INTERACTIONS CARDIOPULMONAIRES ET VENTILATION EN PRESSION POSITIVE

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INTERACTIONS CARDIOPULMONAIRES EN VPP

I. Physiologie des interactions CP

II. Pressions intra-thoraciques et hémodynamie

III. Implications cliniques

I. PHYSIOLOGIE DES INTERACTIONS CP

1. Volumes pulmonaires
2. Résistances vasculaires pulmonaires
3. Fosse cardiaque

I. PHYSIOLOGIE DES INTERACTIONS CP

1. Volumes pulmonaires

- Innervation autonomique
- Expansion en VS-VPP
  - Chronotropisme ⊖
  - Inotropisme ⊖
  - Vasodilatation artérielle ⊖
  - ∝VT
- Abolis vagotomie
- Volumes auriculaires (ADH, ANF)

I. PHYSIOLOGIE DES INTERACTIONS CP

2. Résistances vasculaires pulmonaires

- 2 compartiments
  - Vaisseaux alvéolaires - PALV
  - Vaisseaux extra-alvéolaires -PINT
- Volumes pulmonaires
  Hypoxémie, V.P.H., NO, Surfactant

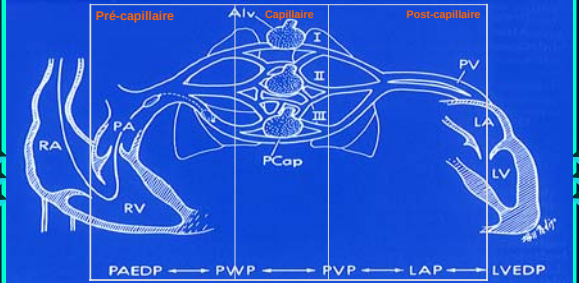
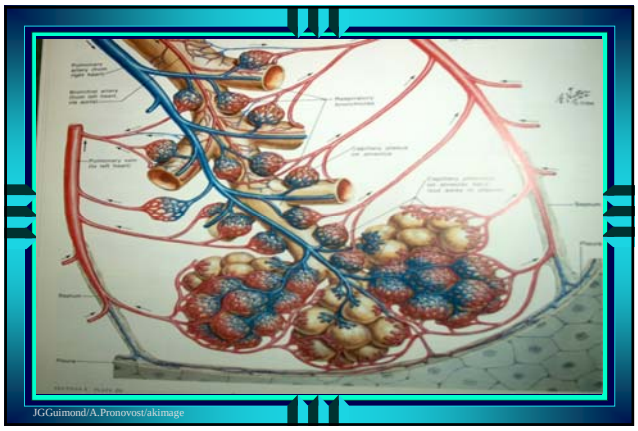


Figure 2. This demonstrates the anatomical position of a PA catheter in the pulmonary artery. The dotted line positions the inflated balloon in the "wedged" position. RA = right atrium; RV = right ventricle; PA = pulmonary artery; ALV = alveolus; Pcap = pulmonary capillary; PV = pulmonary vein; LA = left atrium; LV = left ventricle. I, II, III characterize the relationship of palveolar, parterial, pvenous as described by West. The bottom is a progressive correlation of vascular pressures.



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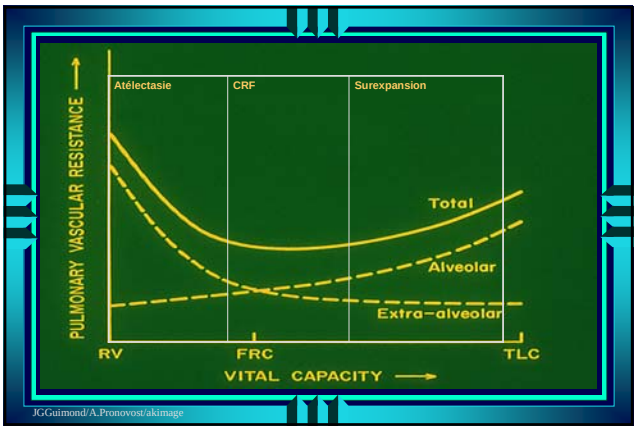

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I. PHYSIOLOGIE DES INTERACTIONS CP

3. Fosse cardiaque

- Contact direct vs Ppl + Pjc
- Volumes pulmonaires > Élevés
  PEEP
- Cardiomégalie

