# SEVRAGE RESPIRATOIRE DIFFICILE: ORIGINE CARDIAQUE?

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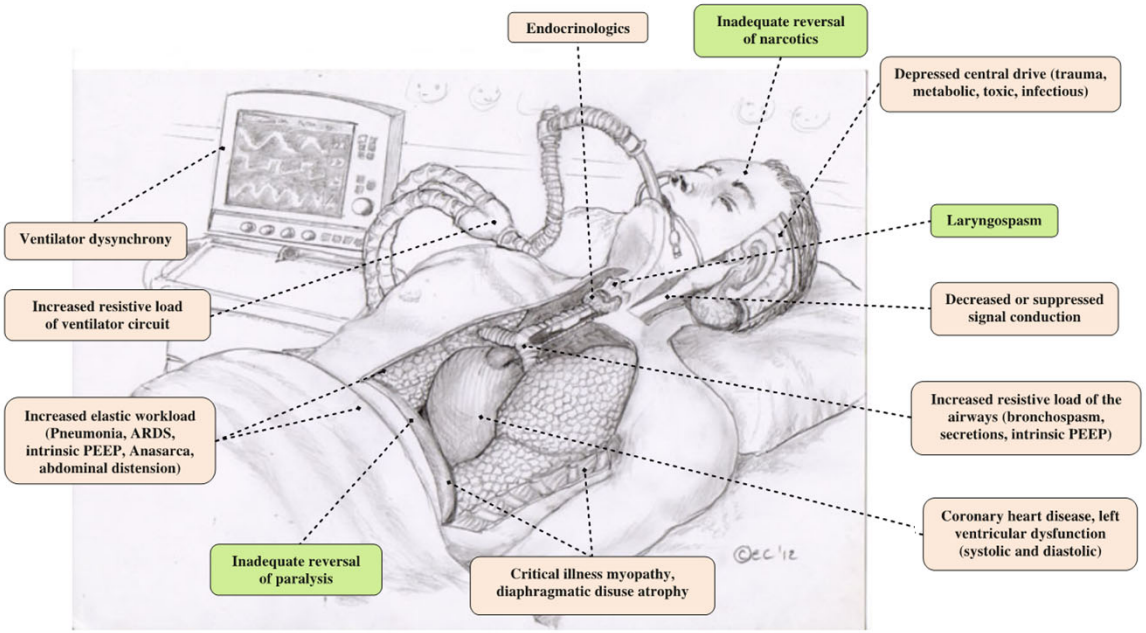
# ECHEC DU SEVRAGE RESPIRATOIRE: DES ORIGINES DIVERSES…




*Perren A et al. Intensive Care Med 2013; 39:1885-95*

Teboul *et al. Critical Care* 2010, **14**:211
http://ccforum.com/14/2/211

CRITICAL CARE

REVIEW

# Weaning failure of cardiac origin: recent advances

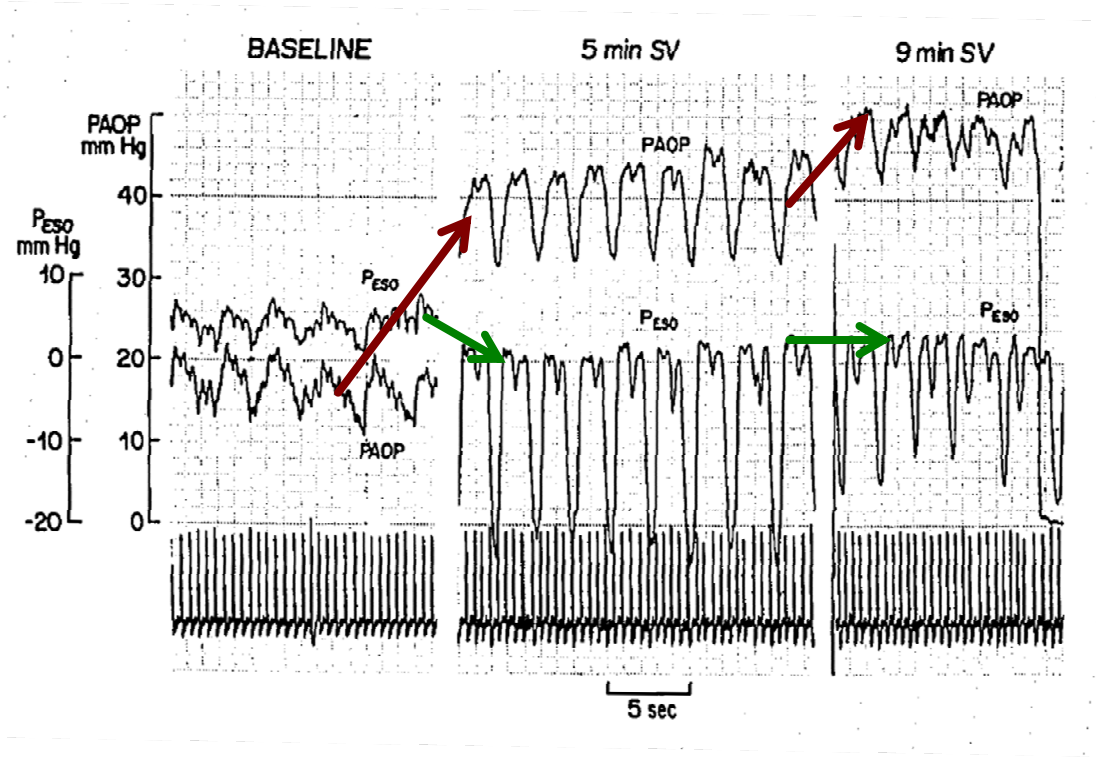
Jean-Louis Teboul*, Xavier Monnet, and Christian Richard

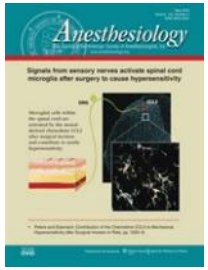
# *Acute Left Ventricular Dysfunction during Unsuccessful Weaning from Mechanical Ventilation*

15 pts BPCO porteurs pathologie cardiaque

- Passage en ventilation spontanée (10 min)
- Pression oesophagienne ↘ de +5 à -2 mmHg
- DC ↗ de 3,2 à 4,3 $L.min^{-1}$
- FC ↗ de 77 à 90 bpm
- PAPO ↗ 8 à 20 mmHg

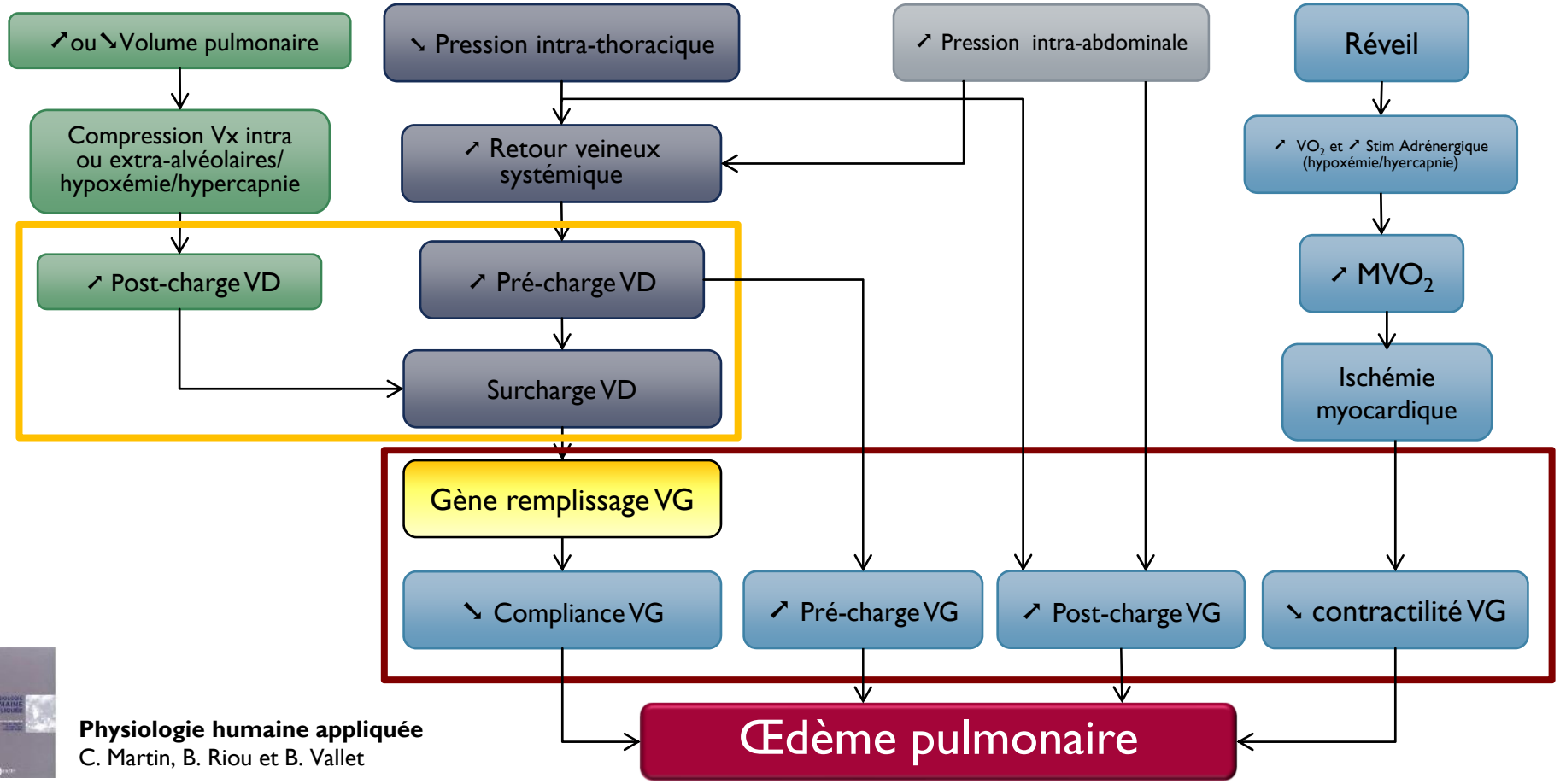

*Lemaire F. et al. Anesthesiology 1988; 69:171-9*




*Lemaire F et al. Anesthesiology 1988; 69:171-9*

## Sevrage de la ventilation mécanique (VS+++)



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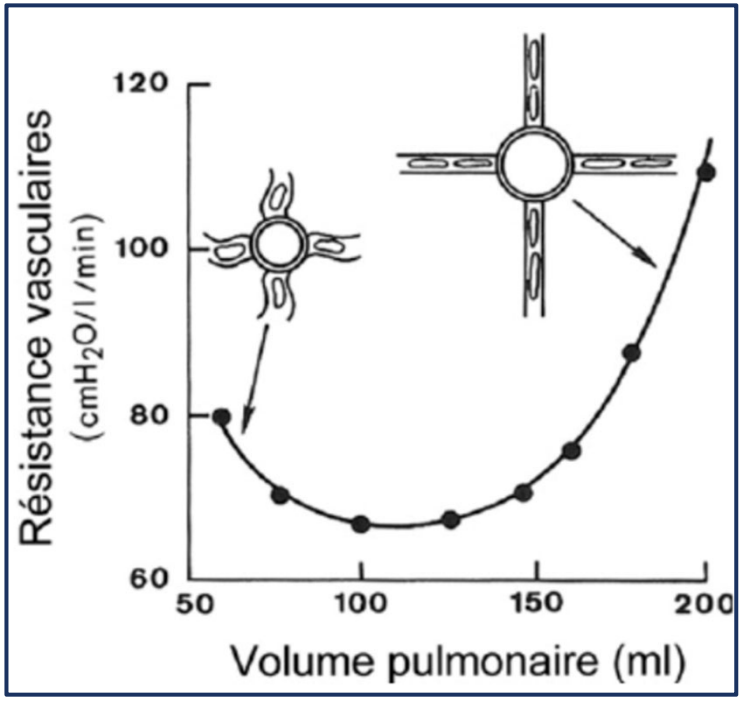
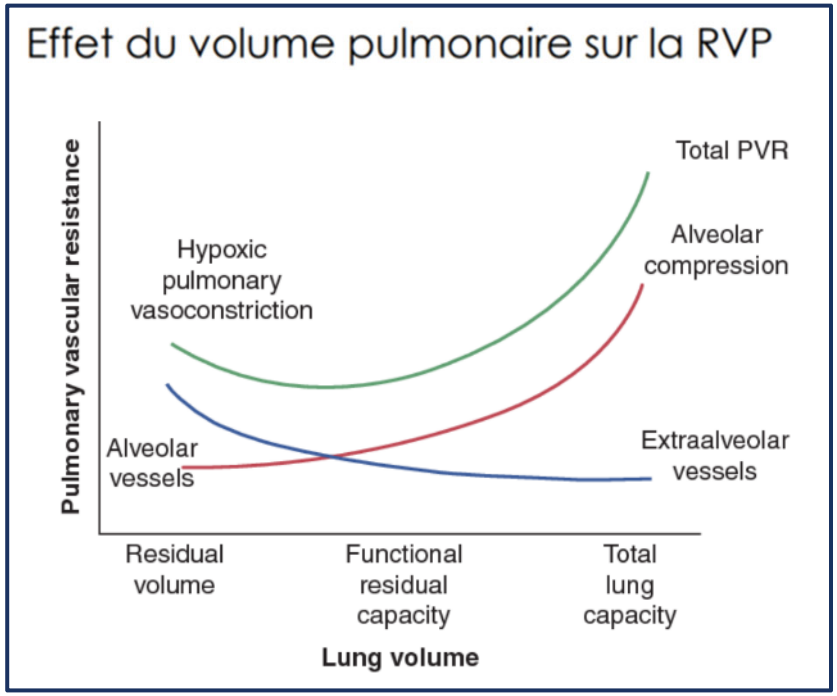
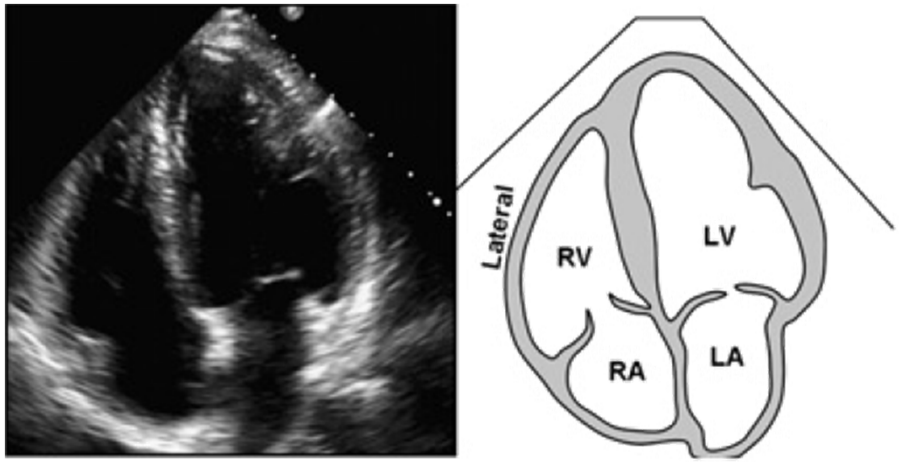
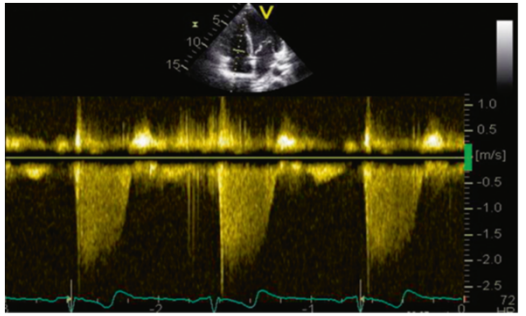
# Volume pulmonaire et Résistances Vasculaires Pulmonaires



