
Left atrial pouch



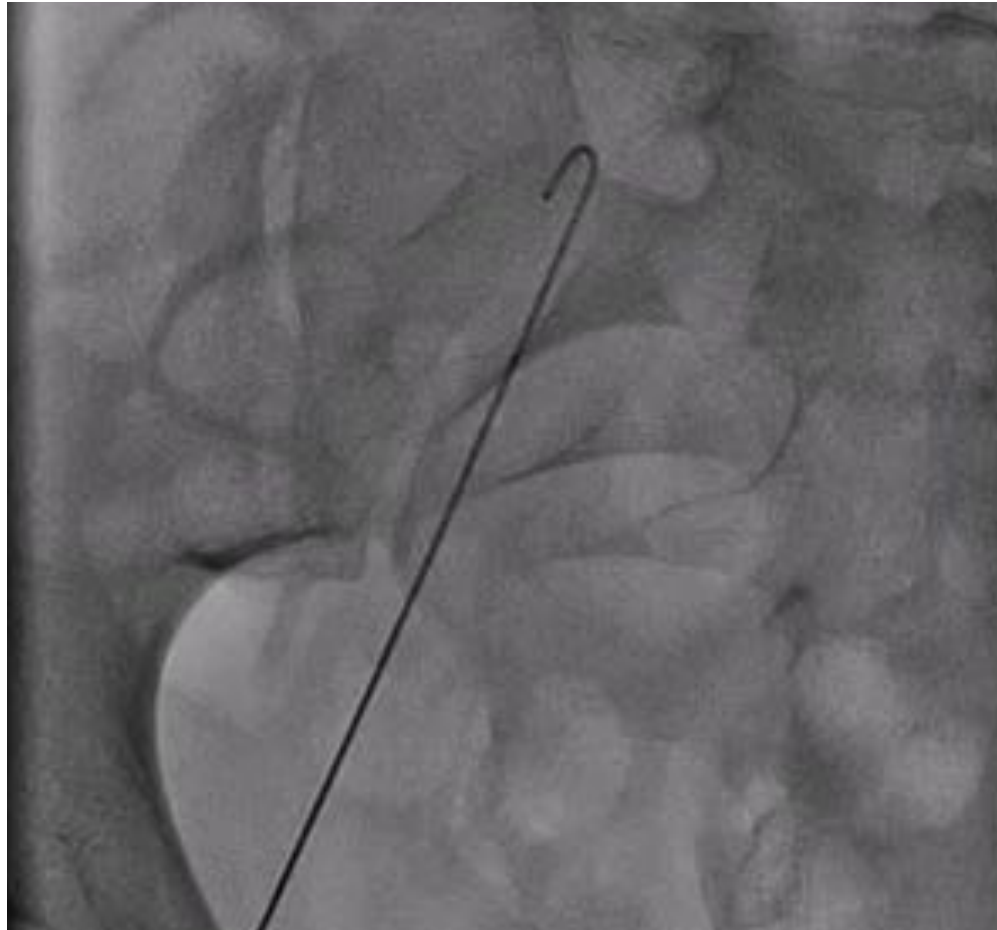
Patient plongeur professionnel: eto à la recherche de fop



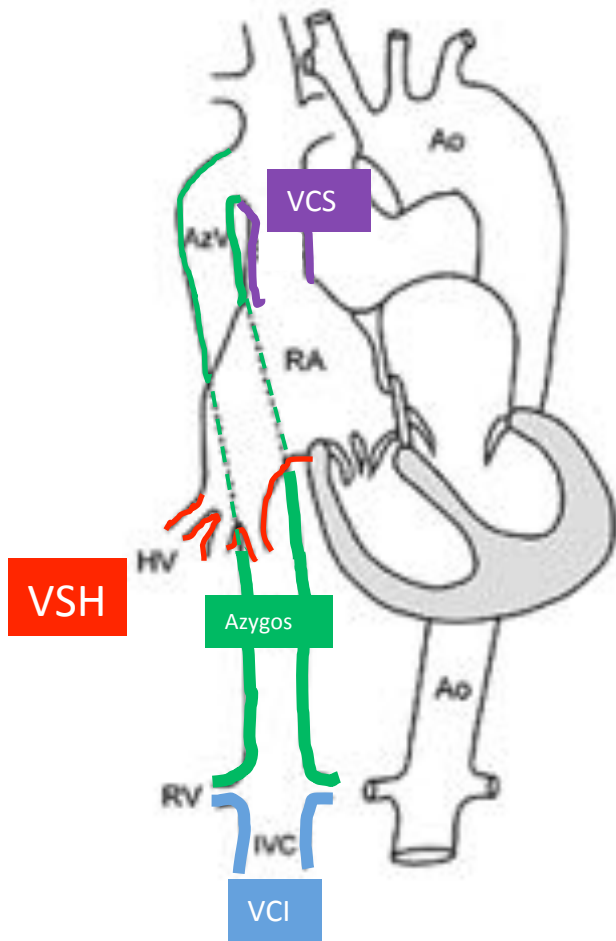
Shunt bidirectionnel



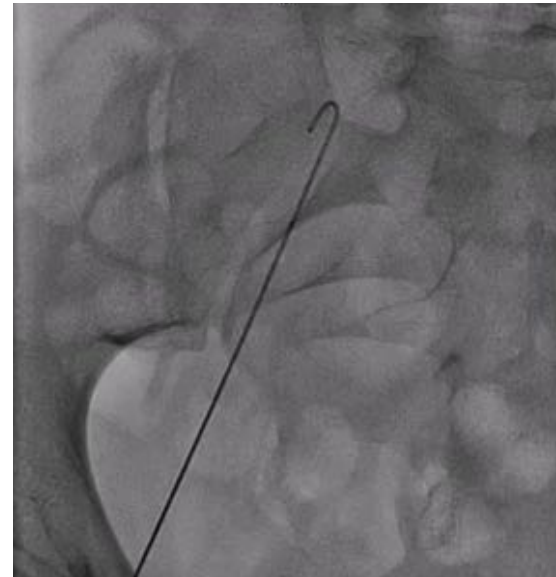
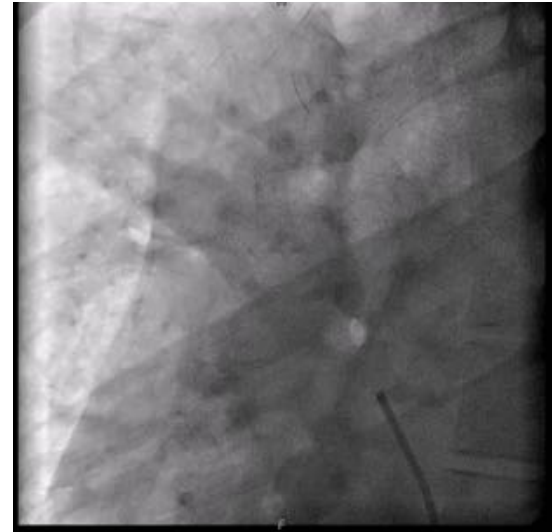
Décision de fermeture de fop