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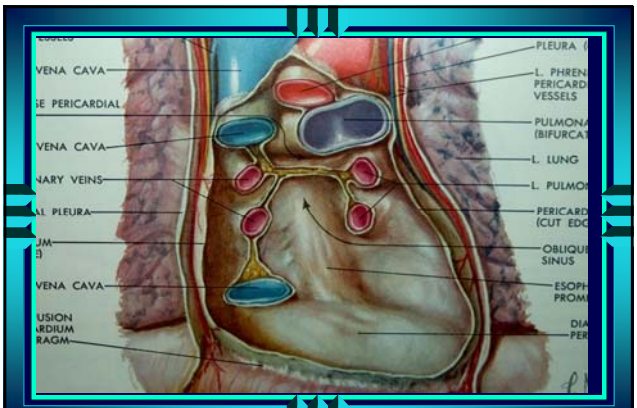

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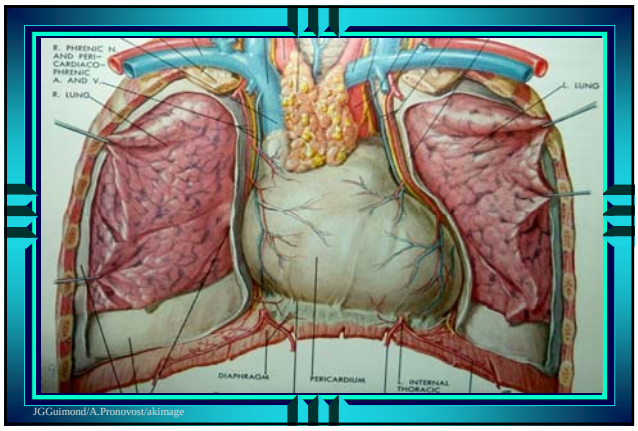

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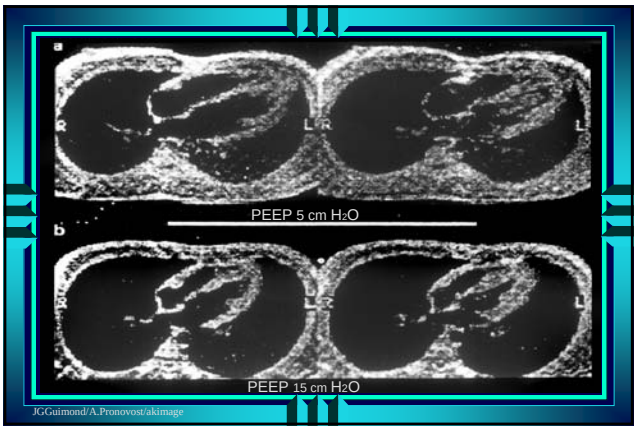

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II. PRESSIONS INTRA-THORACIQUES ET HÉMODYNAMIE

1. Pressions intra-thoraciques
2. Pressions trans-murales
3. Performance ventriculaire droite
4. Interdépence ventriculaire
5. Performance ventriculaire gauche