# ANALYSE ECHO VD: INCIDENCE APICALE 4 CAVITES



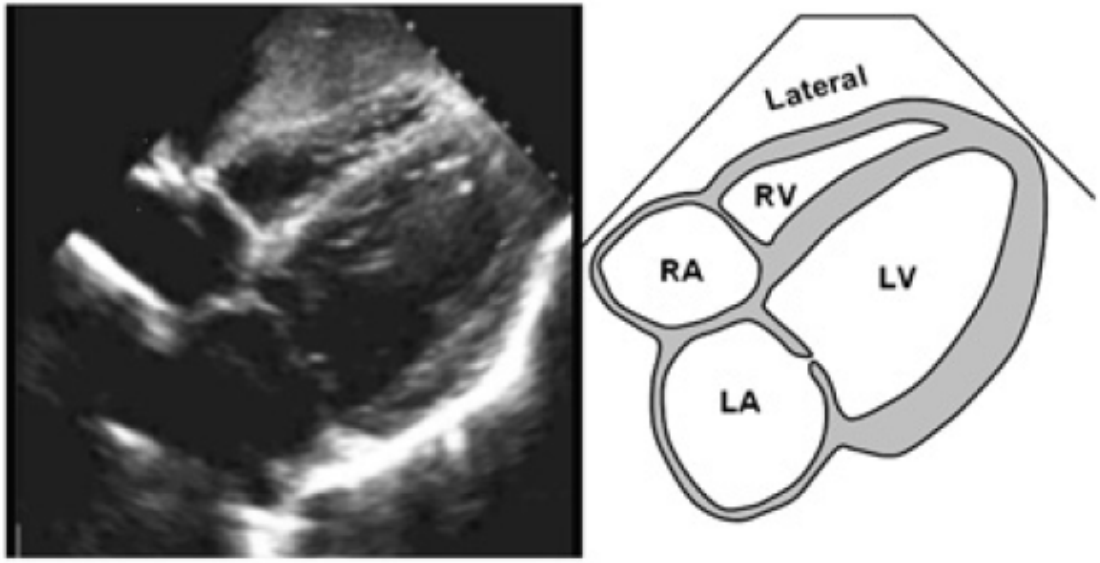



PAPs= $4V_{max}^{2}$ +POD

- Paroi libre (distension des cavités)
- Mesure FR VD (Fractional aera change), TAPSE (mode TM), Tissue doppler (Pic S')
- Estimation pression artérielle pulmonaire (systolique)

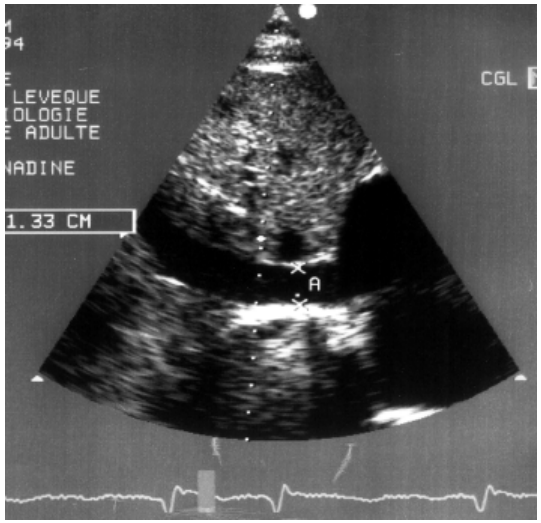
# ANALYSE ECHO VD: INCIDENCE SOUS-COSTALE 4 CAVITES

- Dilatation des cavités droites
- Epaississement paroi libre VD

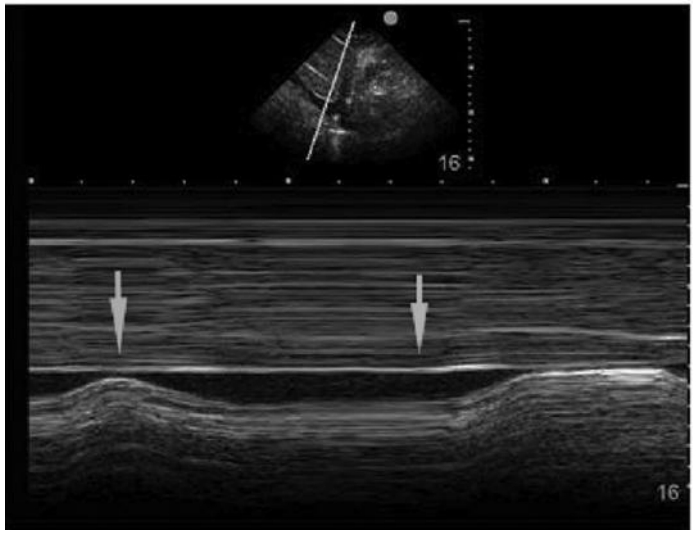


# ANALYSE ECHO VD: INCIDENCE SOUS-COSTALE 4 CAVITES

- Analyse VCI (distension, variabilité)

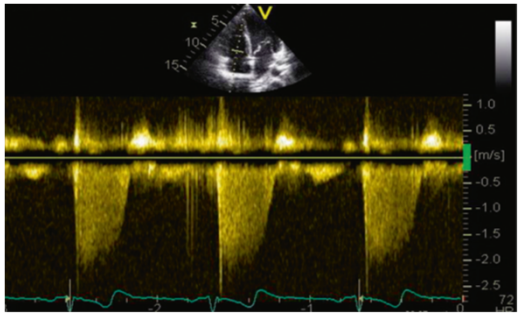



Mesure à 1-2 cm de l'abouchement OD
(N= 14-17 mm)

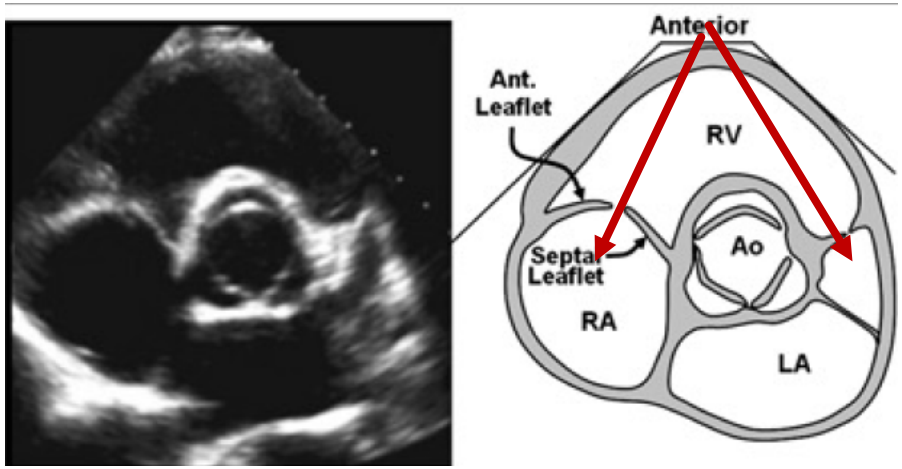


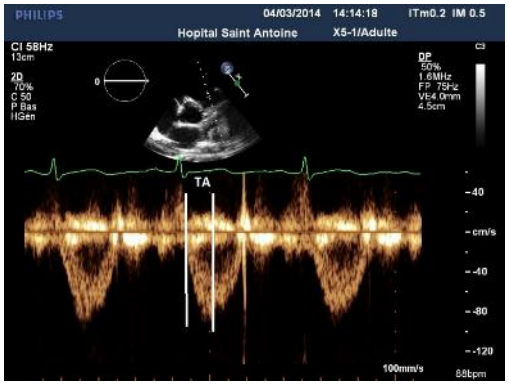
# ANALYSE ECHO VD: INCIDENCE PSG PETIT AXE-BASALE

- Tricuspide (feuillet antérieur et septal)
- Flux régurgitation tricuspide (PAP systolique)
- Flux d'éjection pulmonaire (Doppler pulsé)