Interruption de la VCI avec continuation azygos

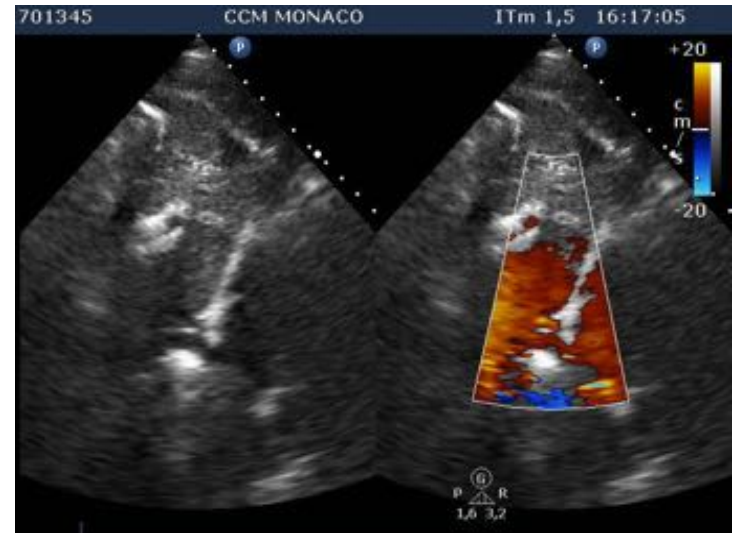


Vci sus rénales

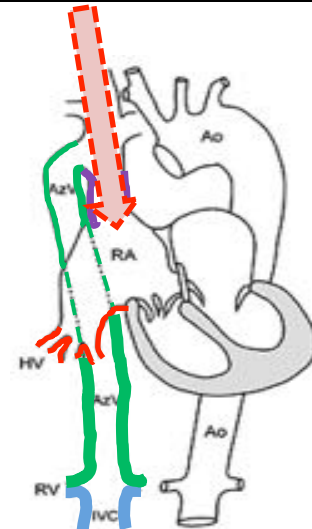
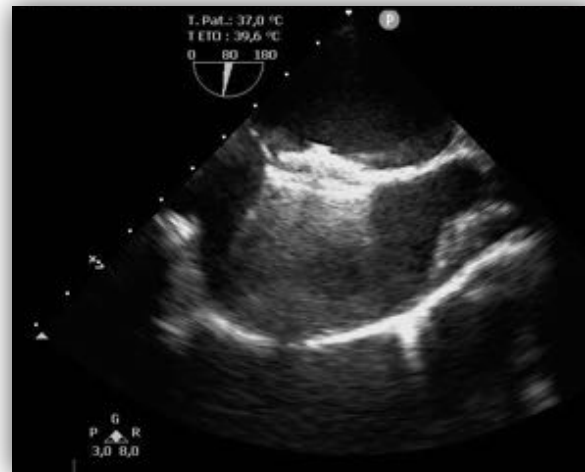
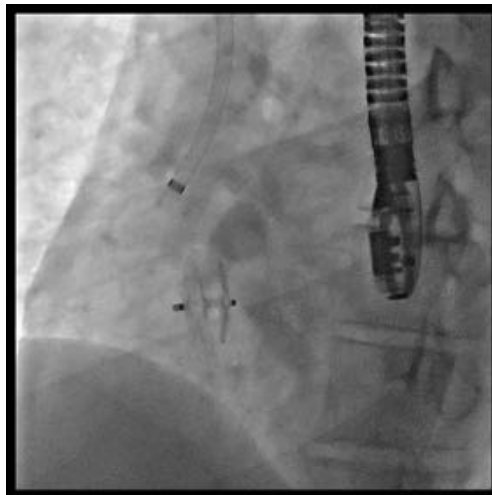
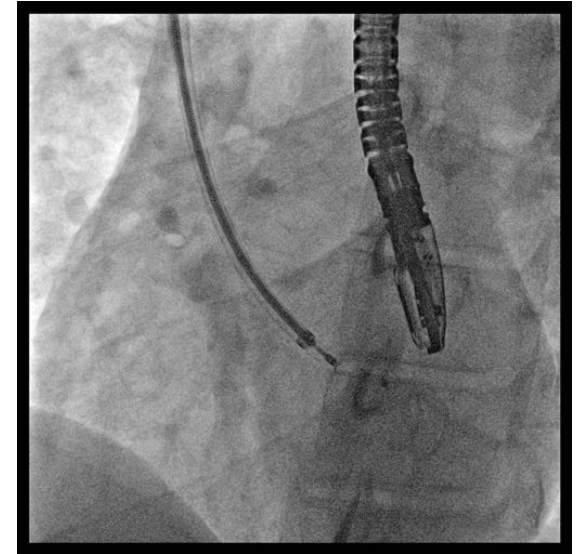
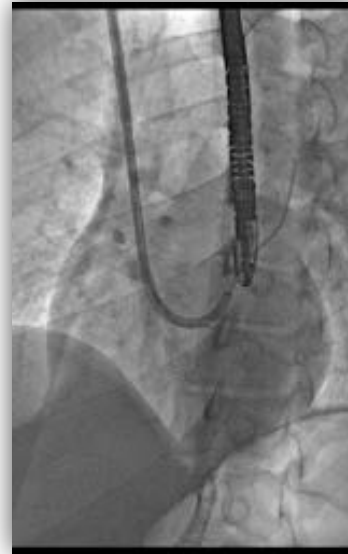
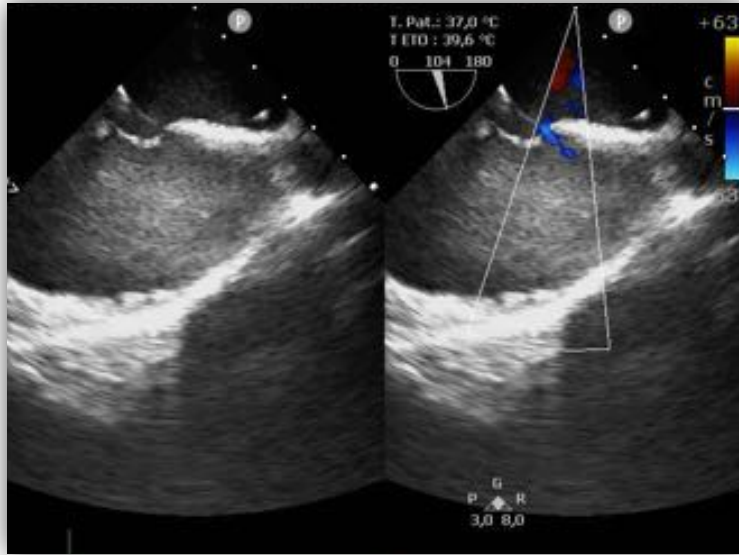


- La continuation azygos de la veine cave inférieure est la seconde anomalie du retour veineux systémique (0.6% des cardiopathies congénitales).
- Le drainage azygos s'effectue en aval dans la veine cave supérieure par l'intermédiaire de la crosse de l'azygos. Seules les veines sus-hépatiques se drainent directement dans l'oreillette droite.
- Cette anomalie congénitale est volontiers associée à un syndrome de polysplénisme (isomérisme gauche). Une forme acquise réalisant un circuit similaire peut s'observer en cas d'obstruction haute de la veine cave inférieure par un processus tumoral ou thrombotique.
- Cette anomalie n'entraîne pas de symptôme d'appel et son diagnostic est évoqué sur la graphie thoracique (déplacement vers le dehors de la ligne paravetrébrale droite) ou sur l'échographie (absence de veine cave retro-hépatique, drainage direct dans l'OD des veines sus-hépatiques).

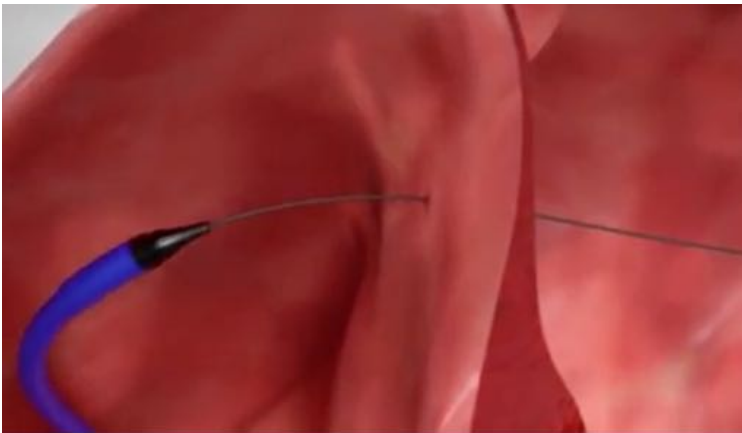
Abouchement des vsh dans l'OD



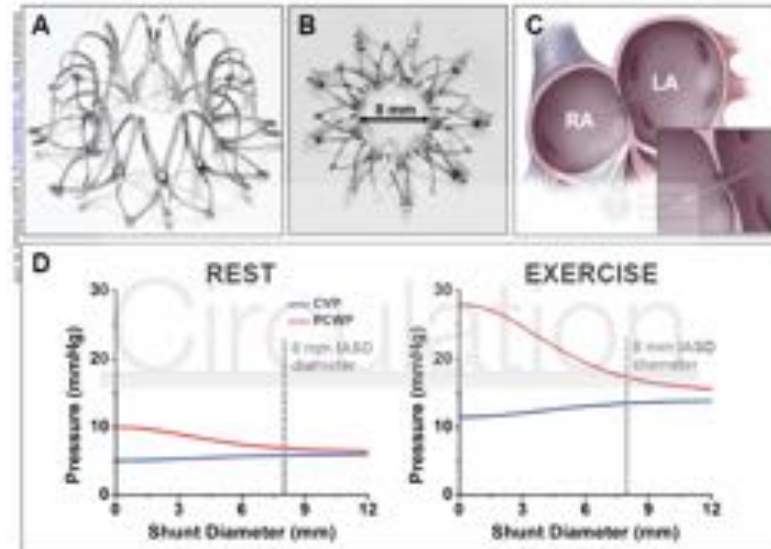
Fermeture de fop par voie jugulaire



Open or close?



REDUCE LAP HF I



HFpEF

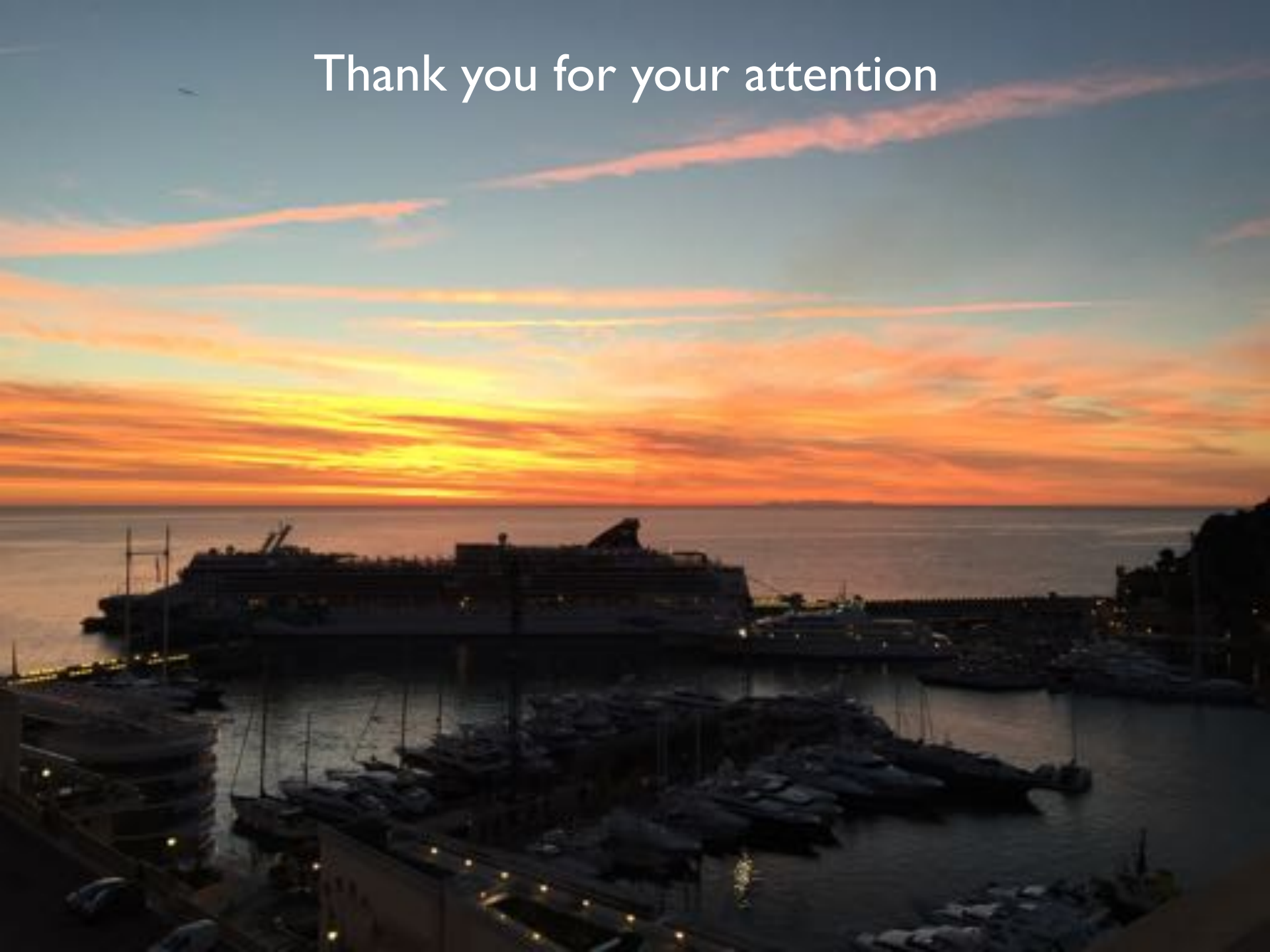
Faisable, sécurisée et diminution des pressions à l'effort.

Amélioration du pronostic ?