II. PRESSIONS INTRA-THORACIQUES ET HÉMODYNAMIE

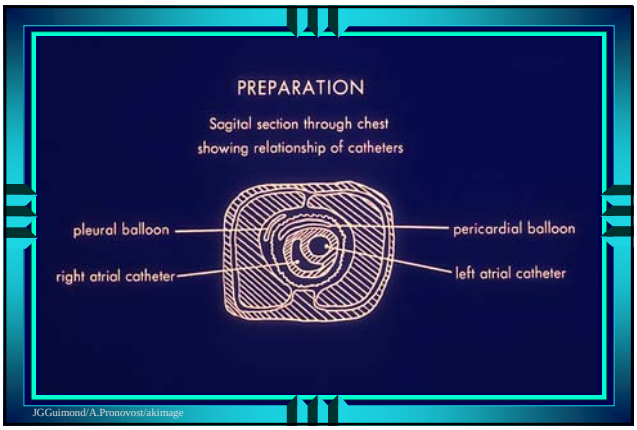
1. Pressions intra-thoraciques

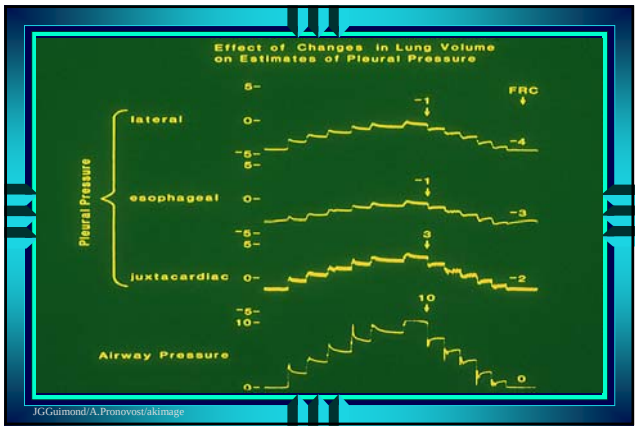
Expansion pulmonaire

II. PIT ET HÉMODYNAMIE

1. Pressions intra-thoraciques

- Ppl, Poes, Pjc
- Variabilité
- Tendances uniformes





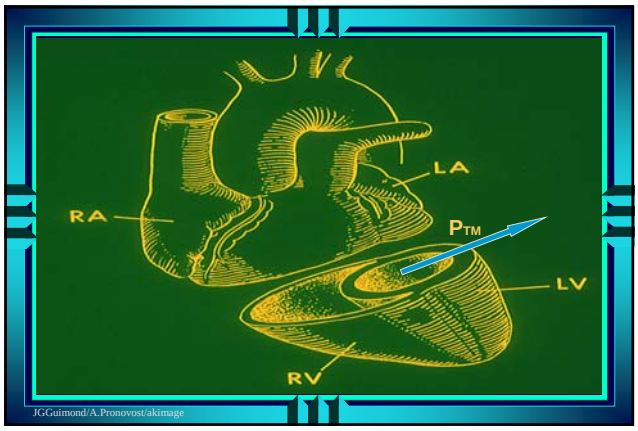
II. PIT ET HÉMODYNAMIE

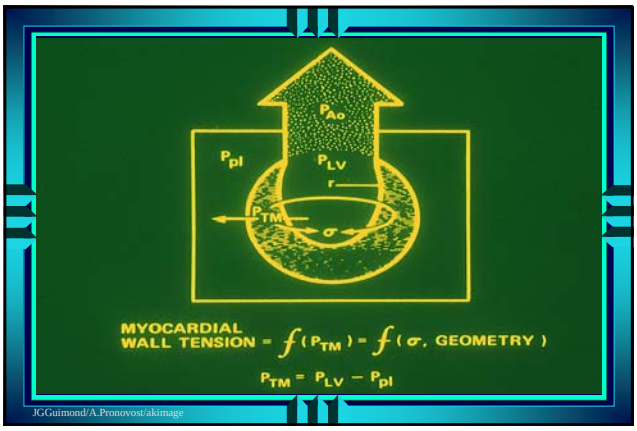
2. Pressions trans-murales

$P_{TM} = P_{IC} - P_{EC}$

$P_{TM} = P_{IC} - P_{IT}$

VS ⊖ VPP ⊕





II. PIT ET HÉMODYNAMIE

2. Pressions trans-murales

Ptm = Pic - Pec

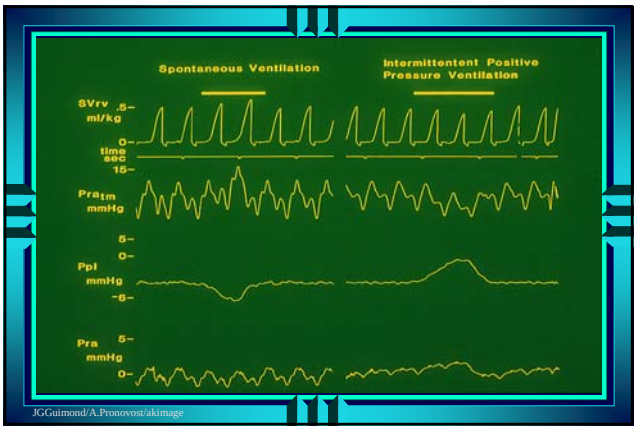
Ptmod = Pod - Ppl

Ptmod = 10 mmHg - (-5 mmHg)

Ptmod = 15 mmHg

Ptmod = 10 mmHg - (+5 mmHg)