PAPs= $4V_{max}^{2}$ +POD

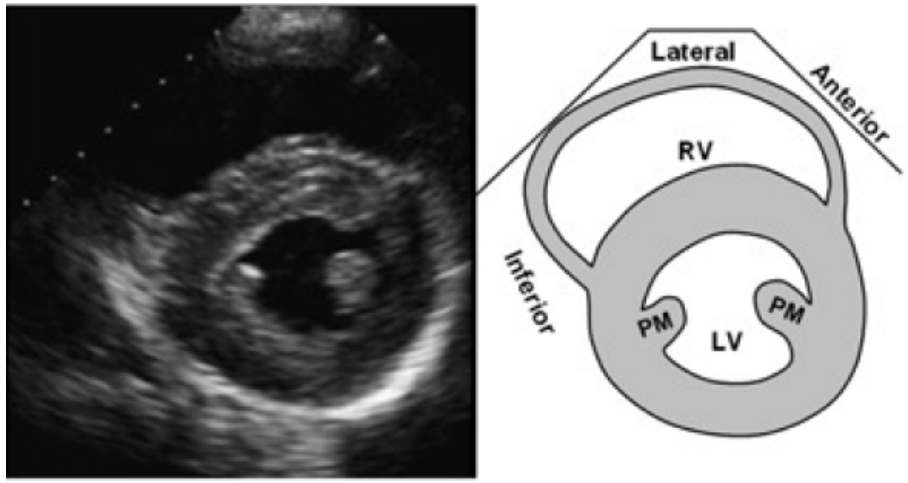


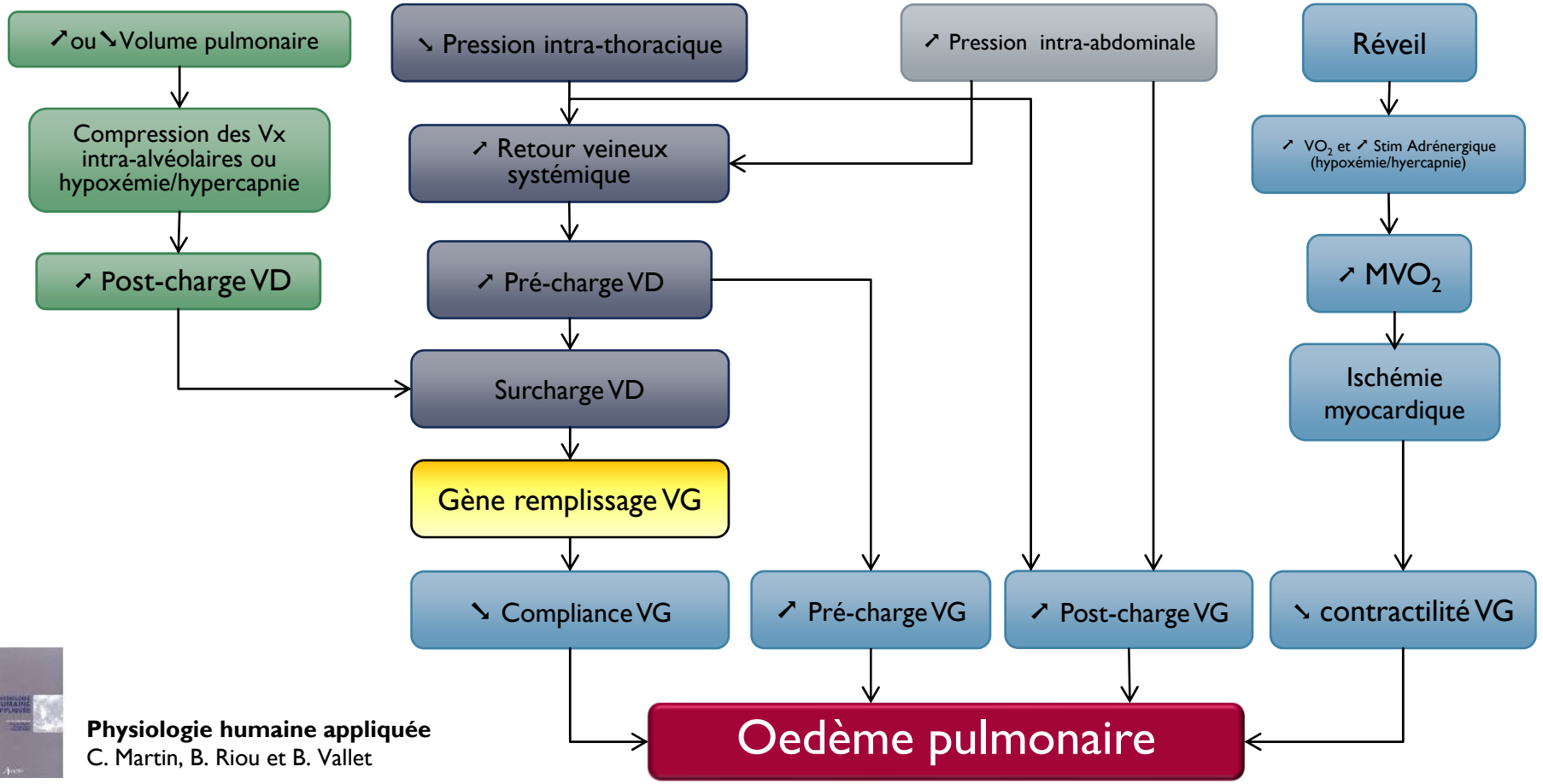

Temps d'accélération flux pulmonaire >130 ms

# ANALYSE ECHO DU VD: INCIDENCE PSG PETIT AXE-TRANSPILIER

- Cinétique VD/VG
- Surcharge systolique VD
- Analyse septum interventriculaire



## Sevrage de la ventilation mécanique (VS +++)



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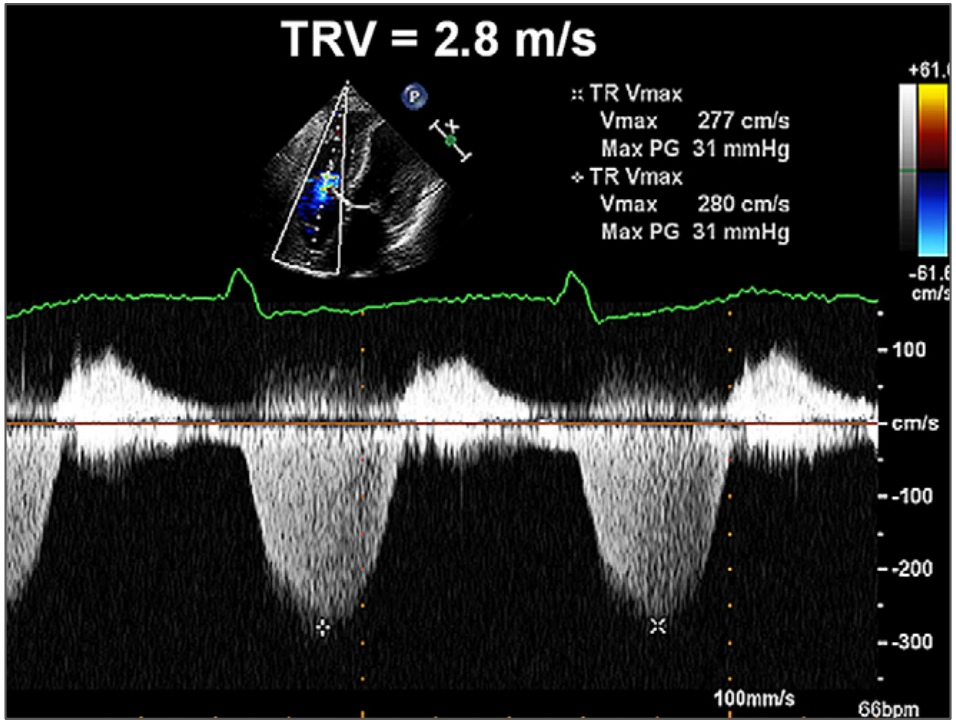
# Analyse régurgitation tricuspide

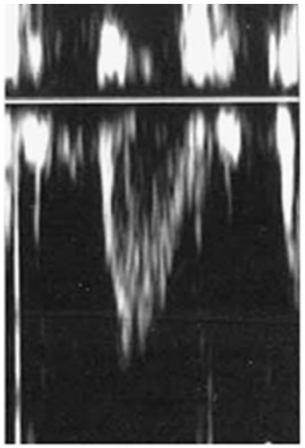
Vitesse maximale (HTAP si > 3 $m.s^{-1}$)

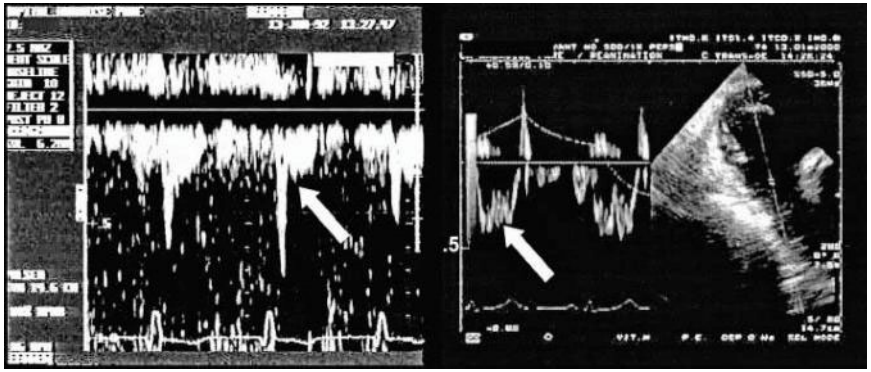
Mesure PAPs (PAPs = $4V_{max}^2$ +POD)

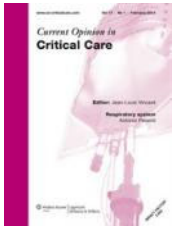


## Analyse flux d'éjection pulmonaire

- Raccourcissement du temps d'accélération < 90-100 ms
- Aspect flux biphasique du flux d'éjection pulmonaire
- Signe d'augmentation  post-charge VD



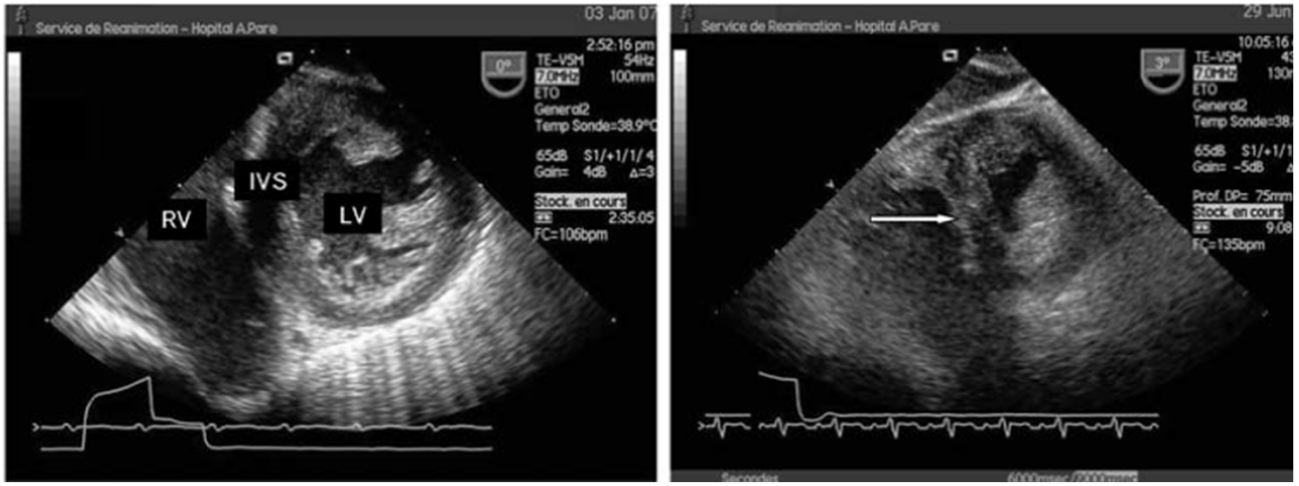




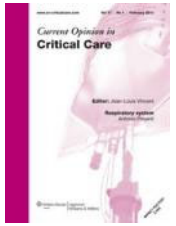

*Veillard Baron A. Current Opinion in Critical Care 2009, 15:254–260*

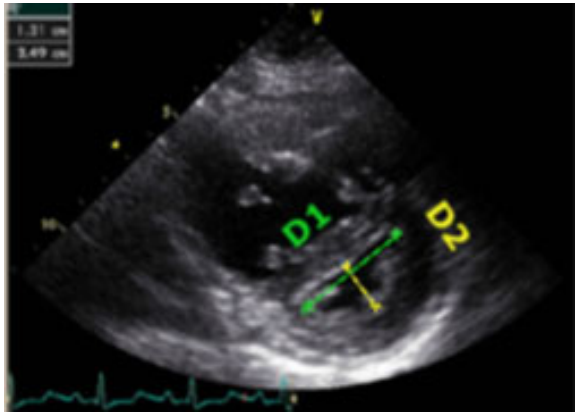
# ANALYSE MORPHOLOGIQUE (SURCHARGE SYSTOLIQUE DU VD)

- Septum plat ou paradoxal



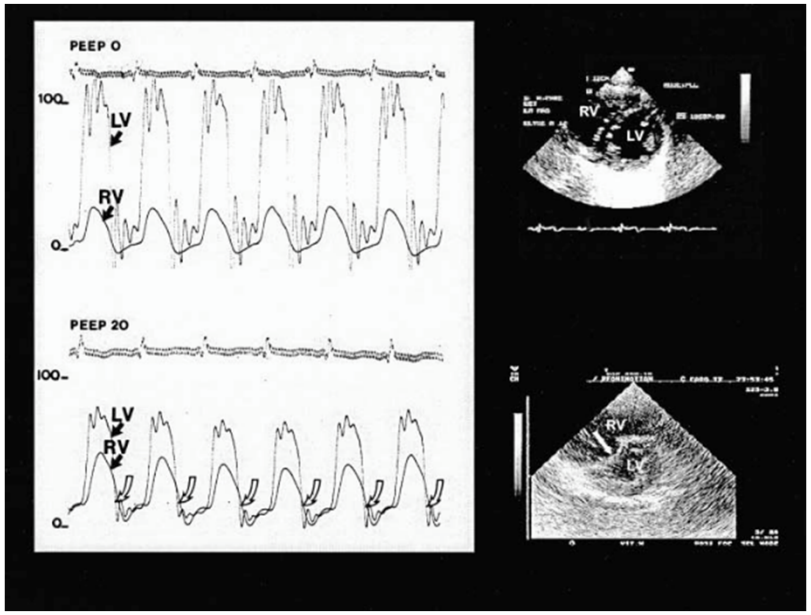

*Veillard Baron A. Current Opinion in Critical Care 2009, 15:254–260*





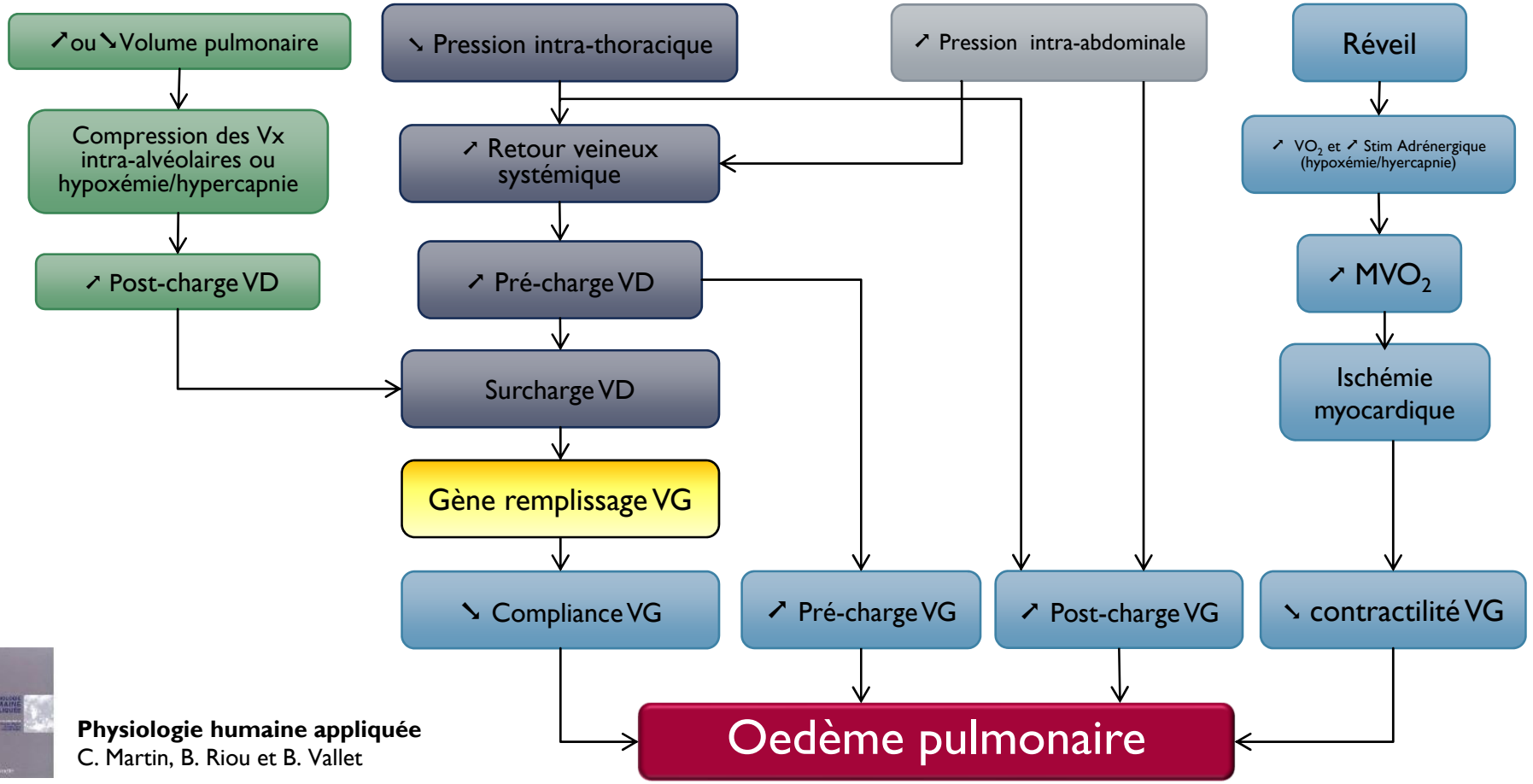

## Index d'excentricité

- Valeur normale D2/D1 = 1 (Pathologique > 1)