Conclusion

- Anatomie (pathologique)
- Diagnostic de FOP et ASIA
 - Comment? ETT/ETO
 - Manœuvres de sensibilisation
- Sévérité du shunt
- Pièges

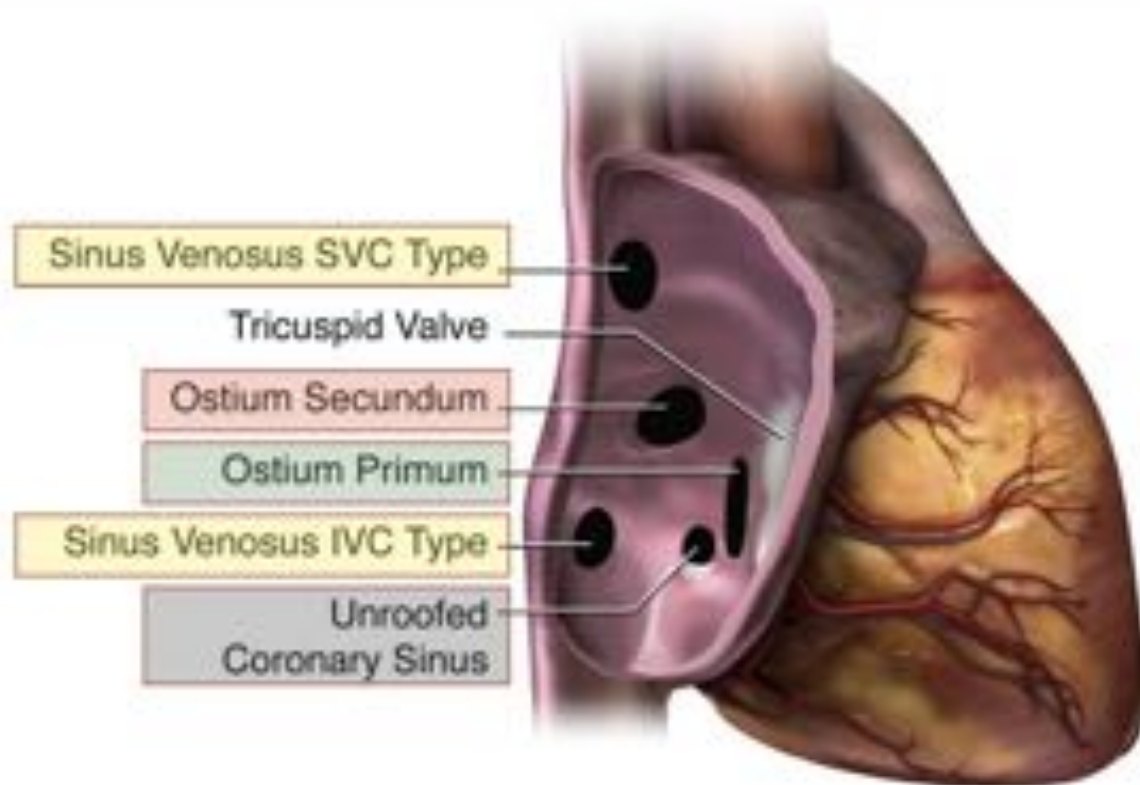
Thank you for your attention



Pathologies du SIA



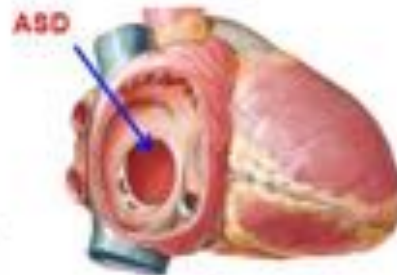
CIA



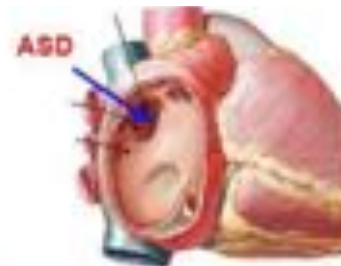
ATRIAL SEPTAL DEFECTS



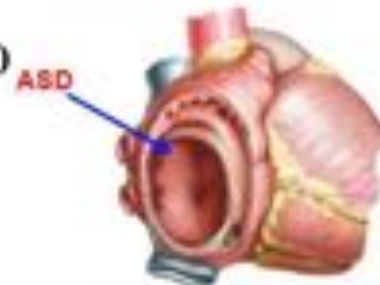
**Primum ASD
(AV canal spectrum)**



**Secundum ASD
(Fossa ovalis ASD)**



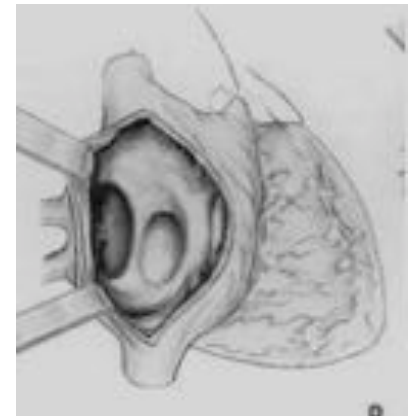
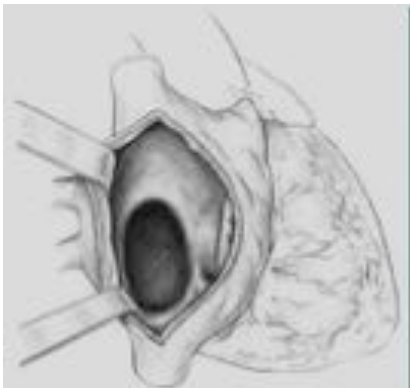
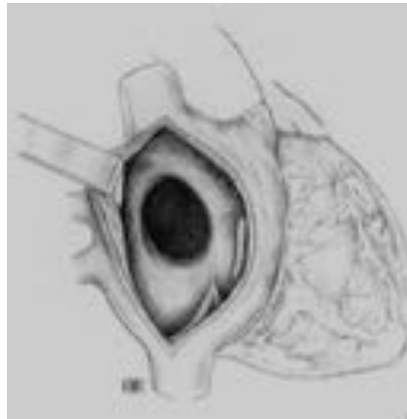
**Sinus venosus ASD
(SVC-type)**



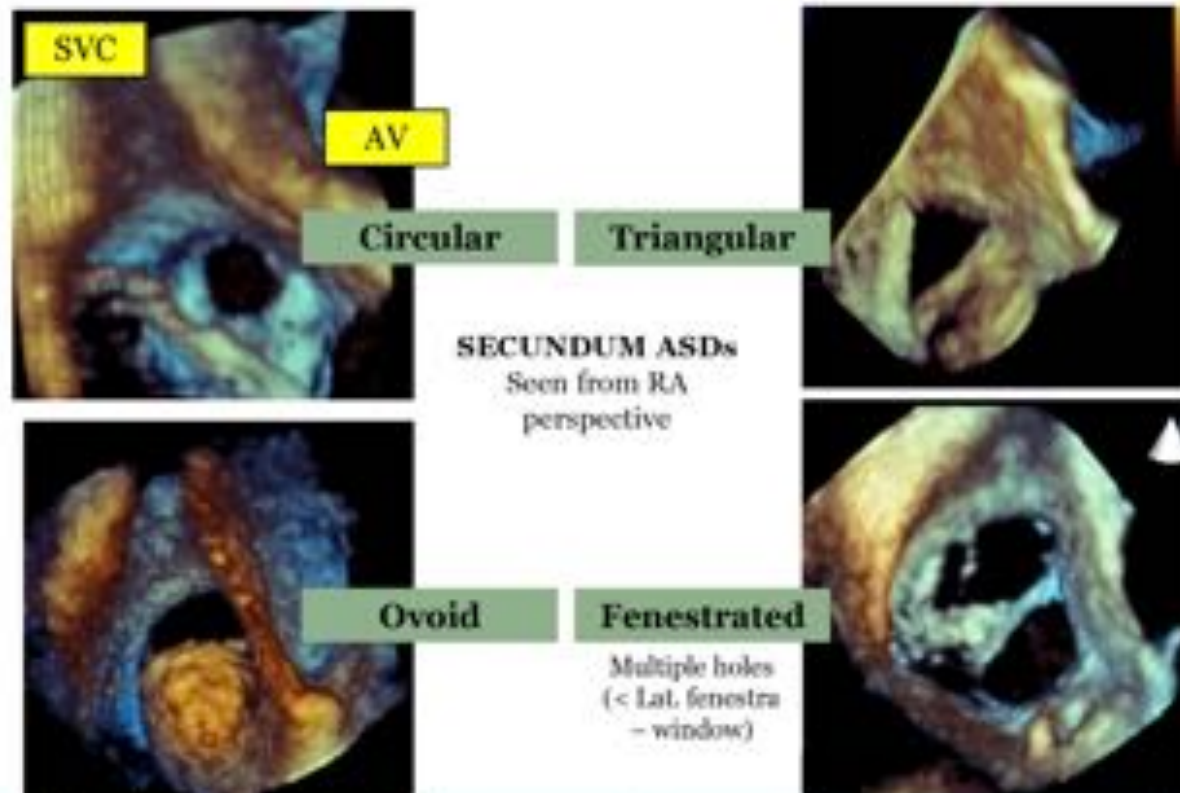
Common atrium

CIA

Ostium secundum centrale



ATRIAL SEPTAL DEFECTS | SHAPE & SIZE VARIABILITY



Ostium secundum

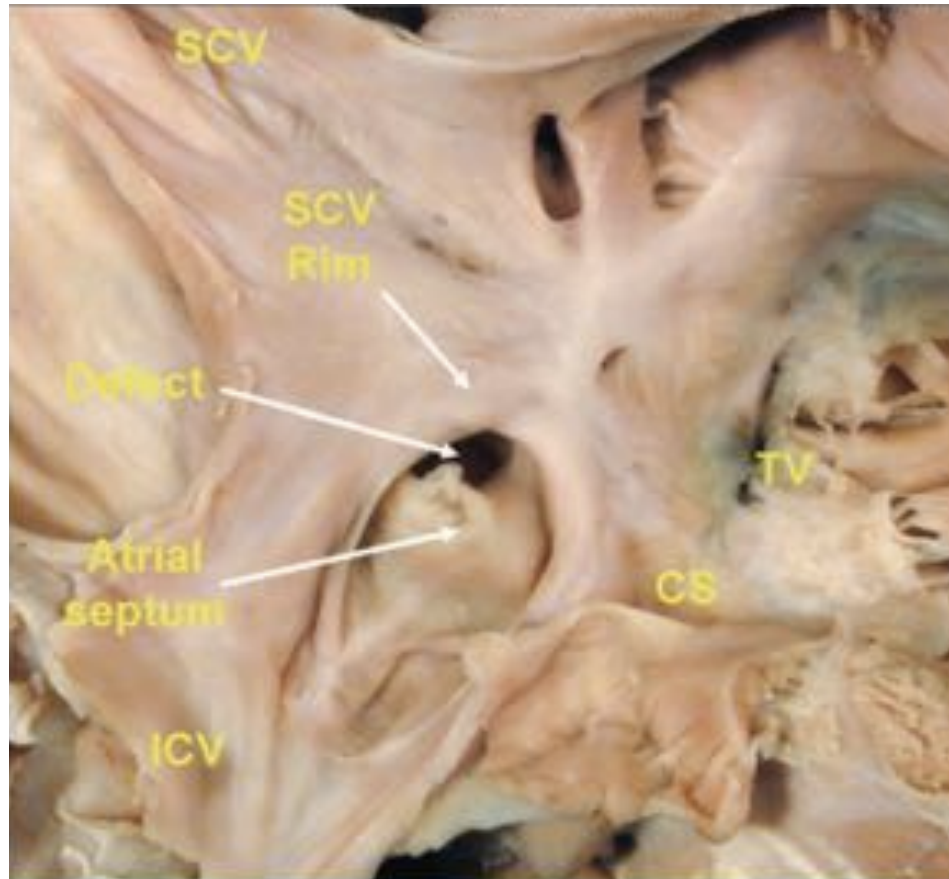
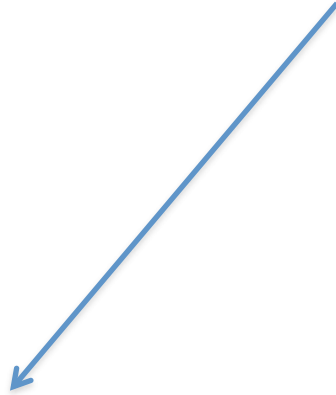




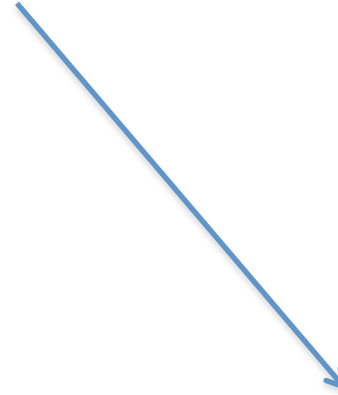
Fig. 1.1 Chest x-ray demonstrating enlarged cardiac silhouette, enlarged central pulmonary arteries, and increased pulmonary vascularity.