Ptmod = 5 mmHg



II. PIT ET HÉMODYNAMIE

2. Pressions trans-murales

Inspiration

↓ VS ↓ VPP

↑ Pré-charge ↓

↑ Post-charge ↓

II. PIT ET HÉMODYNAMIE

3. Performance ventriculaire droite

Pré-charge

Retour veineux

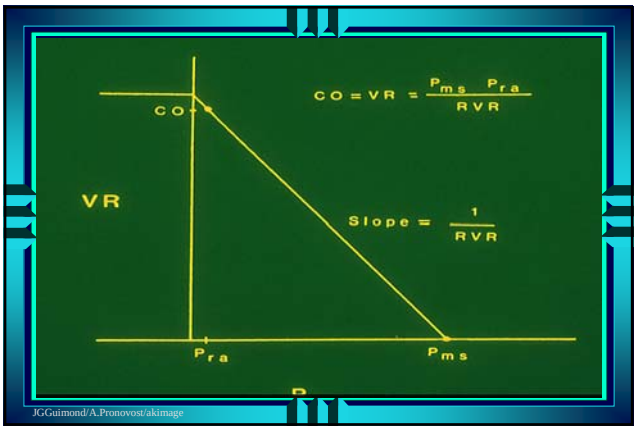
↓ VS ↑ VPP ↓

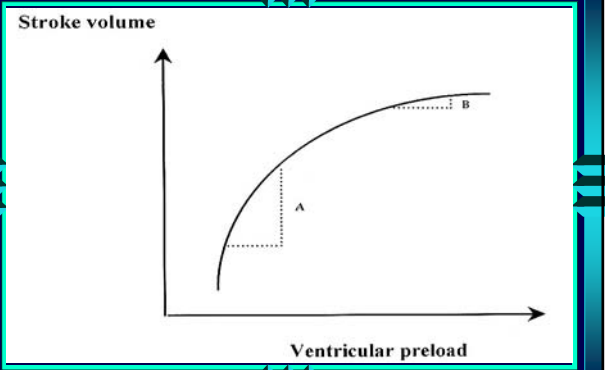
II. PIT ET HÉMODYNAMIE

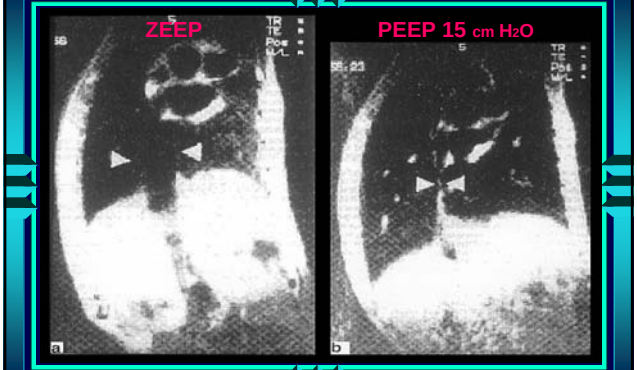
3. Performance ventriculaire droite

Pré-charge

RV = Psm - POD / RRV







II. PIT ET HÉMODYNAMIE

3. Performance ventriculaire droite

Post-charge

- Pressions artère pulmonaire :
  - Résistances vasculaires pulmonaires
  - Débit cardiaque

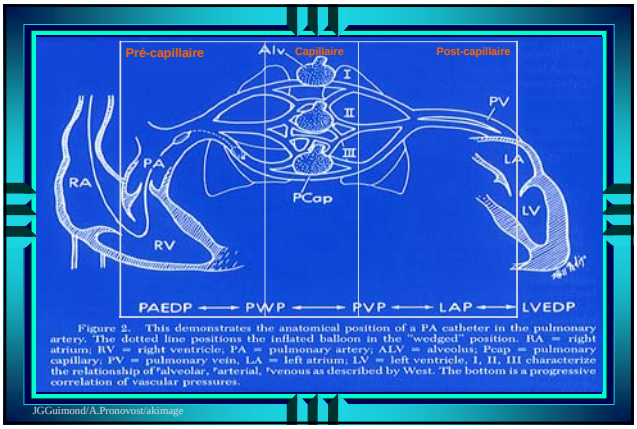
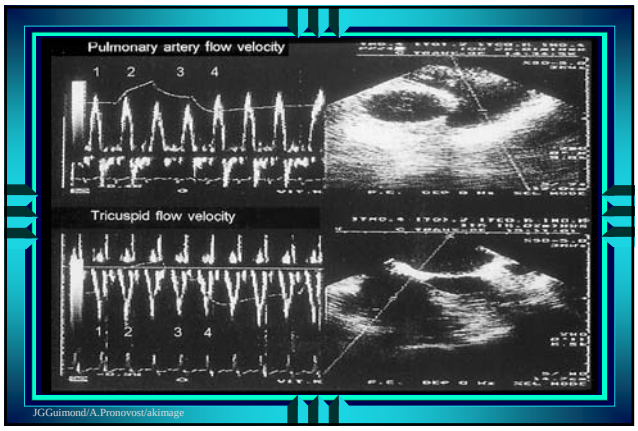


Figure 2. This demonstrates the anatomical position of a PA catheter in the pulmonary artery. The dotted line positions the inflated balloon in the "wedged" position. RA = right atrium; RV = right ventricle; PA = pulmonary artery; ALV = alveolus; Pcap = pulmonary capillary; PV = pulmonary vein; LA = left atrium; LV = left ventricle. I, II, III characterize the relationship of palveolar, parterial, pvenous as described by West. The bottom is a progressive correlation of vascular pressures.