Veillard-Baron A et al. Am J Resp Crit Care Med 2002; 166:1310-9

# Sevrage de la ventilation mécanique



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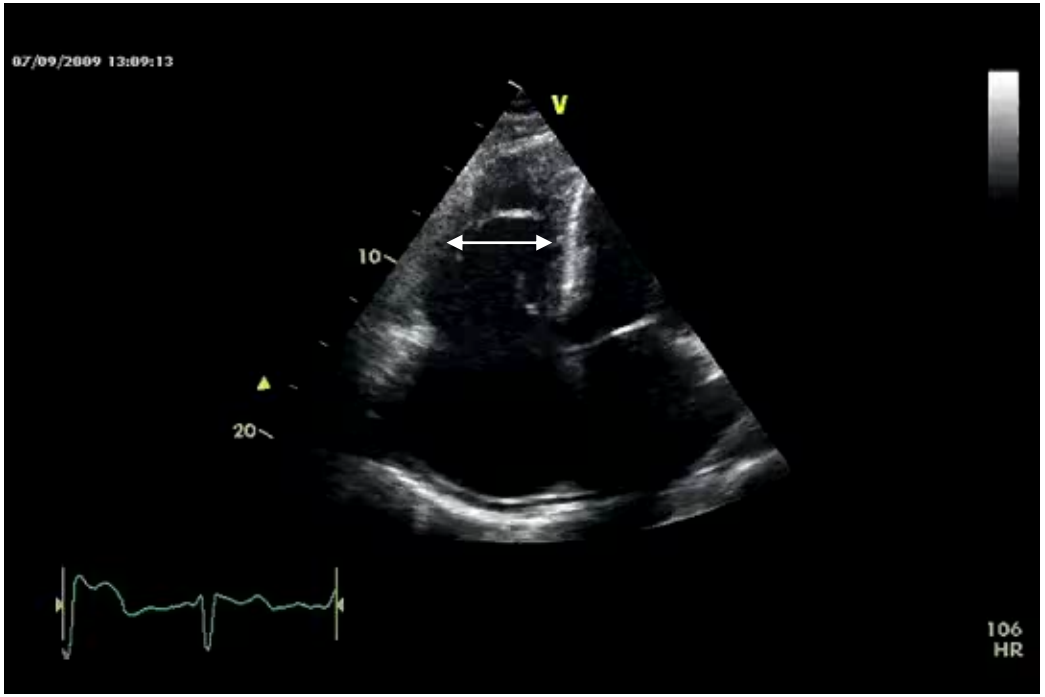
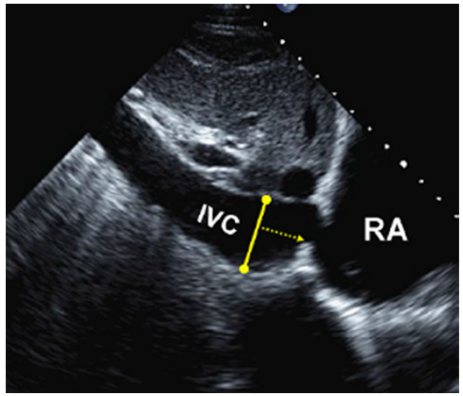
- 7 patients BPCO
- Sans dysfonction cardiaque gauche préalable
- Cathéter de Swan-Ganz
  - Augmentation PAP 25 à 28 mmHg au sevrage
  - Pas de modification significative FEVD 0,36 à 0,35
  - **Volume télé-diastolique VD 117 à 126 ml**

*Teboul JL, Intensive Care Med. 1988;14 Suppl 2:483-5*




Incidence apicale 4 cavités

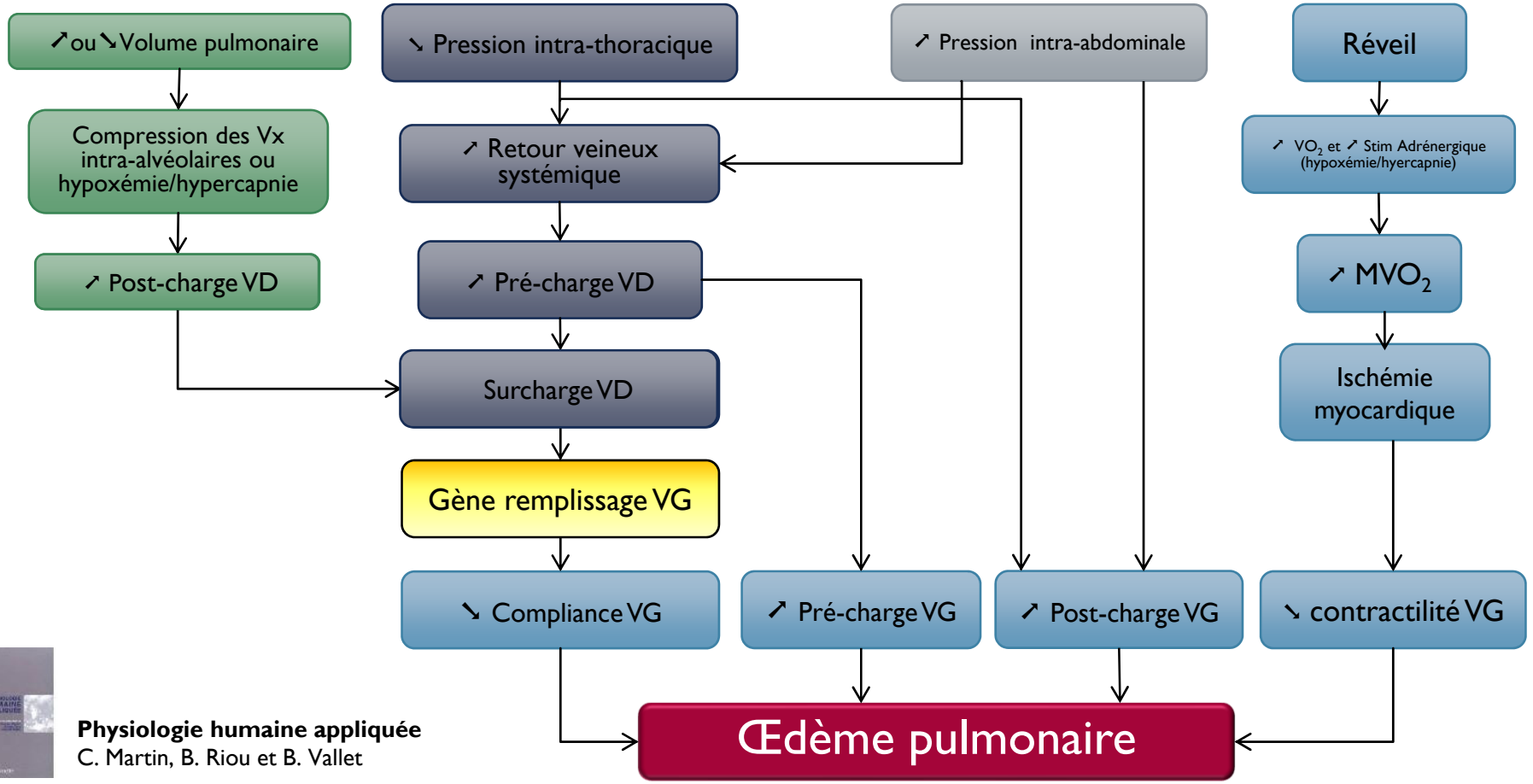



Incidence sous-costale 4 cavités (centrée sur VCI)

Table 3 Estimation of RA pressure on the basis of IVC diameter and collapse

| Variable | Normal (0-5 [3] mm Hg) | Intermediate (5-10 [8] mm Hg) | | High (15 mm Hg) |
|---|---|---|---|---|
| IVC diameter | ≤2.1 cm | ≤2.1 cm | >2.1 cm | >2.1 cm |
| Collapse with sniff | >50% | <50% | >50% | <50% |
| Secondary indices of elevated RA pressure | | | | • Restrictive filling<br>• Tricuspid E/E′ > 6<br>• Diastolic flow predominance in hepatic veins (systolic filling fraction < 55%) |

## Sevrage de la ventilation mécanique



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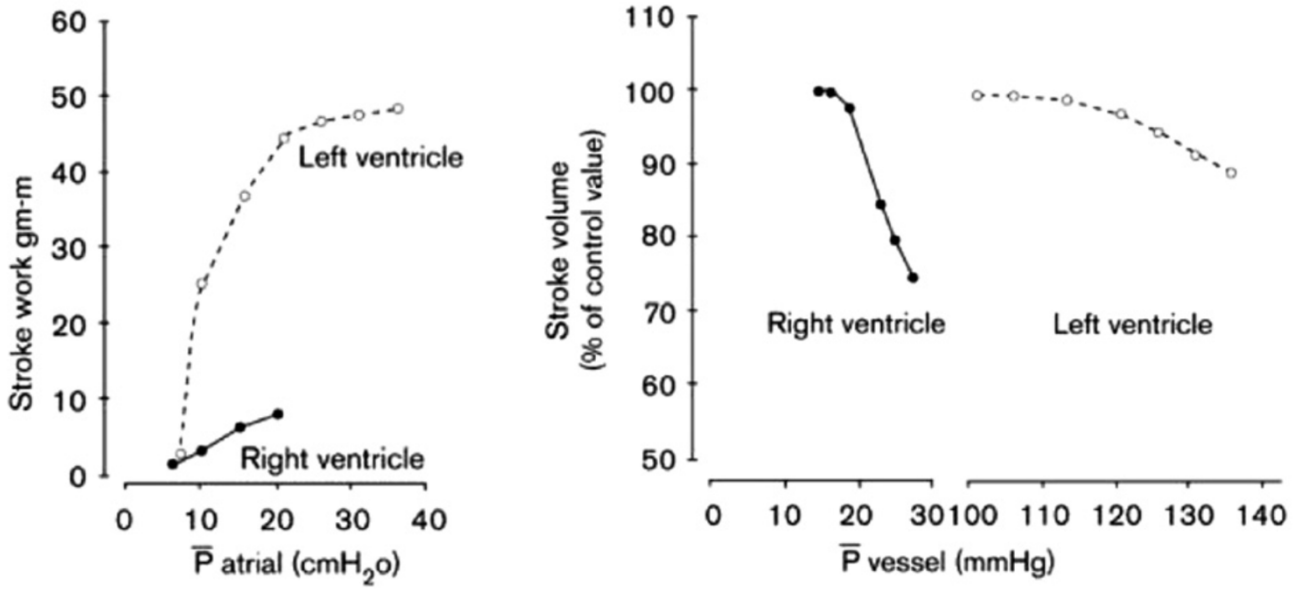
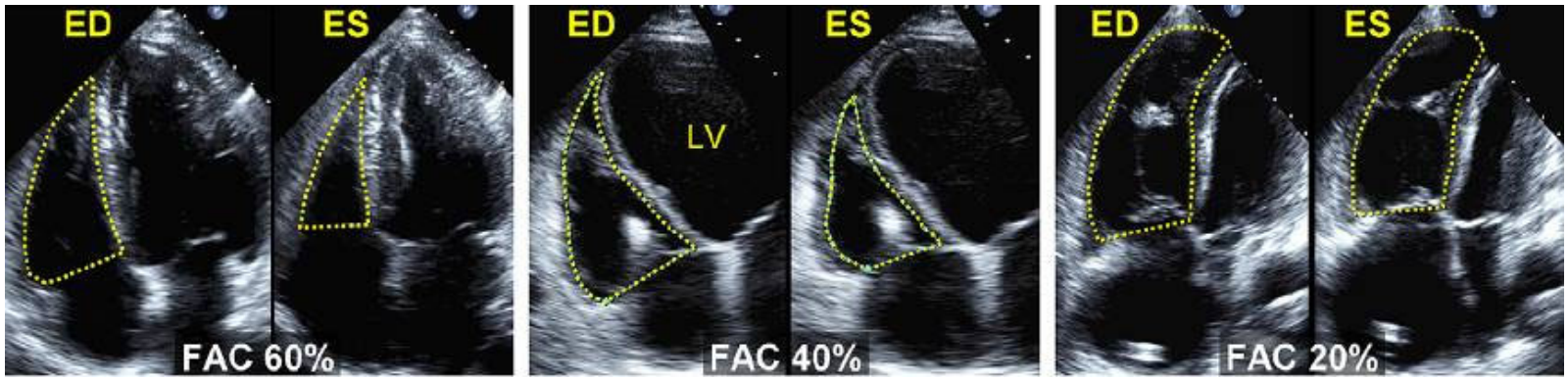
# Réponse adaptive différente aux conditions de charge…..