CIA

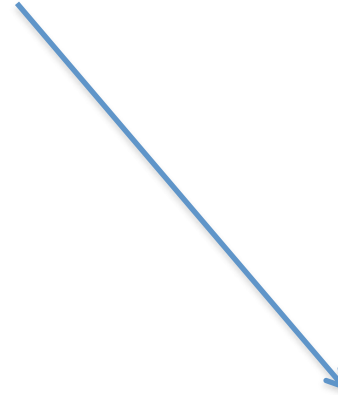
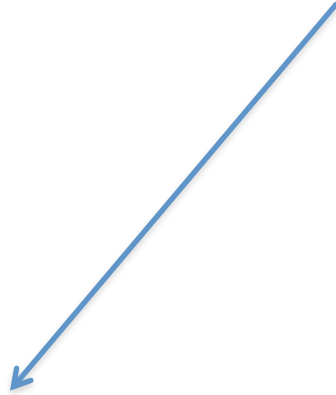


Diagnostic
anatomique



Retentissement VD
HTAP

CIA



Diagnostic
anatomique

Retentissement VD
HTAP

Diagnostic anatomique

Taille de la CIA

Nombre

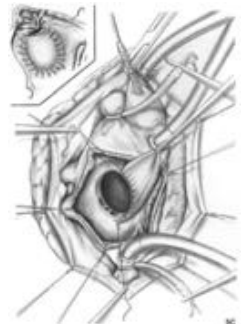
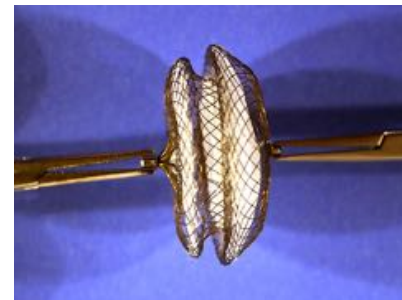
Localisation

Anomalies associées (RVPA, VCSG)

Berges

Importance du shunt

Possibilité de fermeture percutanée ?