*Ventetuolo CE et al. Ann Am Thorac Soc 2014; 11:811-22*

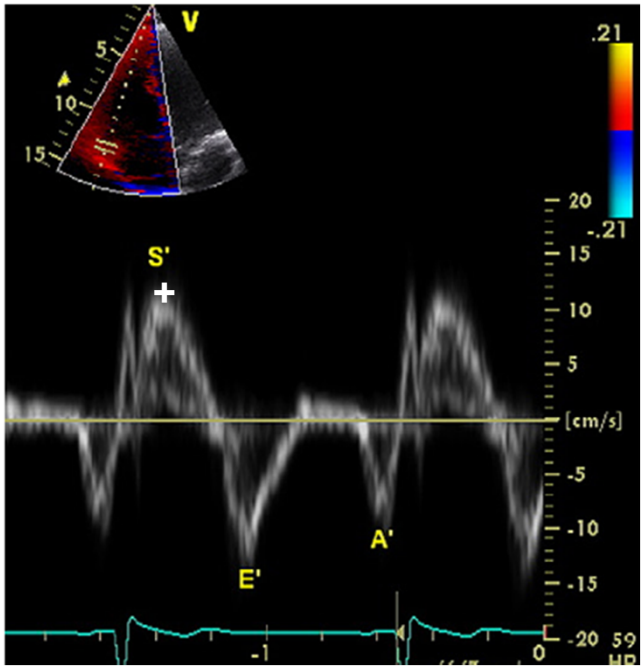
# FRACTION DE RACCOURCISSEMENT DE SURFACE (FRS OU FAC)




FAC = [(STDVD – STSVD)/ STDVD]X100

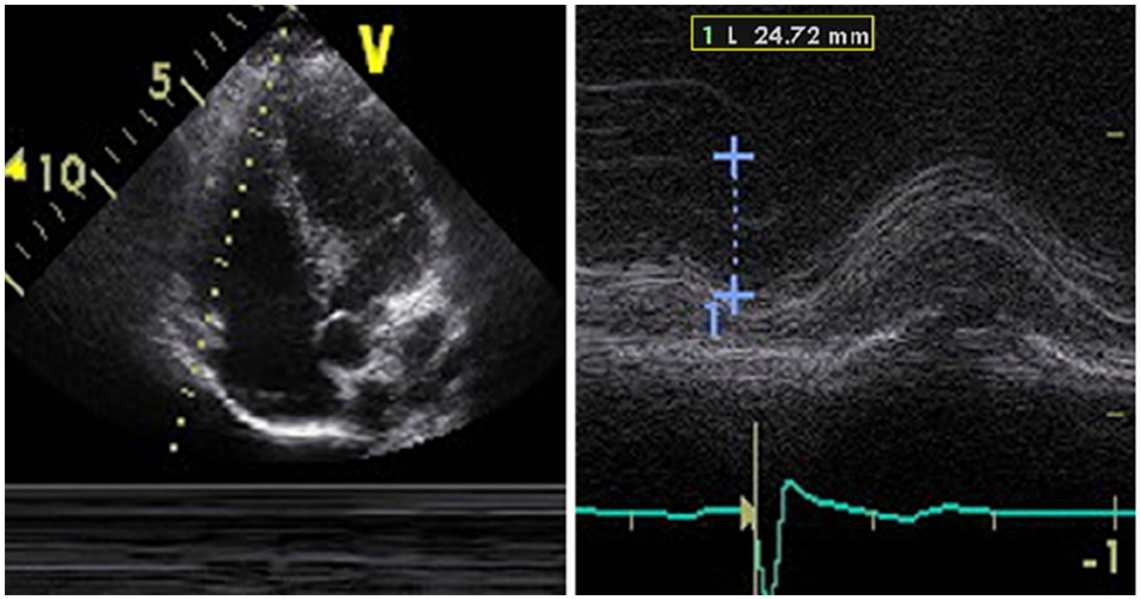
**(valeur normale = 50%)**

# PIC VÉLOCITÉ SYSTOLIQUE À L'ANNEAU TRICUSPIDIEN EN DOPPLER TISSULAIRE (ONDE S')



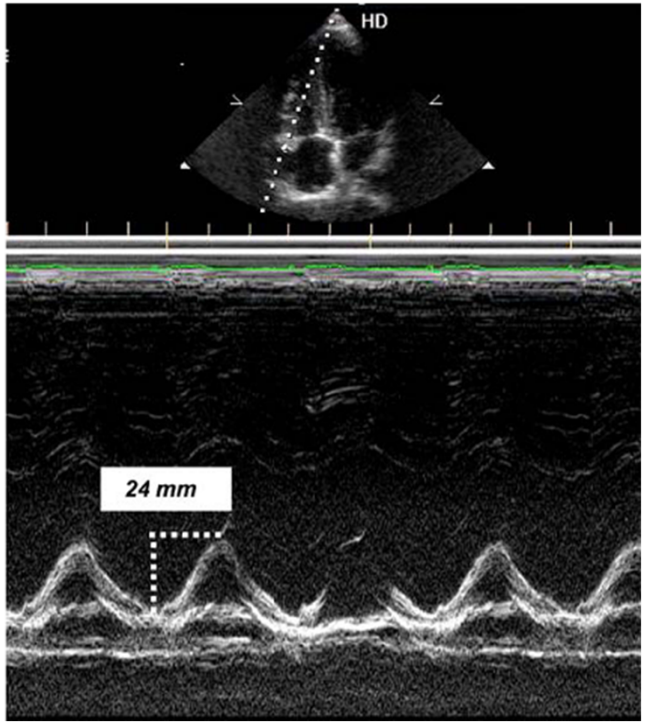

- Angle entre bord libre VD et curseur <30°
- Dysfonction VD si <10 cm/s

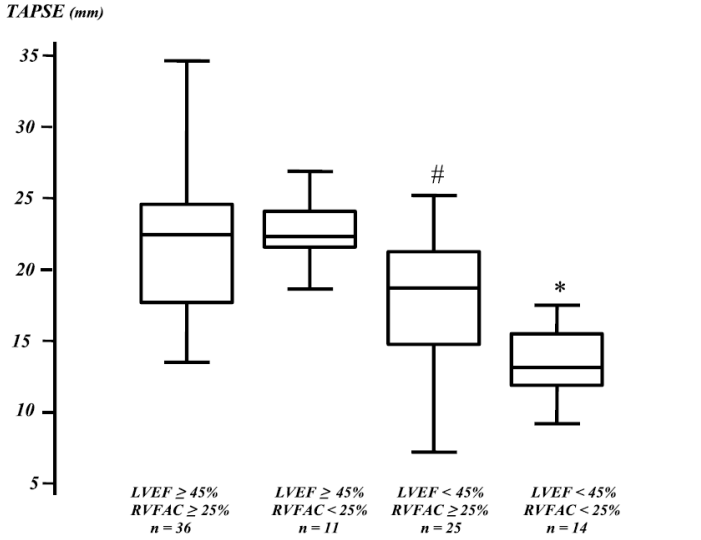
# TRISCUPID ANNULAR PLANE SYSTOLIC EXCURSION (TAPSE)




- Angle entre bord libre VD et curseur <30° (dysfonction VD si < 15 mm)

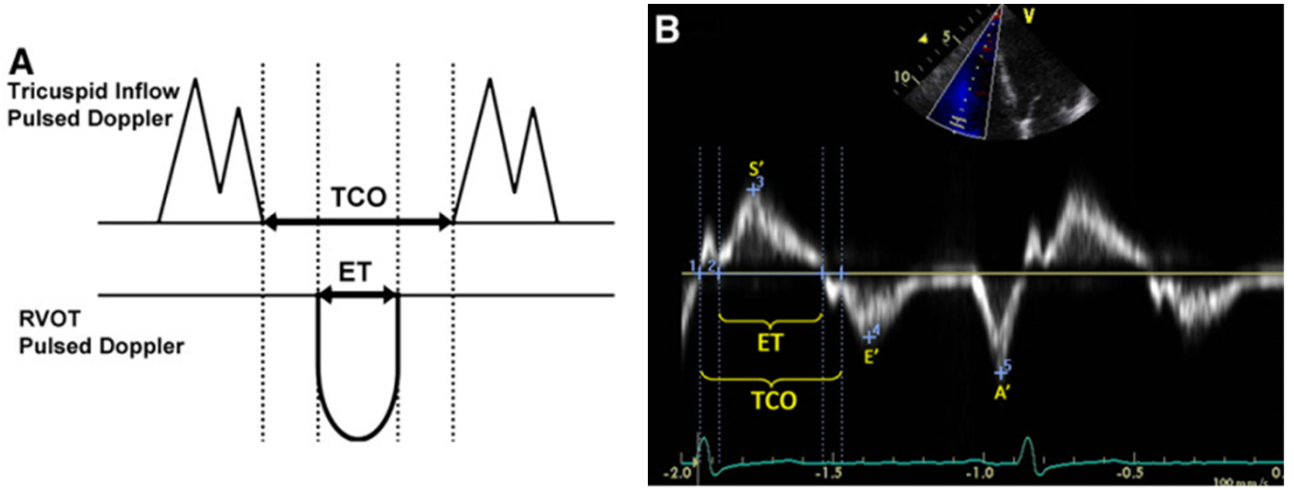
# ANALYSE DU TAPSE POUR LA FONCTION VG AUX VARIATIONS DE CHARGE




Lamia B. Intensive Care Med. 2007 Dec;33(12):2143-9

# INDEX TEI VD




**Tei index = (TCO-TE)/TE**

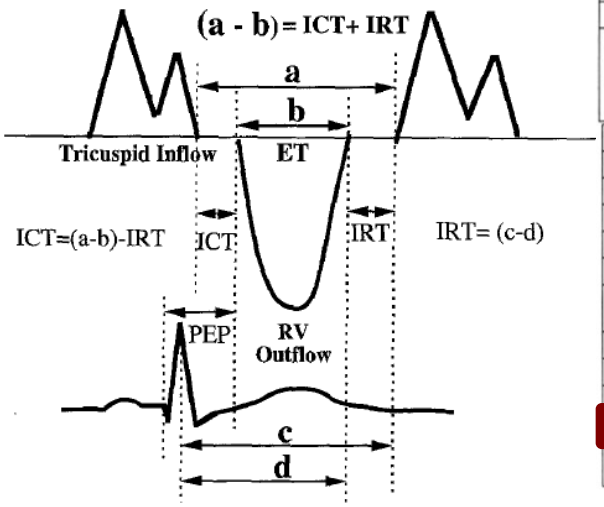
# CALCUL TEI VD (MYOCARDIAL PERFORMANCE INDEX)

| TEI Cœur Droit | | | |
|---|---|---|---|
| | Summary of Doppler intervals | | |
| | Normal subjects | PPH | p Value |
| PEP (msec) | 101 _+ 13 | 109 + 19 | <0,05 |
| ICT (msec) | 38 _+ 7 | 80 _+ 35 | <0,001 |
| IRT (msec) | 49 _+ 9 | 131 + 35 | <0,001 |
| ICT + IRT (msec) | 90 + 14 | 214 + 50 | <0,001 |
| ET (msec) | 322 + 21 | 242 _+ 40 | <0,001 |
| PEP/ET | 0,32 _+ 0,04 | 0,46 + 0,10 | <0,001 |
| ICT/ET | 0,12 + 0,02 | 0,33 + 0,16 | <0,001 |
| Index | 0,28 _+ 0,04 | 0,89 + 0,25 | <0,001 |

PPH,Primary pulmonary hypertension ICT,isovolumetric contraction time
IRT,isovolumetric relaxation time ET, ejection time.


*Tei C. J Am Soc Echocardiogr 1996;9:838-47*

$$\text{Index} = \frac{(a - b)}{b} = \frac{(ICT+IRT)}{ET}$$




| TEI Cœur Gauche | | |
|---|---|---|
| | Control | CHF |
| E/A | 0·86 +/-0·27 | 0·90 +/- 0·44 |
| DT (ms) | 203 +/- 42 | 206 +/-36 |
| ICT (ms) | 43 +/-17 | 66 +/-27 |
| ET (ms) | 349 +/-38 | 283 +/-33** |
| IRT (ms) | 93 +/-16 | 104 +/-28 |
| (ICT+IRT)/ET | 0·39 +/-0,1 | 0·60 +/-0,18** |

CHF=congestive heart failure E=peak velocity of the early diastolic transmitral flow A=peak velocity of the late diastolic transmitral flow E/A=ratio of peak early vs late transmitral flow velocity DT=deceleration time ICT=isovolumic contraction time ET=ejection time IRT=isovolumic relaxation time.

| TEI Cœur Droit | | | |
|---|---|---|---|
| | Summary of Doppler intervals | | |
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PPH,Primary pulmonary hypertension ICT,isovolumetric contraction time IRT,isovolumetric relaxation time ET, ejection time.


Tei C. J Am Soc Echocardiogr 1996;9:838-47

# FACTEURS PRÉDICTIFS DYSFONCTION VD

| | Sensitivity (%) | Specificity (%) | ROC AUC (95% CI) |
|---|---|---|---|
| TAPSE <1.5 cm | 59 | 94 | 0.82 (.68–.95) |
| DTI peak systolic velocity <10 cm/s | 59 | 92 | 0.83 (.72–.85) |
| MPI > 0.40 | 100 | 35 | 0.8 (.69–.91) |

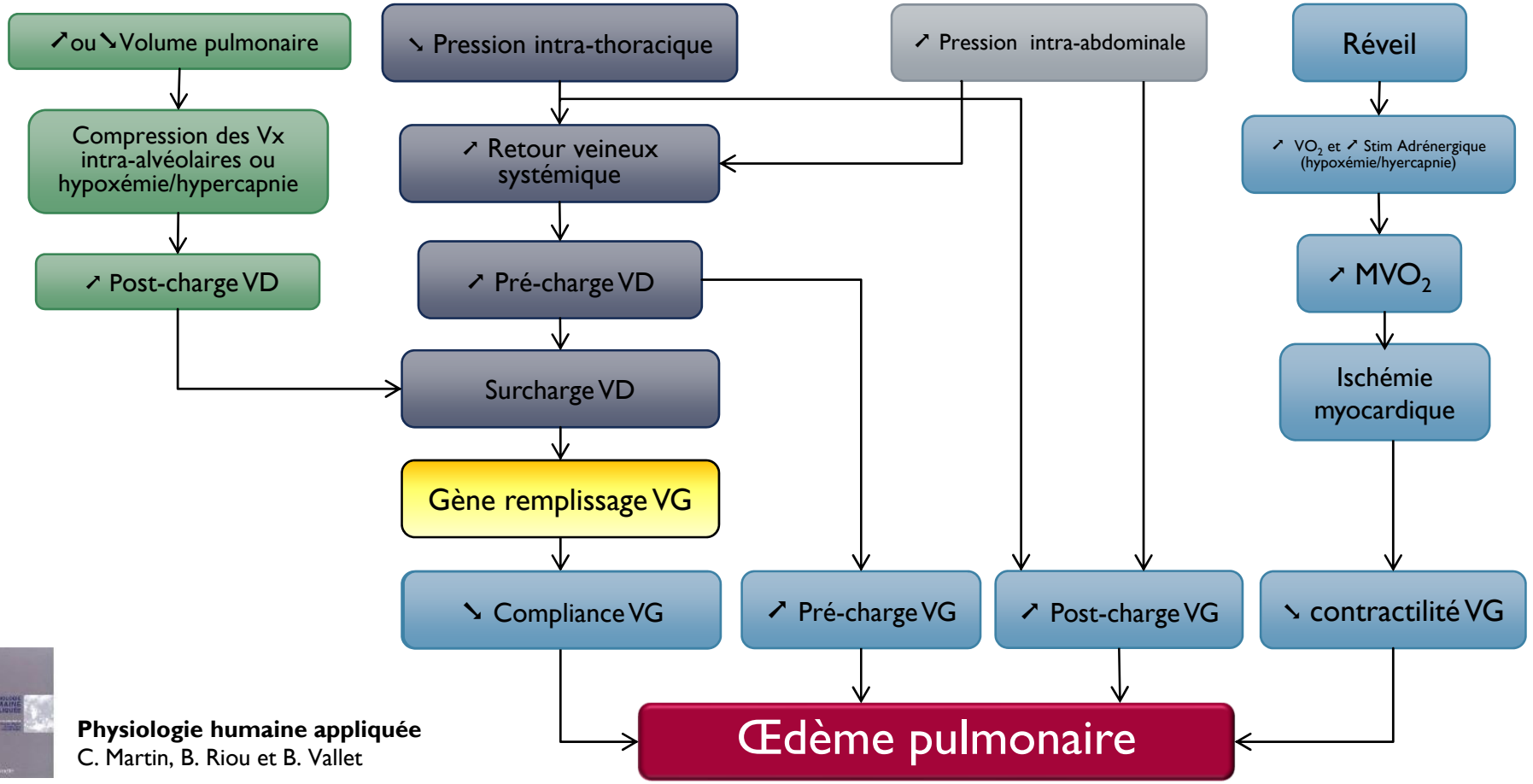
- *MPI= myocardial performance index*

| Variable | Unit | Abnormal | Illustration |
|---|---|---|---|
| Chamber dimensions | | | |
| RV basal diameter | cm | >4.2 | Figure 7 |
| RV subcostal wall thickness | cm | >0.5 | Figure 5 |
| RVOT PSAX distal diameter | cm | >2.7 | Figure 8 |
| RVOT PLAX proximal diameter | cm | >3.3 | Figure 8 |
| RA major dimension | cm | >5.3 | Figure 3 |
| RA minor dimension | cm | >4.4 | Figure 3 |
| RA end-systolic area | $cm^2$ | >18 | Figure 3 |
| Systolic function | | | |
| TAPSE | cm | <1.6 | Figure 17 |
| Pulsed Doppler peak velocity at the annulus | cm/s | <10 | Figure 16 |
| Pulsed Doppler MPI | — | >0.40 | Figure 16 |
| Tissue Doppler MPI | — | >0.55 | Figures 16 and 18 |
| FAC (%) | % | <35 | Figure 9 |
| Diastolic function | | | |
| E/A ratio | — | <0.8 or >2.1 | |
| E/E′ ratio | — | >6 | |
| Deceleration time (ms) | ms | <120 | |

*FAC*, Fractional area change; *MPI*, myocardial performance index; *PLAX*, parasternal long-axis; *PSAX*, parasternal short-axis; *RA*, right atrium; *RV*, right ventricle; *RVD*, right ventricular diameter; *RVOT*, right ventricular outflow tract; *TAPSE*, tricuspid annular plane systolic excursion.

J Am Soc Echocardiogr 2010;23:685-713

# Sevrage de la ventilation mécanique



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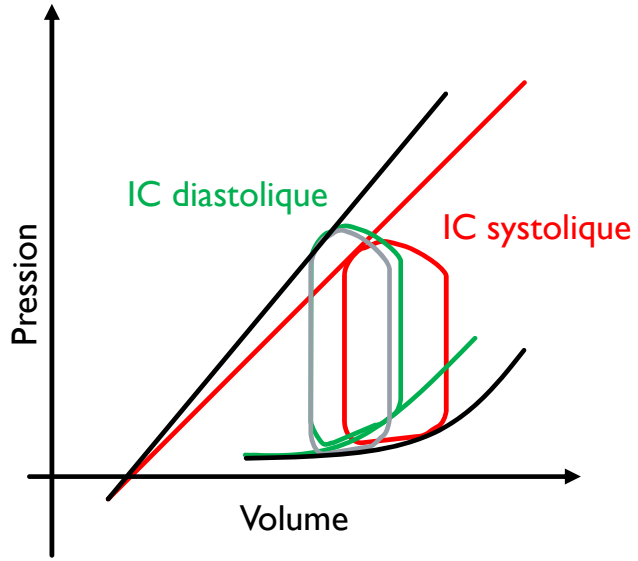
C. Martin, B. Riou et B. Vallet

# LA BOUCLE PRESSION / VOLUME



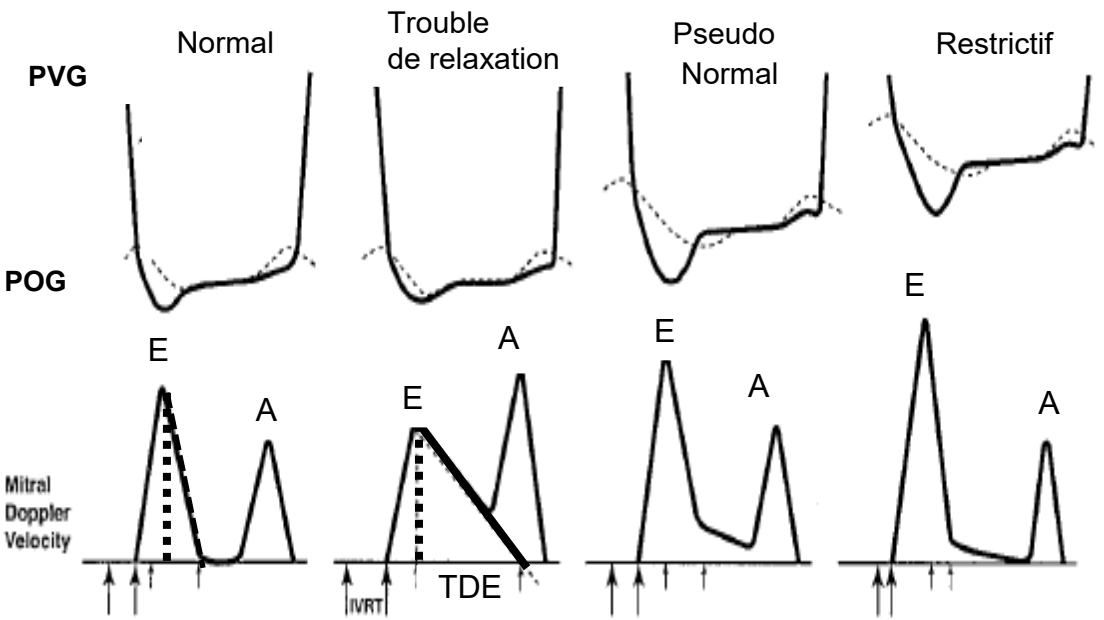
# Echocardiographic diagnosis of pulmonary artery occlusion pressure elevation during weaning from mechanical ventilation*

Bouchra Lamia, MD, MPH, PhD; Julien Maizel, MD; Ana Ochagavia, MD; Denis Chemla, MD, PhD; David Osman, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD

- 39 patients en echec de mise en RS
- Augmentation PAPO chez 17 patients
- Analyse echographique


Bouchra L . Crit Care Med 2009; 37:1696–1701

# ANALYSE DU PROFIL TRANSMITRAL




E = 50 ± 20 cm/s
A = 30 ± 10 cm/s
dA =
E/A = 1,5
TDE = 200 ± 30 ms
TRIV 70 ms

E/A <1
TDE >220 ms
TRIV ↑

E/A>1
TDE = 200 ± 30 ms
TRIV ↓

E/A> 2
TDE ↓
TRIV ↓

*Zile MR et al. Circulation 2002; 105:1387-1393*

# Flux transmitral et evaluation des pression de remplissage

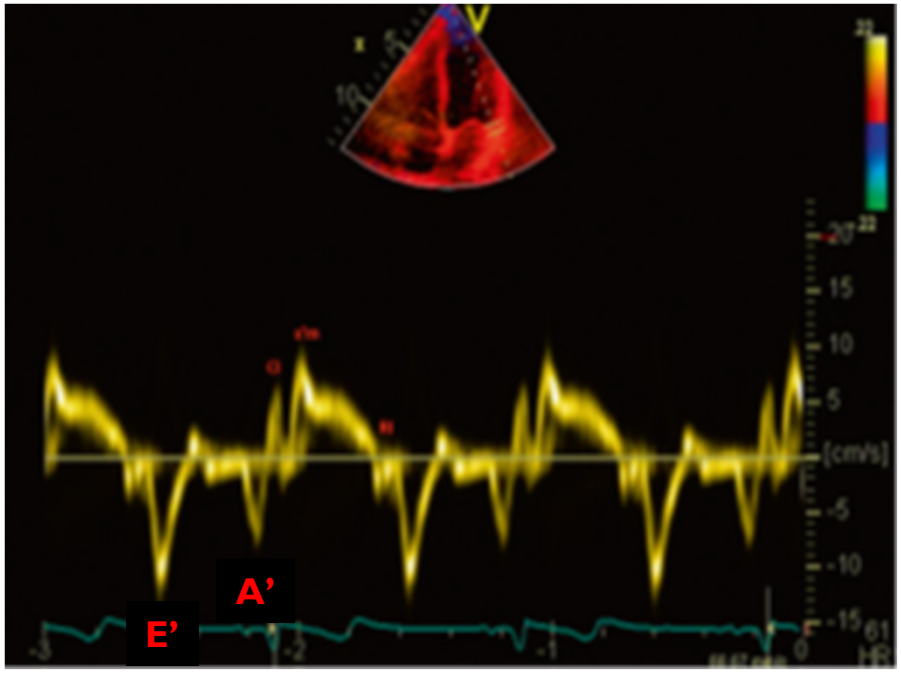
Ajuster flux transmitral à un paramètre spécifique de relaxation

$$\frac{\text{Flux TM (E)}}{???} \approx \frac{\text{Relaxation} \times \text{Pression de remplissage}}{\text{Relaxation}}$$

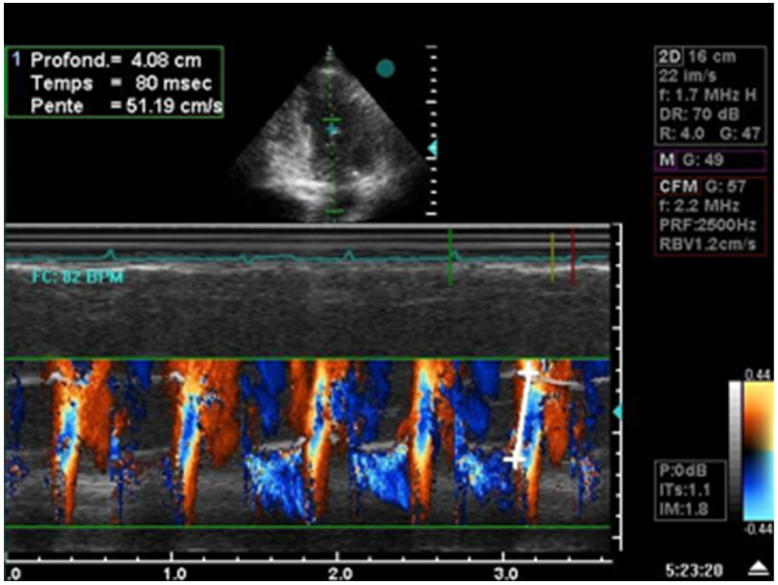
- Doppler pulsé tissulaire à l'anneau mitral (dTi)

- TM couleur de remplissage proto-diastolique du VG (Vp)

## DOPPLER TISSULAIRE À L'ANNEAU MITRAL (DTI) APICALE 4 CAVITÉS




## TM COULEUR DE REMPLISSAGE PROTO-DIASTOLIQUE DU VG (VP) APICALE 4 CAVITÉS

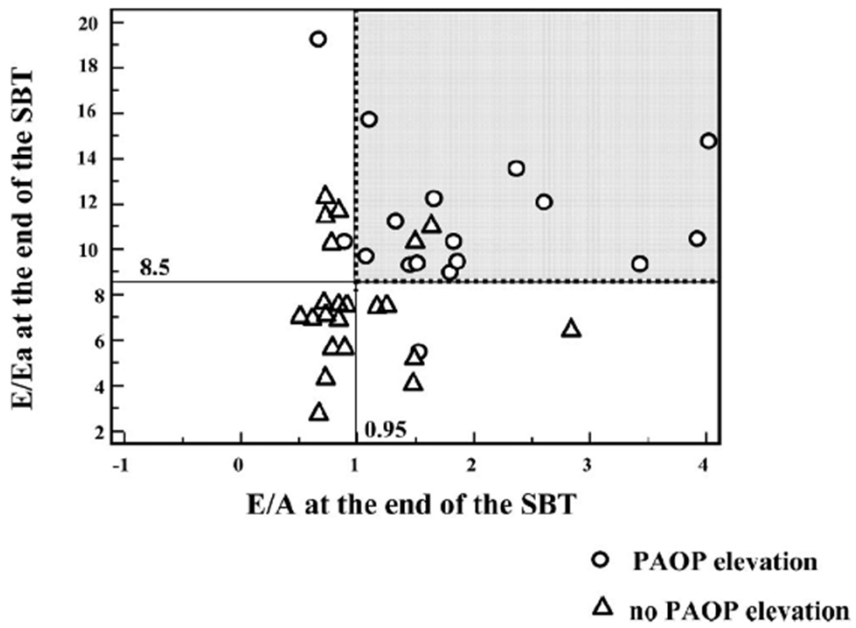



Trouble de relaxation si Vp< 45 cm/s

Peu utilisé

| FONCTION DIAST | Normal | Pseudo-normal (type 2) | Anomalie relaxation (type 1) | Anomalie compliance (type 3) |
|---|---|---|---|---|
| Rapport E/A | > 1 | > 1 | < 1 | > 2 |
| Tps décélérat° onde E | 160-240 | 160-240 | > 240 | < 160 |
| TRIV ms) | 70-120 | 70-120 | > 120 | < 70 |
| E/Ea | <8 | >15 | >15 | >15 |
| E/Vp | <1.5 | >2.5 | >2.5 | >2.5 |
| Rapport S/D | >1 | <1 | >1 | <1 |
| Durée Ap/Amit | $A_{mit}>A_p$ | $A_{mit}<A_p$ | $A_{mit}>A_p$ | $A_{mit}<A_p$ |