PHILIPS

02/05/2011

16:38:46

ITm2.1 IM 1.2

08301620110502

S5-1/CARDIO2

CI 14Hz

20cm

20

60%

C 54

P Bas

HPen

Coil

66%

2.5MHz

FP Haut

Moy

C2 C4

458.7

50.7

cm/s



JPG

67 bpm

PHILIPS

02/05/2011

16:45:30

ITm2.4 IM 1.1

08301620110502

S5-1/CARDIO2

CI 13Hz

26cm

20

73%

C 54

P Bas

HPen

Coul

71%

2.3MHz

FP Haut

Bas

C2 C4

+61.6



-61.6
cm/s



JPEO

66 bpm

08301620110502

CHU AMIENS SUD

S5-1/CARDIO2

4:24:32

CI 13Hz
26cm

2D
73%
C 54
P Bas
HPén

Coul
71%
2.3MHz
FP Haut
Bas

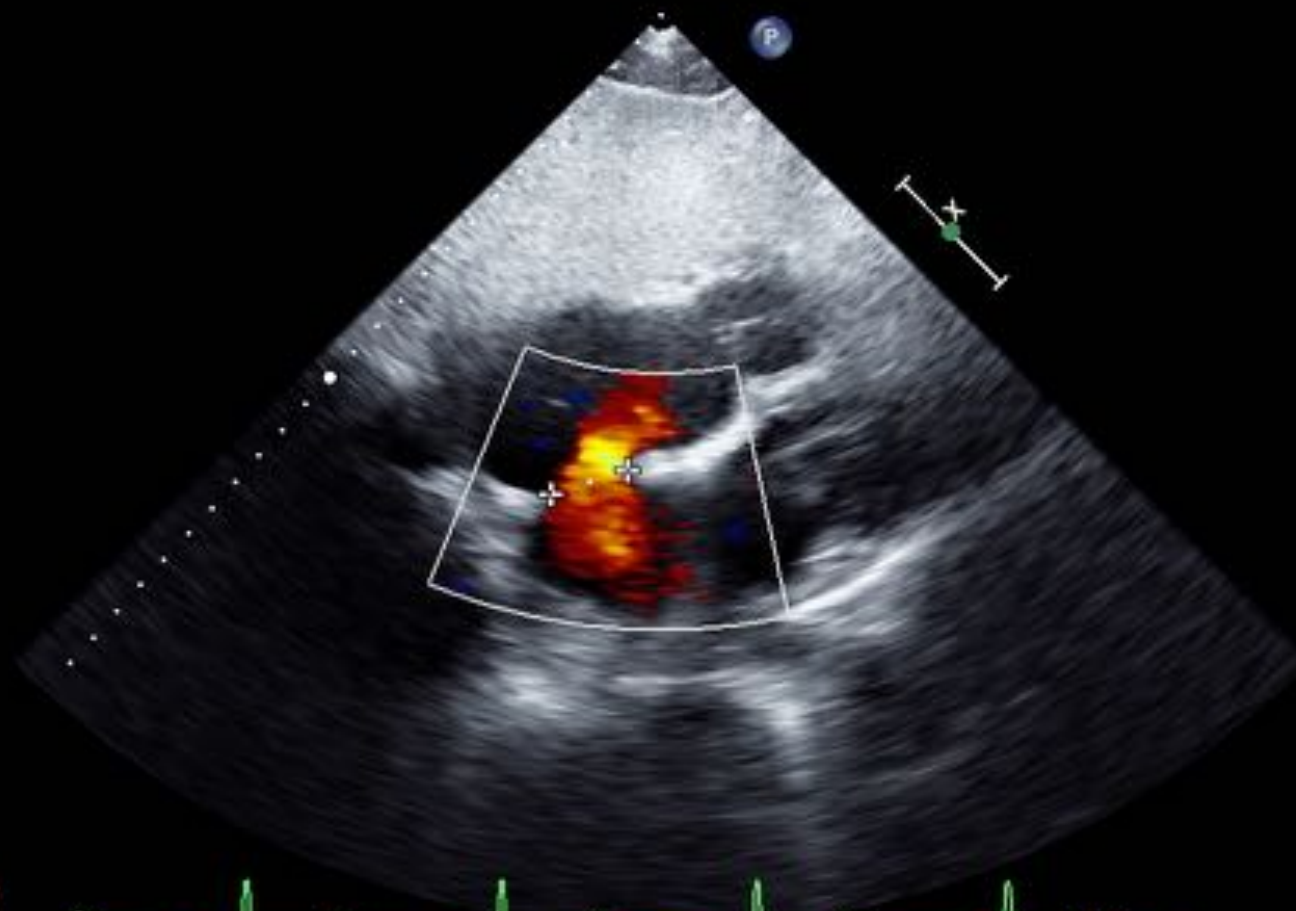
C2 C4
+61.6

-61.6
cm/s

G
P R
1.4 2.8

Dist 2.28 cm

69bpm

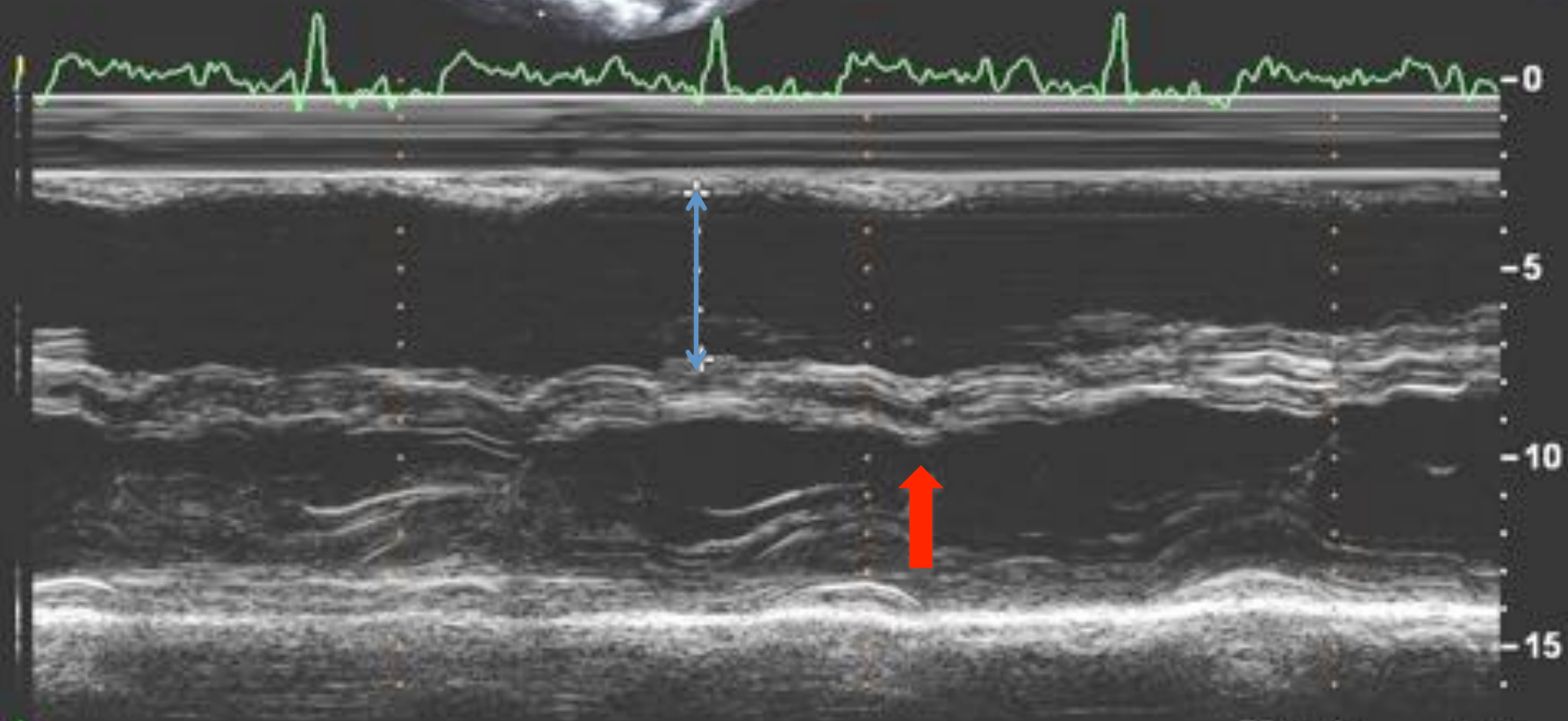


CI 25Hz
17cm

2D / TM
57% 53%
C 50
P Bas
HPén

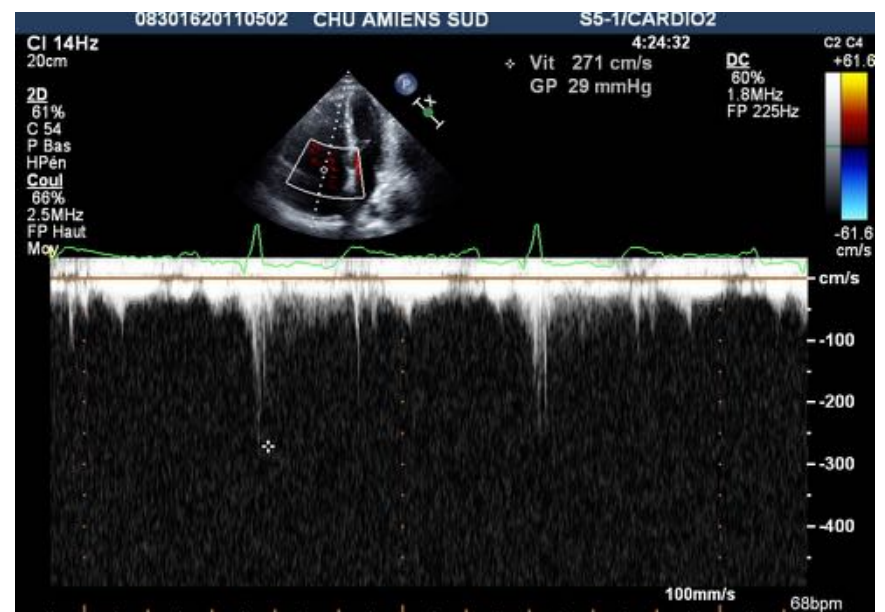
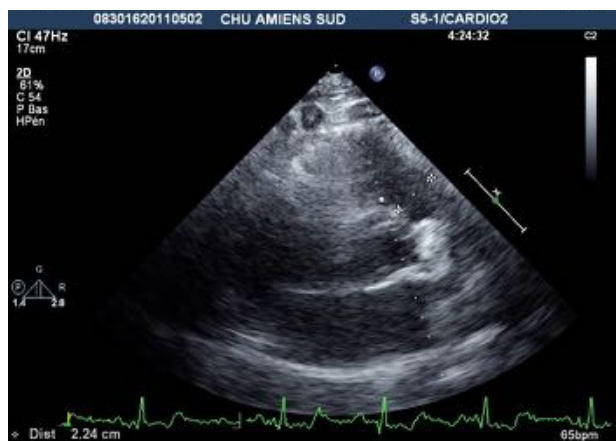
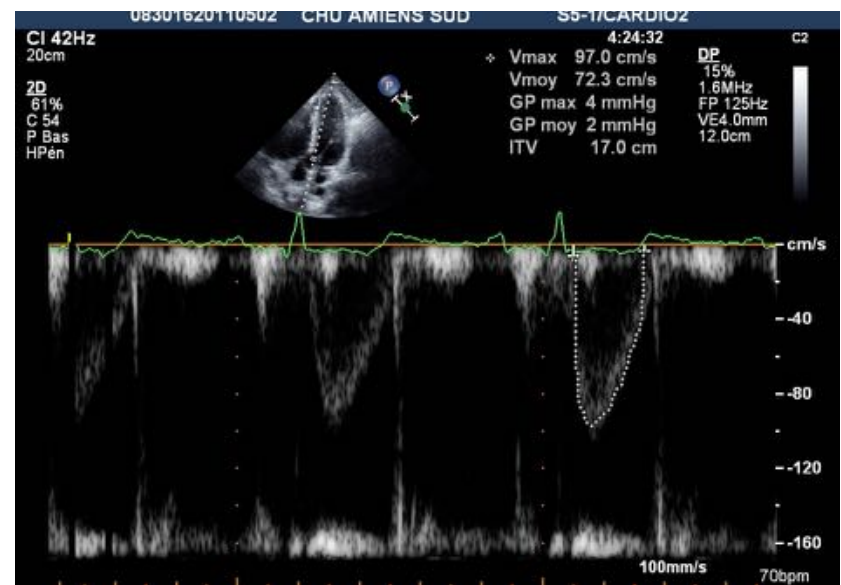
4:24:32
÷ Dist 4.38 cm
Temps 11 ms
Pente 415 cm/s

C2



75mm/s

71bpm



14081320110421

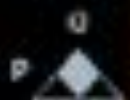
CX7-2JETO

CI 7Hz
15cm

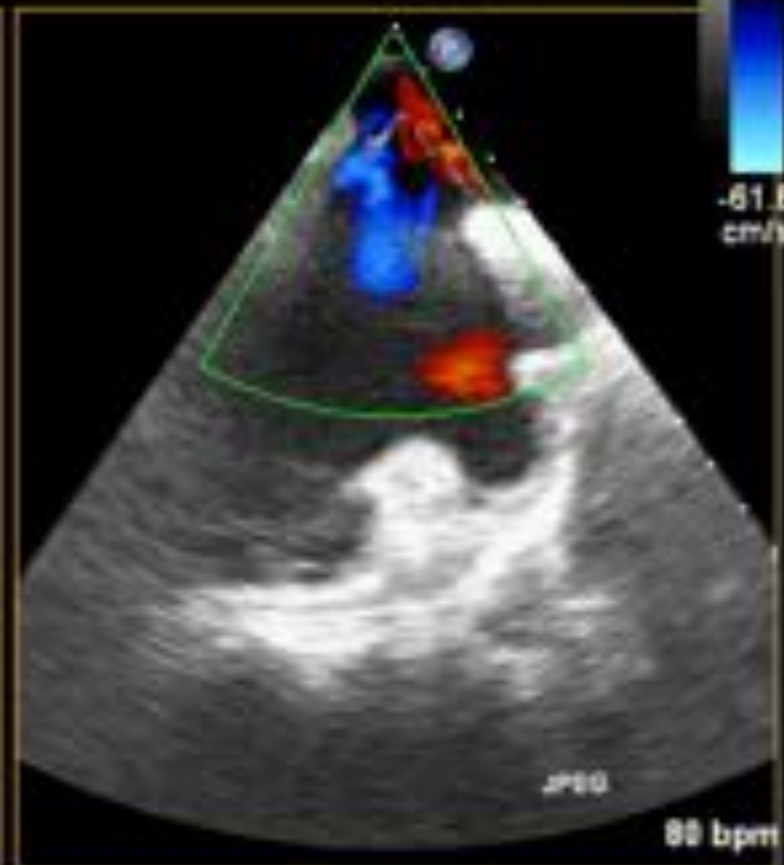
xPlane

82%
82%
50dB
P Arrêt
Gén

Coul
59%
4.4MHz
FP Haut
Moy

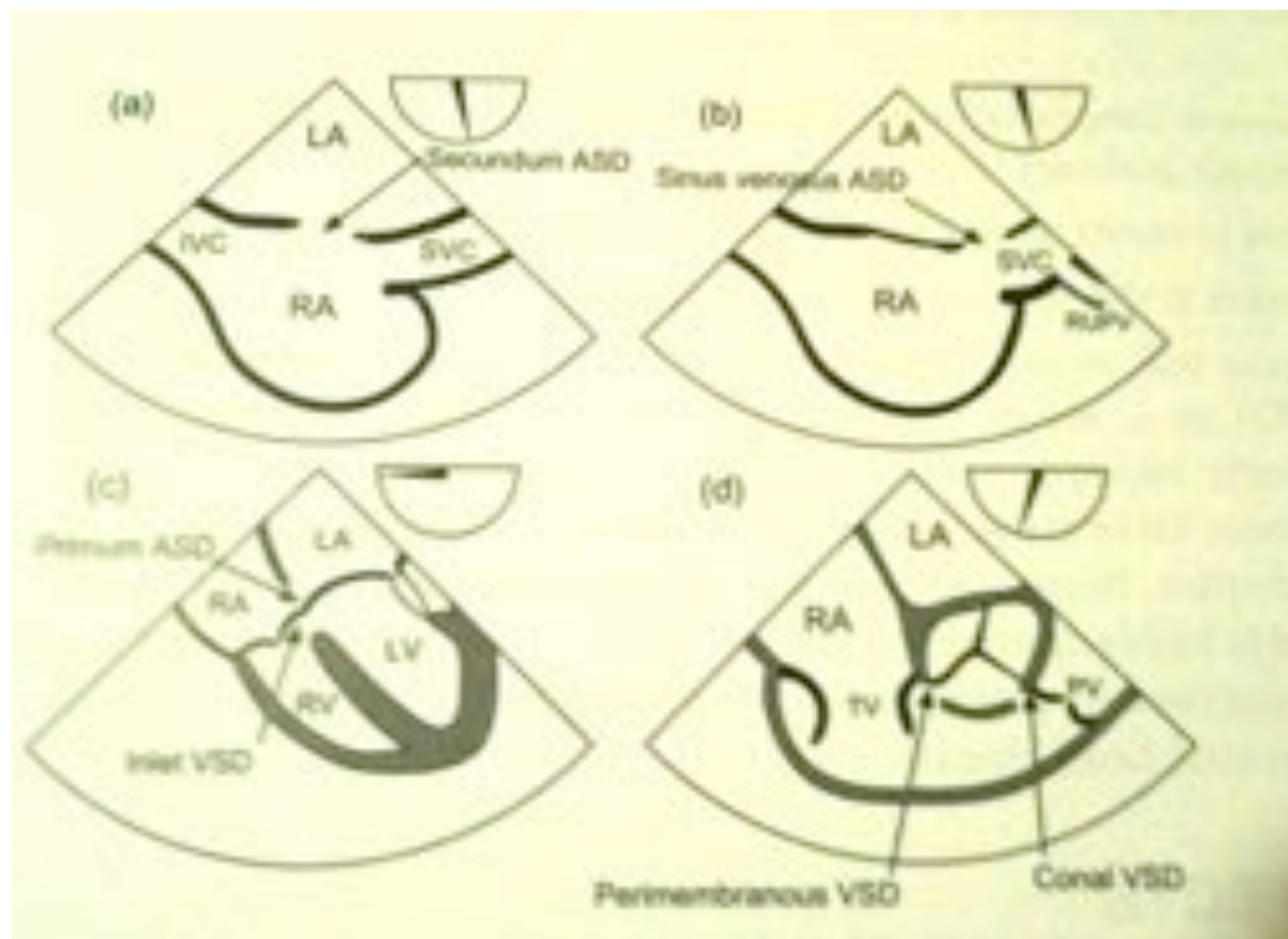


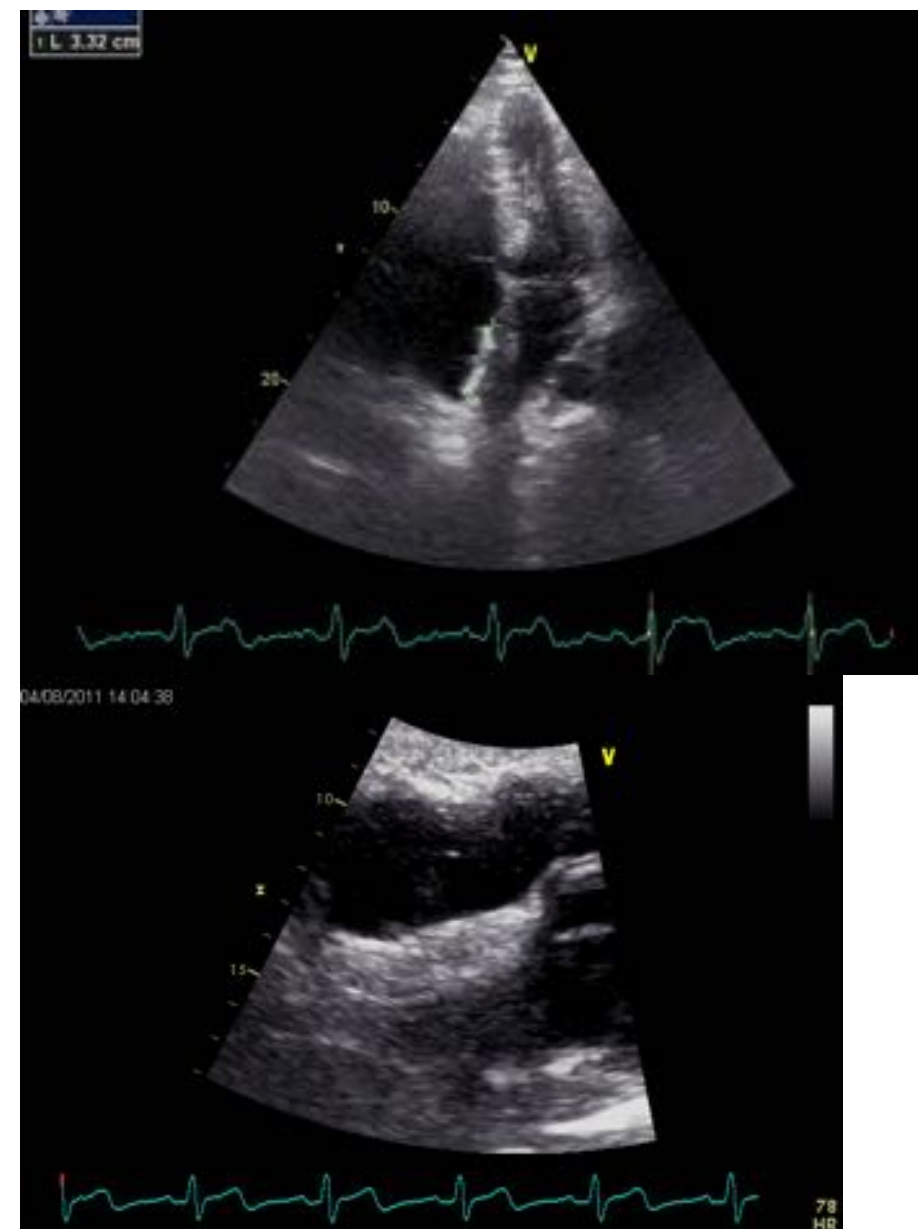
C5 C4
+61.6



T PAT: 37.0C
T ETO: 38.5C

88 bpm





EUSTACHIAN VALVE | PARTIAL VALVE OF IVC



BARTOLOMEO EUSTACHIO
Latinized as Eustachius
(1514 -1574)
Italian anatomist

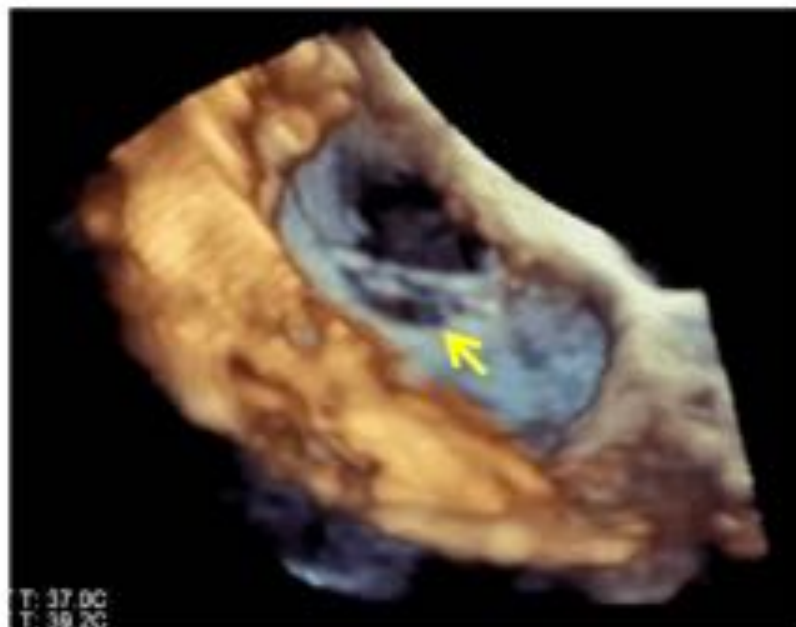


specific guidelines are provided for each category of embolic sources including aortic aneurysm and left aortic appendage, left ventricle, heart valves, cardiac tumors, and thoracic aorta. In addition, there are recommen-

EUSTACHIAN VALVE | PARTIAL VALVE OF IVC



BARTOLOMEO EUSTACHIO
Latinized as Eustachius
(1514 -1574)
Italian anatomist



ATRIAL SEPTAL ANEURYSM

DEFINITION

- Redundancy or saccular deformity of the atrial septum
- Increased mobility of the atrial septal tissue.
- Excursion of the septal tissue (typically the fossa ovalis) of **≥ 10 mm** from the plane of the atrial septum into the RA or LA, or
- A combined total excursion right and left of **≥ 15 mm**

PREVALENCE

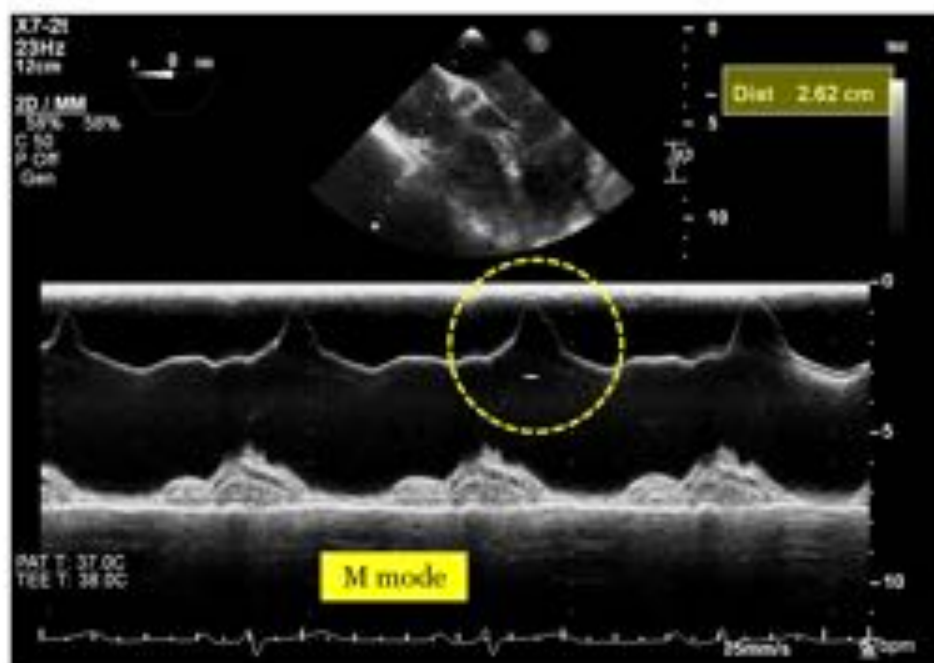
- 2%-3% of humans

ASSOCIATIONS

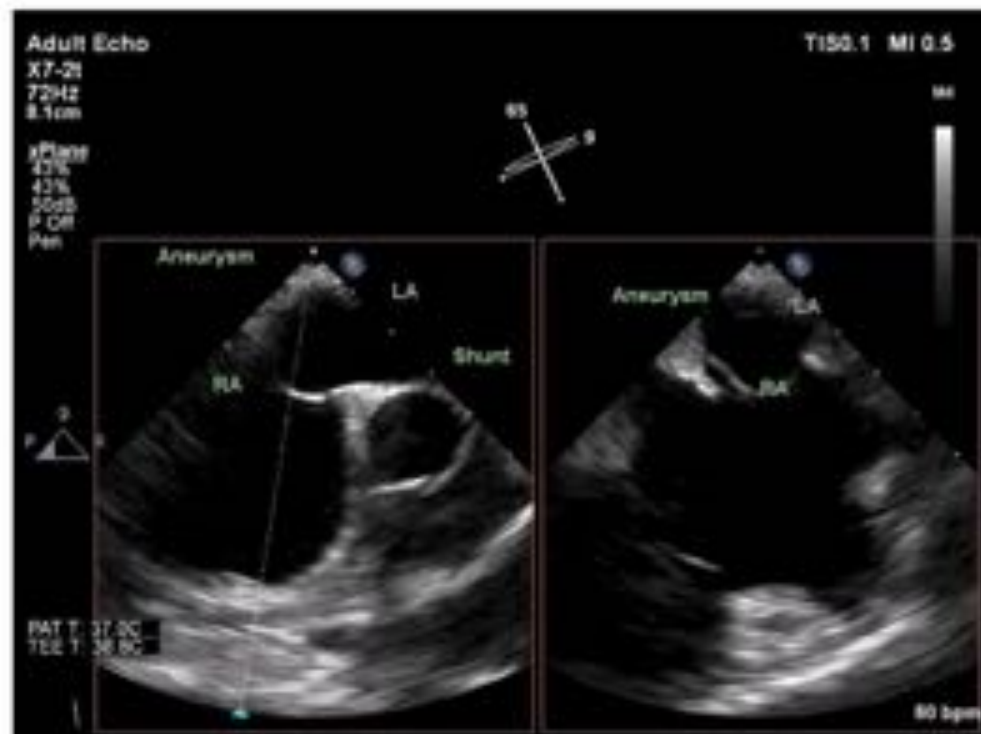
- Increase prevalence of PFO
- Increased size of a PFO
- Increased prevalence of cryptogenic stroke
- Multiple septal fenestrations (fenestrated ASD)



ATRIAL SEPTAL ANEURYSM



ATRIAL SEPTAL ANEURYSM | PFO SHUNT WITH SALINE CONTRAST



INTRACARDIAC VS. INTRAPULMONARY SHUNT

- **PROVOCATIVE MANEUVERS**

Agitated saline injections should be performed at rest and **provocative maneuvers** to increase the right atrial pressure, such as cough and the Valsalva maneuver.