# PRÉDICTION DE L'AUGMENTATION DE PAPO AU SEVRAGE

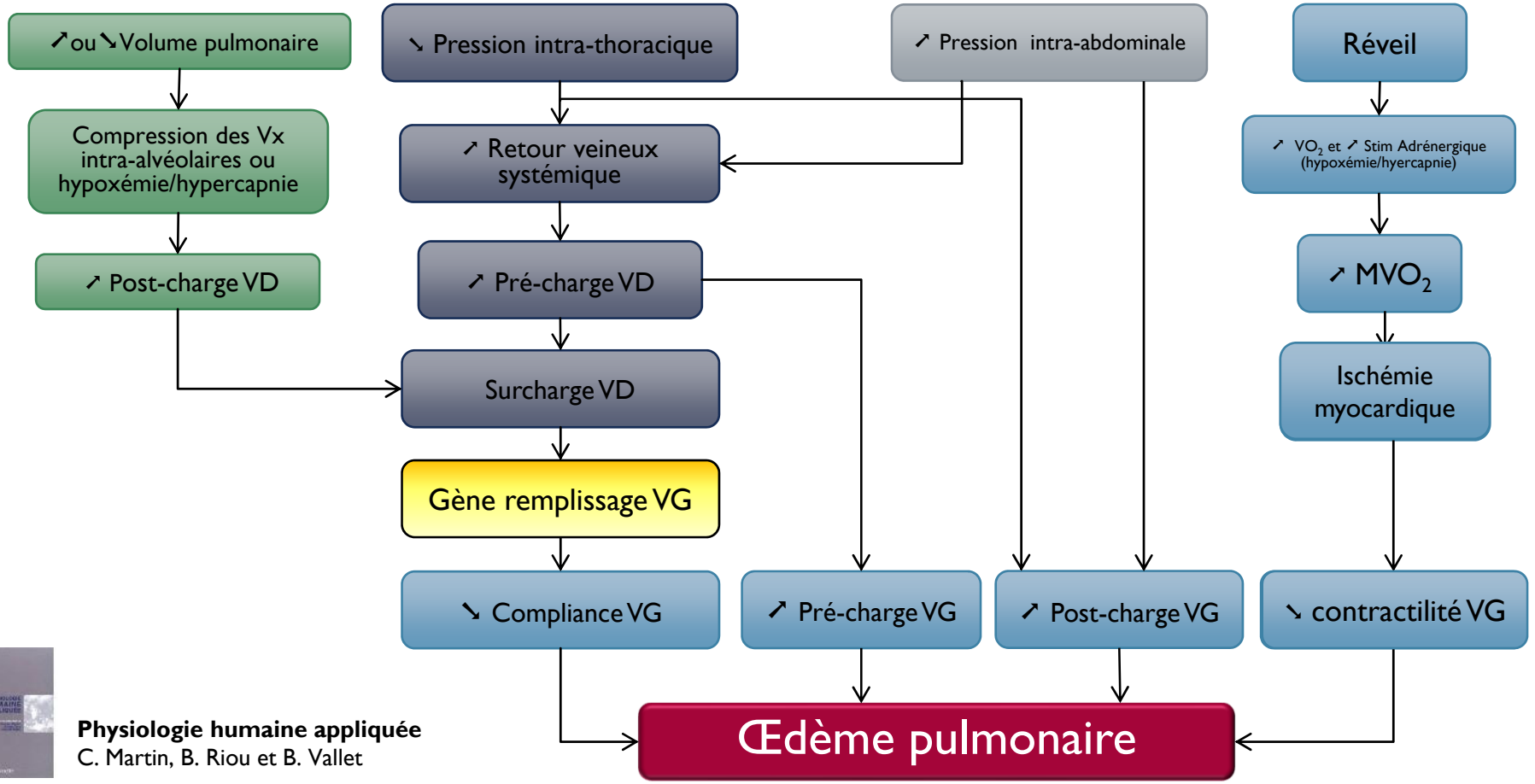




- E/A >0.95 fin épreuve de RS de 1h
  - Élévation PAPO
  - Se 88%; Sp 68%
- E/Ea >8.5 à la fin de l'épreuve de RS de 1h
  - Elévation PAPO
  - Se 94% Sp 73%
- La combinaison des 2 indices prédit l'augmentation de PAPO
  - Se 82%; Sp 91%.

*Bouchra L . Crit Care Med 2009; 37:1696–1701*

## Sevrage de la ventilation mécanique






**Physiologie humaine appliquée**
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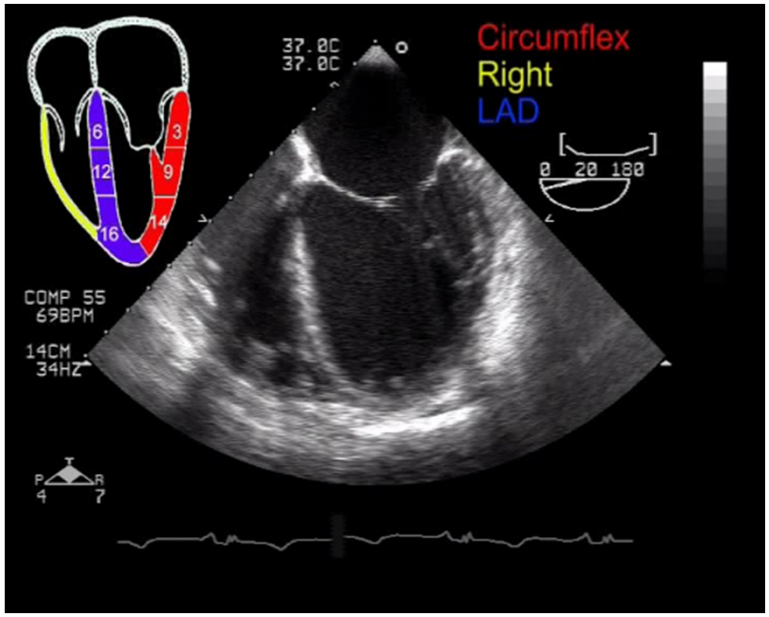
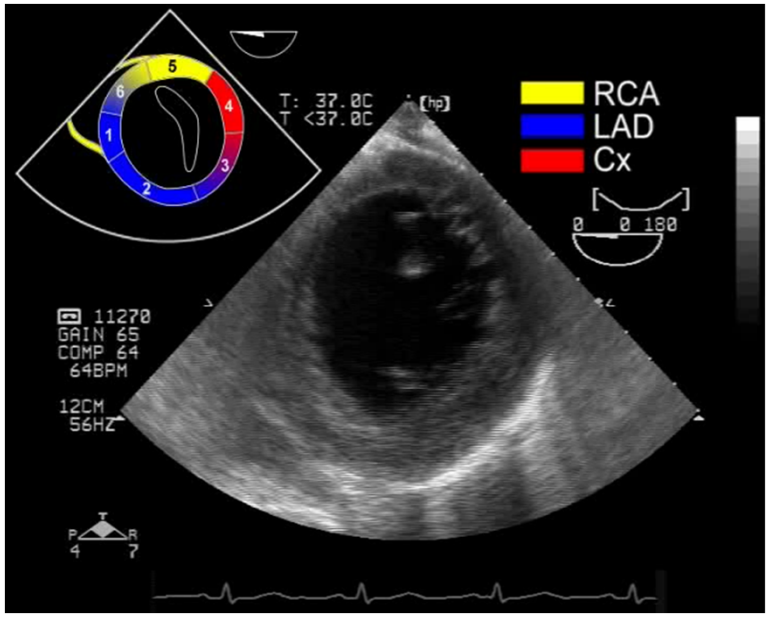
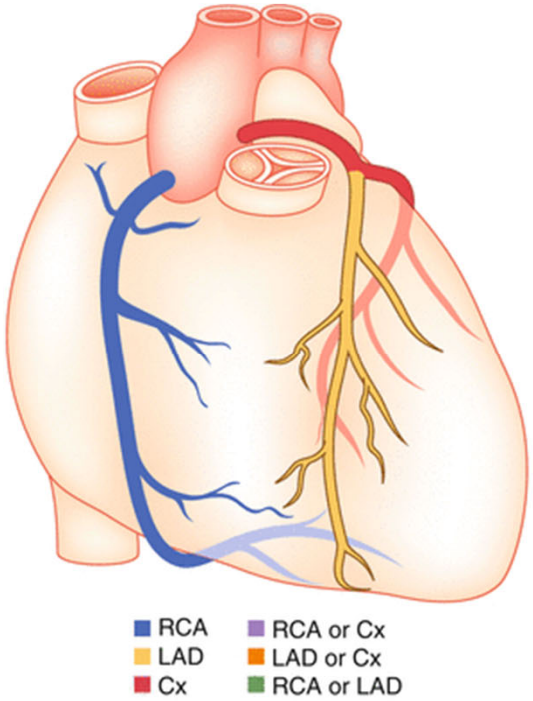
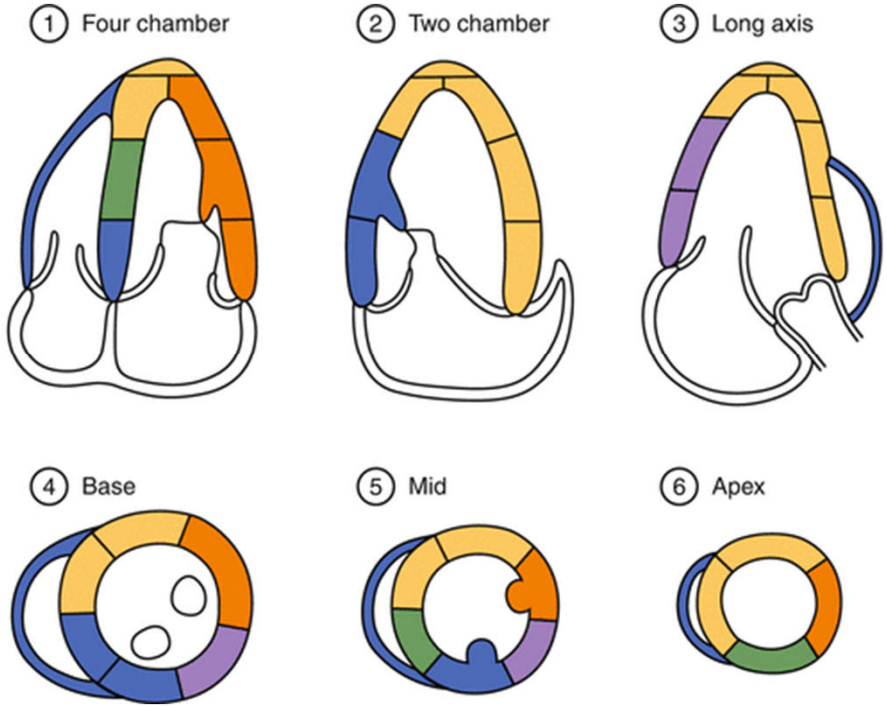
# ANALYSE SEGMENTAIRE ETO

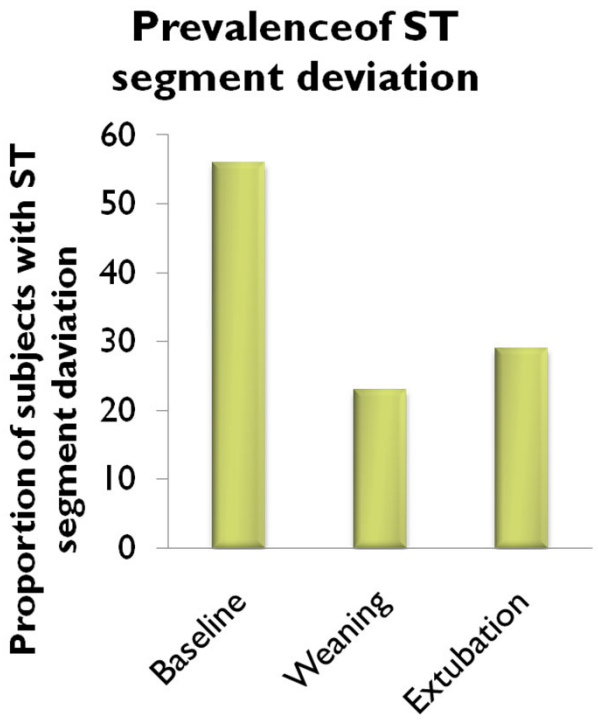


# ANALYSE SEGMENTAIRE ETT






- 43 patient, 21% maladie coronaire connue
- Ischémie souvent silencieuse
- Modifications du ST à l'intubation pronostique du sevrage


Frazier SK Heart Lung. 2006 Nov-Dec;35(6):363-73.