- **PFO**

Within 3 cardiac cycles

The presence of PFO is presumed when agitated saline contrast is noted in the left atrium within 3 cardiac cycles after complete opacification of the right atrium.

- **INTRAPULMONARY SHUNT**

After 5 cardiac cycles

If the agitated saline contrast is noted after 5 cardiac cycles after complete opacification of the right atrium, pulmonary arteriovenous malformations (AVMs) must be considered.

- **LARGE SHUNT**

> 20 bubbles

Various classification schemes have been proposed to assess the sizes of shunts, though none have been universally accepted yet. However, >20 bubbles crossing the PFO from the right to left atrium is considered to be a large shunt



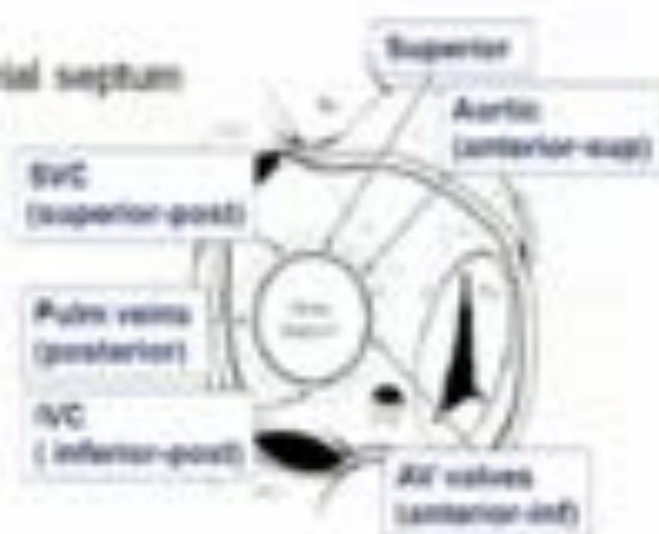
Conclusion

L' échocardiographie est présente
dans toutes les étapes : diagnostic (ETT/ETO)
quantification
guidage des procédures



Selection of patients : TTE

- Closure's indication
- Systematic study of atrial septum
 - Rime
 - Size
 - Solidity
 - Number of defects
 - Atrial septum's size

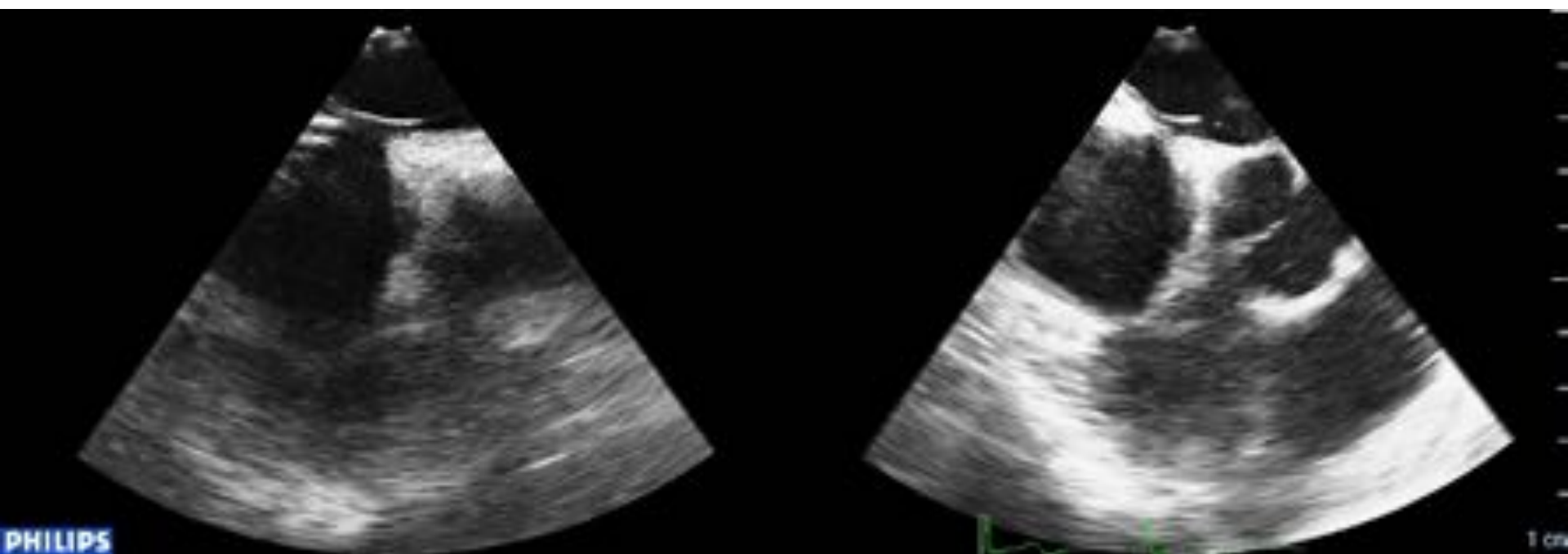


Amor, Cath-Cardiovasc-inter, 2008

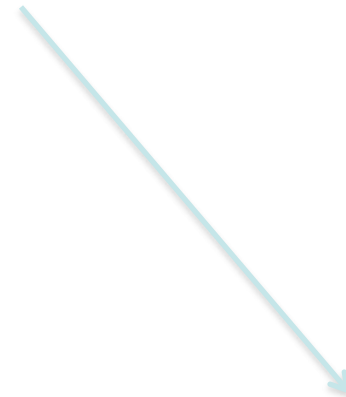
14/09/2011 12:30:15

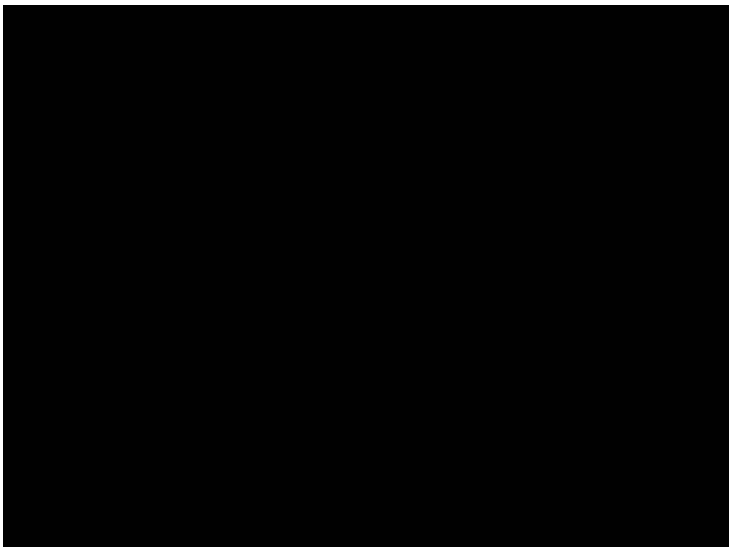


87
HR



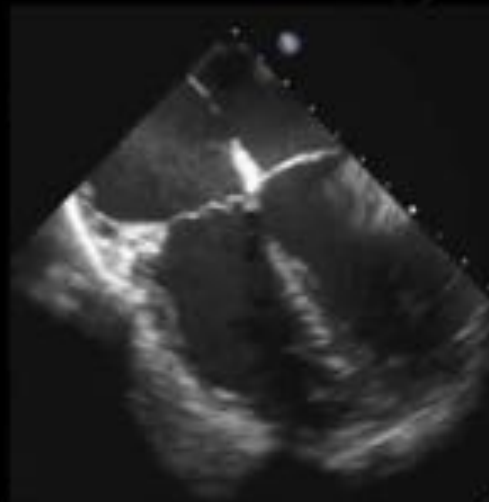




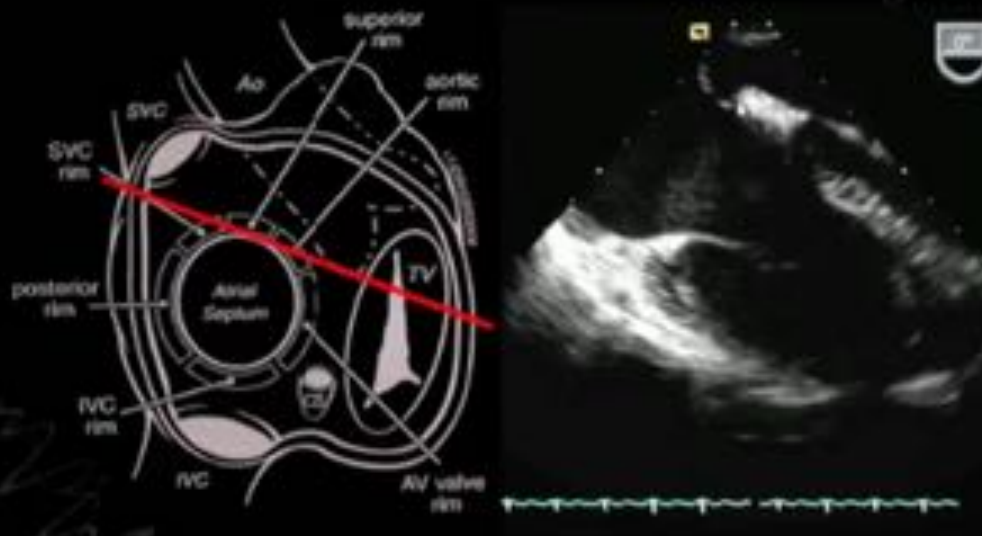




TOE 0°

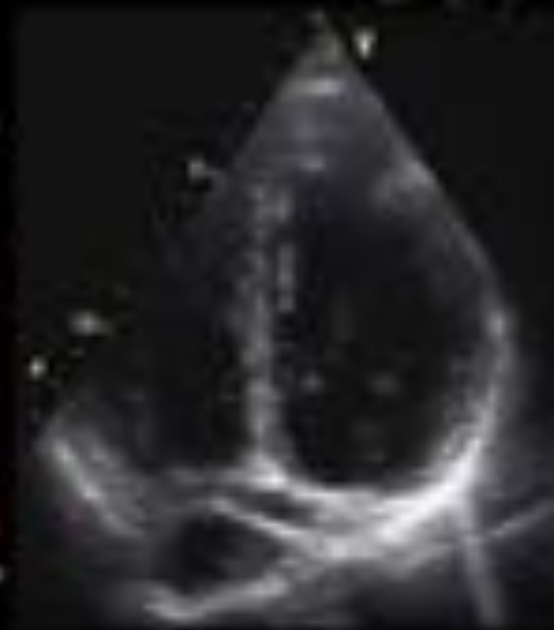


TOE 0° North



STRUCTURAL HEART
DISEASE AUSTRALIA

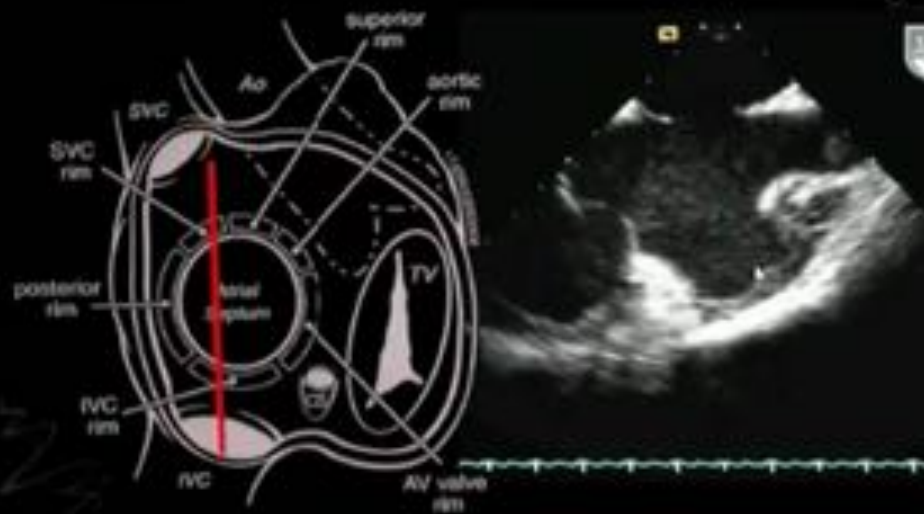
TOE 0° South



TOE 60°



TOE 90-120° Bicaval



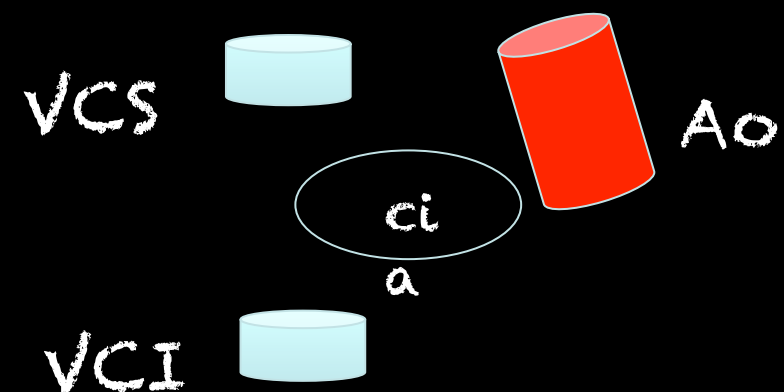
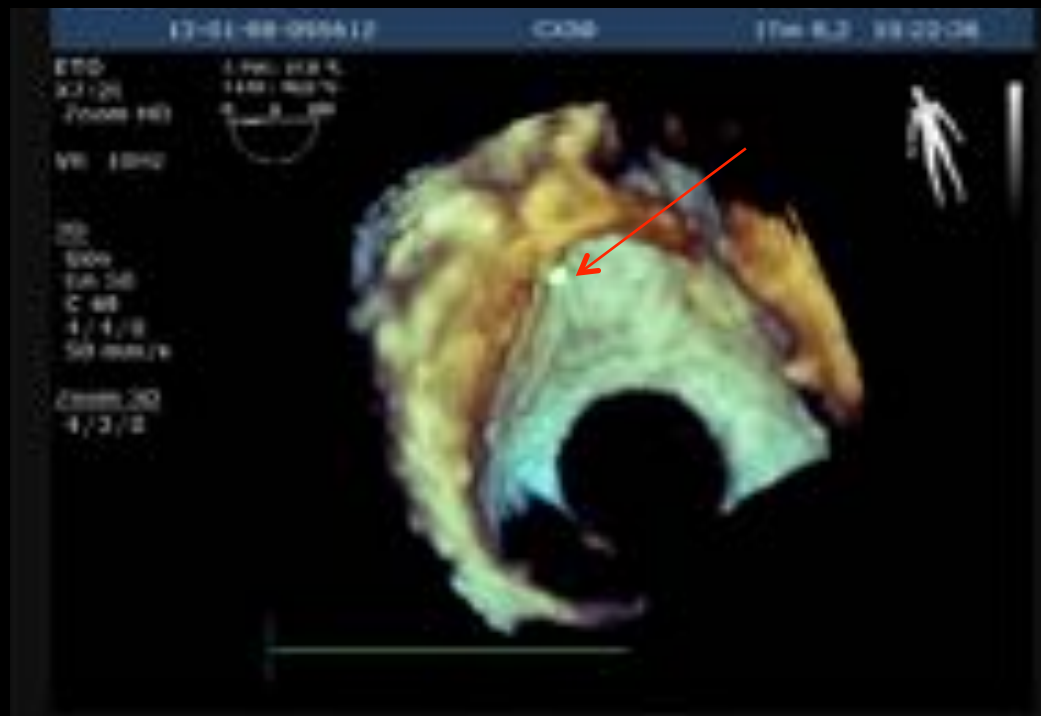
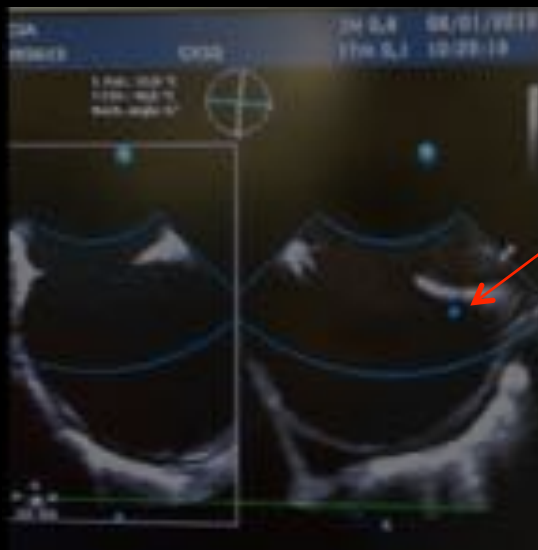


ASE GUIDELINES & STANDARDS

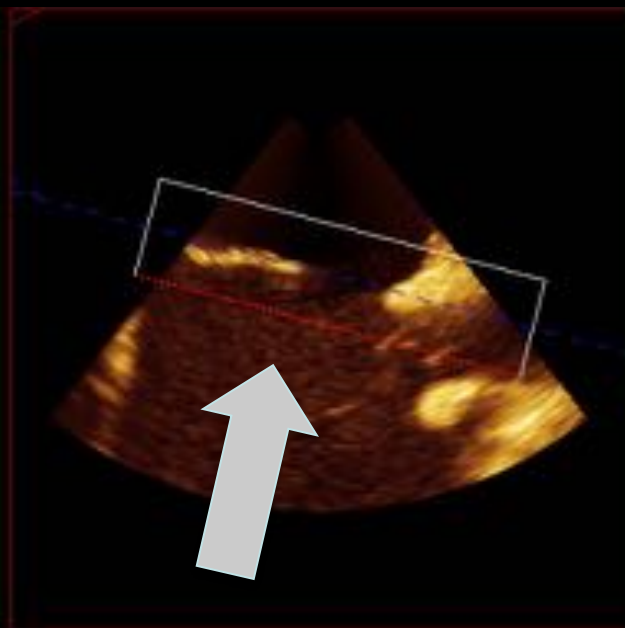
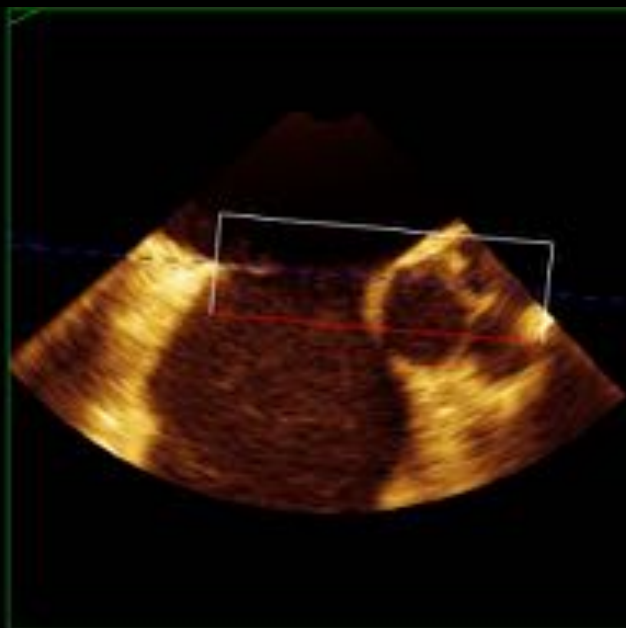
Guidelines for the Echocardiographic Assessment of Atrial Septal Defect and Patent Foramen Ovale: From the American Society of Echocardiography and Society for Cardiac Angiography and Interventions

Frank E. Silvestry, MD, FASE, Chair, Meryl S. Cohen, MD, FASE, Co-Chair, Laurie B. Armsby, MD, FSCAI,
Nitin J. Burkhle, MD, DM, FASE, Craig E. Fleischman, MD, FASE, Ziyad M. Hijazi, MD, MPH, MSCAI,
Roberto M. Lang, MD, FASE, Jonathan J. Reame, MD, and Yan Wang, RDCS, Philadelphia, Pennsylvania;
Portland, Oregon; Thane, India; Orlando, Florida; Doha, Qatar; and Chicago, Illinois

- Guidelines ase+++++
- ASIA :
- Shunt large
 - > 30 Bulles dans close
 - > 25 dans Gore REDUCE



Guidelines 2012



Distance(s)	
D1 = 1.82 cm	r x
D2 = 1.48 cm	r x
D3 = 1.86 cm	r x
D4 = 1.48 cm	r x