# AUTRES ÉTIOLOGIES D'HYPOXÉMIE AU SEVRAGE DE LA VENTILATION

Intensive Care Med (2005) 31:734–737
DOI 10.1007/s00134-005-2616-2

BRIEF REPORT

Chris Adamopoulos
Matthew Tsagourias
Kostoula Arvaniti
Fotini Veroniki
Dimitrios Matamis

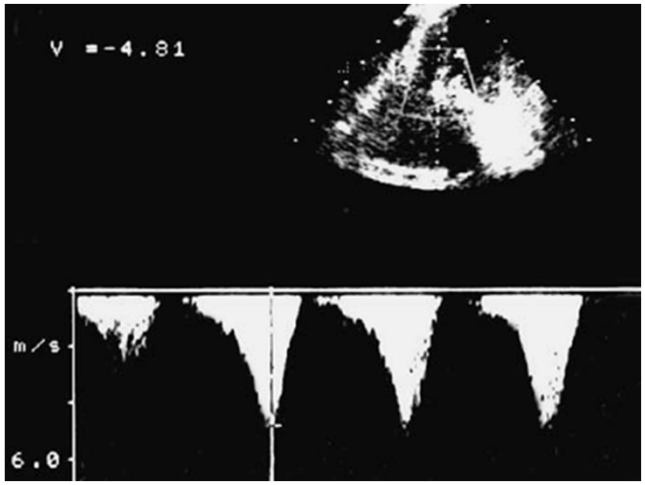
**Weaning failure from mechanical ventilation due to hypertrophic obstructive cardiomyopathy**

- Case report
- Modifications cardiaques liées aux conditions de charge et aux vitesses des flux

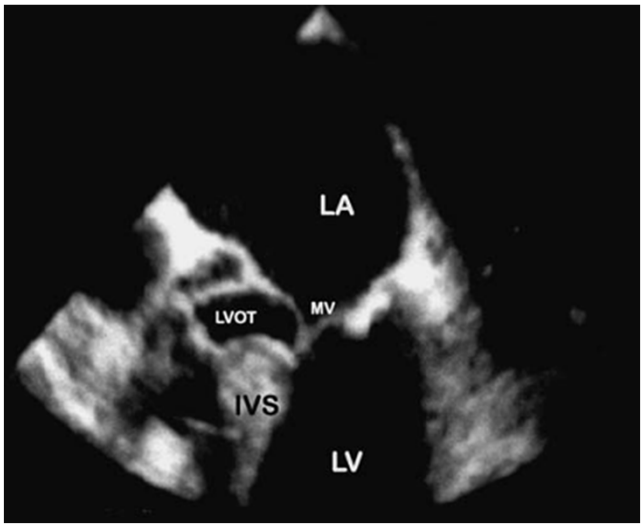
*Adamopoulos C. Intensive Care Med (2005) 31:734–737*

# HYPOXÉMIE BRUTALE AU SEVRAGE DE LA VENTILATION

**Obstacle dans la chambre de chasse: Accélération du flux transaortique (Vmax=4.81 m/s) . GRADmax =92 mmHg**

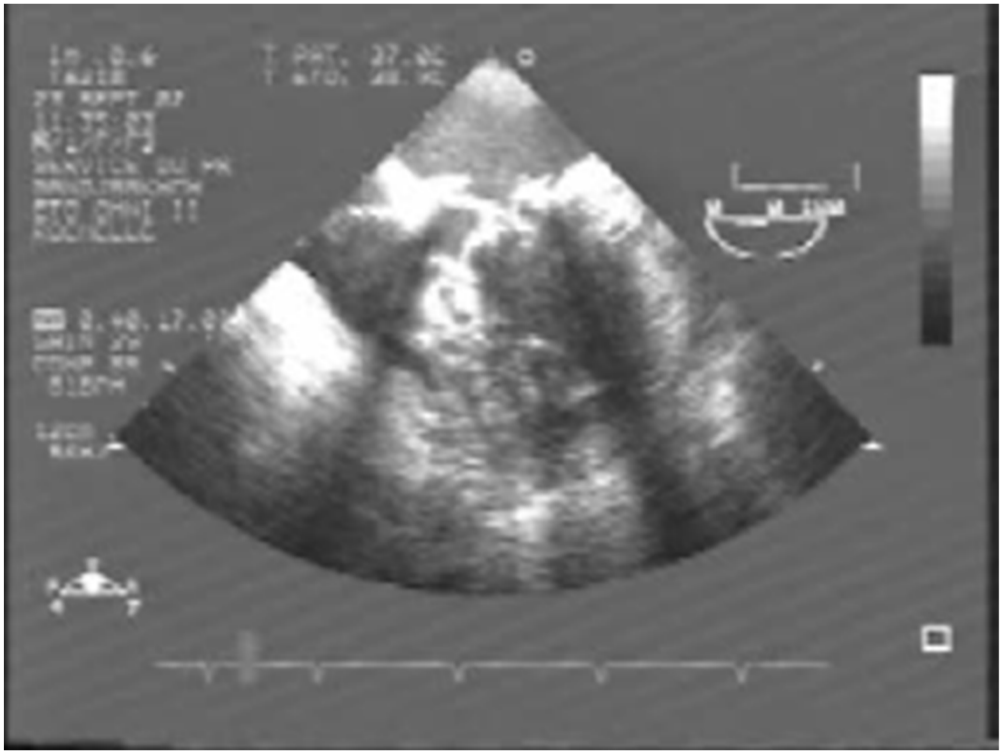


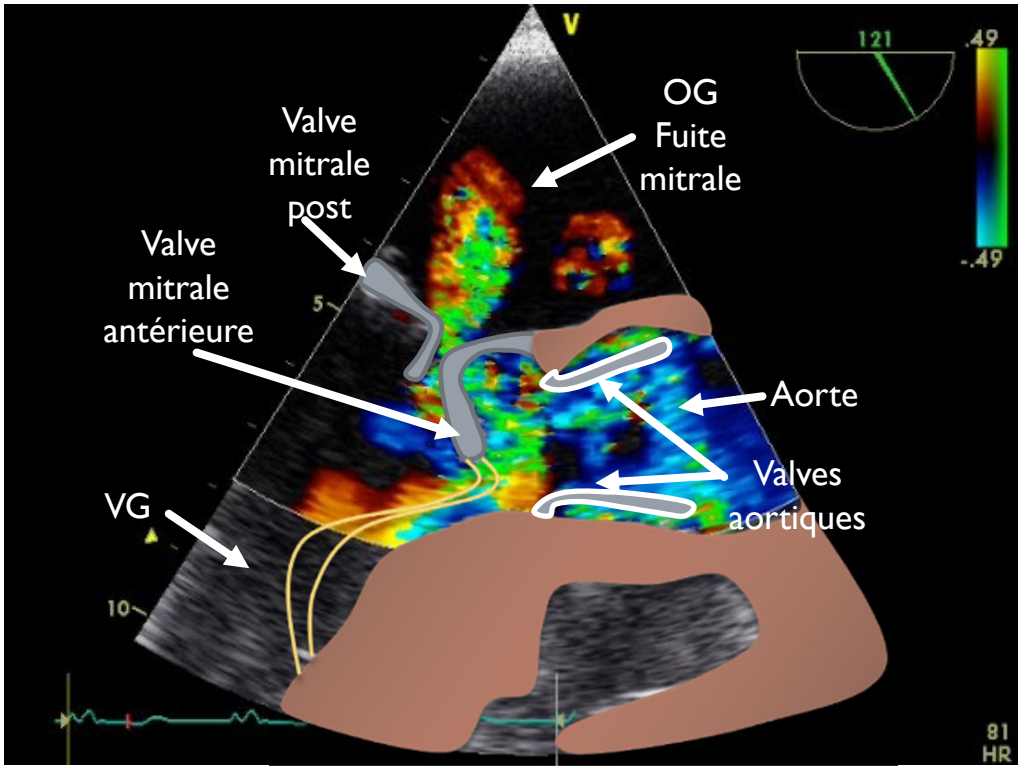

**Mouvement systolique antérieur de la grande valve mitrale**



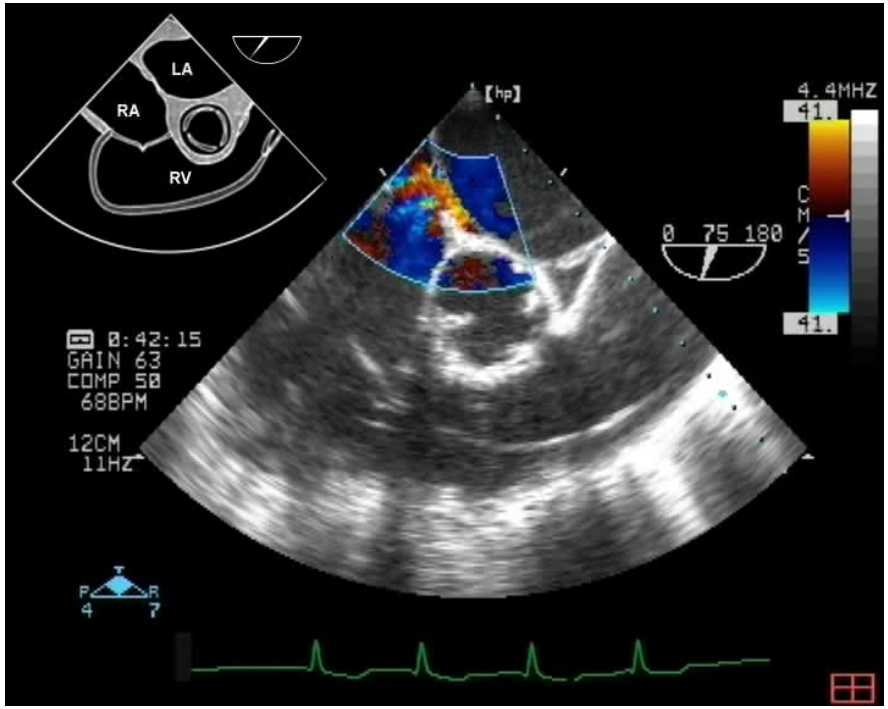

Adamopoulos C. Intensive Care Med (2005) 31:734–737

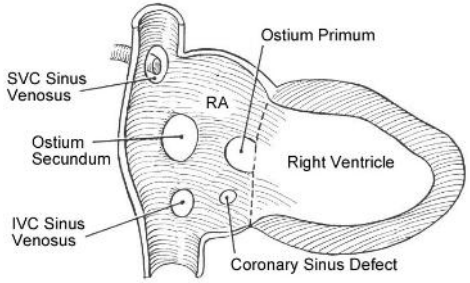
# HYPOXÉMIE BRUTALE AU SEVRAGE DE LA VENTILATION



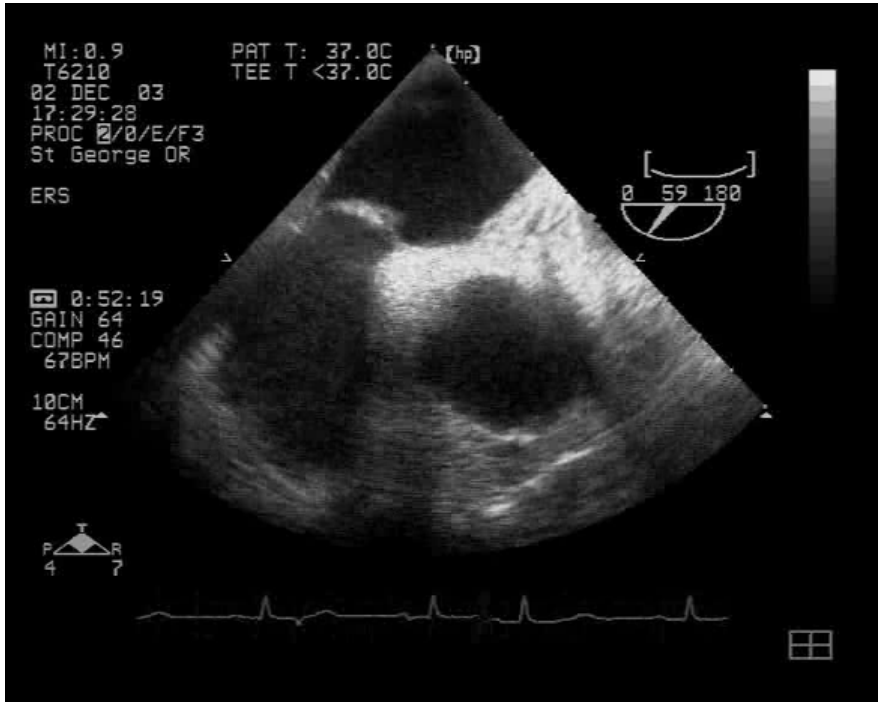

Valve mitrale post
OG Fuite mitrale
Valve mitrale antérieure
Aorte
Valves aortiques
VG
121
.49
-.49
81 HR

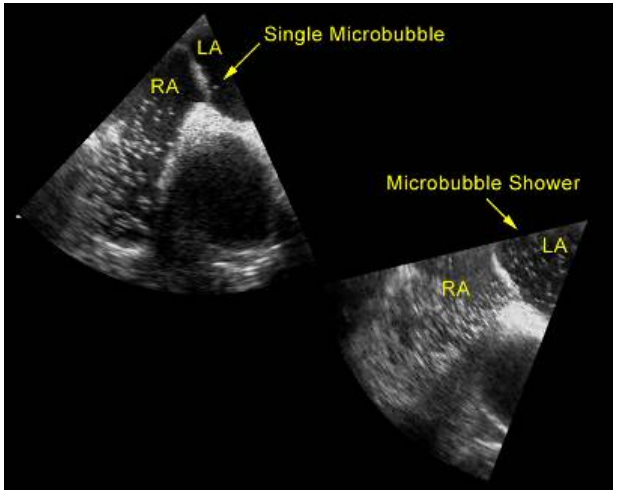
# FORAMEN OVALE PERMÉABLE (FOP)



# MANŒUVRE DE VALSALVA ET TEST DE CONTRASTE



# EPREUVE DE CONTRASTE

- Distinction  Foramen Ovale Perméable (FOP) et Shunt Intra Pulmonaire (SIP)
  - FOP : passage immédiat (moins de 3 battements cardiaques) des microbulles dans les cavités gauches dès leur apparition dans les cavités droites
  - SIP : passage retardé (plus de 3 battements cardiaques)

- Mais…
  - FOP > 3 battements si dépendant de la ventilation
  - SIP < 3 battements si proximal

# CONCLUSION

- Le sevrage respiratoire peut être en échec dés les premières heures
  - Étiologie respiratoire
  - Modification des conditions de charge VG/ VD +++
- ETT , ETO permettent d'évoquer le diagnostic
  - Rôle des indices combinés reste à valider dans cette indication
  - Limites classiques liées à une pathologie préexistante ou à des anomalies rythmiques
  - Cathéterisme de Swan-Ganz peut se révéler intéressant mais reste invasif
- Traitement vise à améliorer les conditions de charge
  - Déplétion hydrique, dérivés nitrés, inhibiteurs calciques, milrinone…