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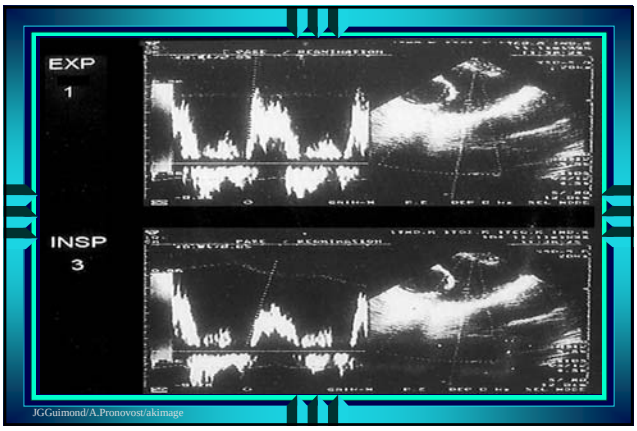

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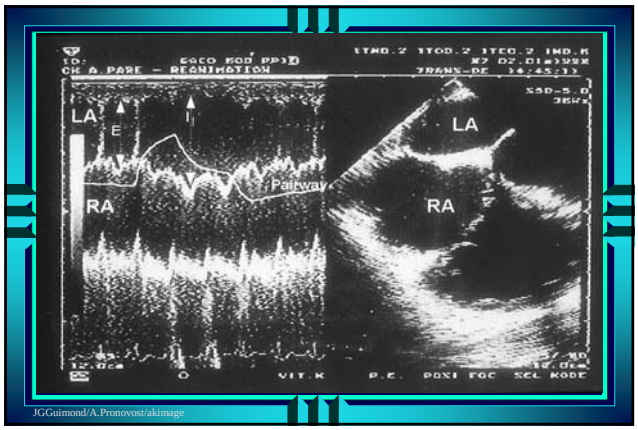

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II. PIT ET HÉMODYNAMIE

4. Interdépendance ventriculaire

- Deux ventricules
- Péricarde limitant
- Volume biventriculaire fixe
- Applicable
  - PAP ↑
  - Volume VD ↑
- Entraîne
  - Septum paradoxal
  - Compliance VG ↓

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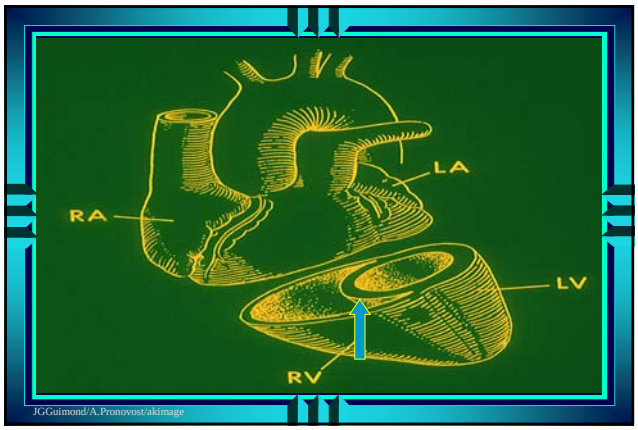

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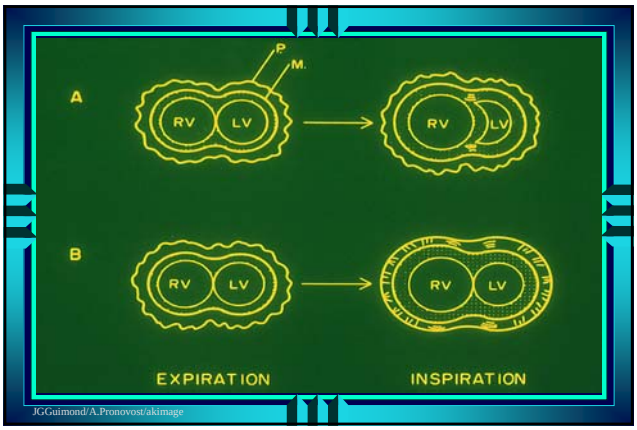

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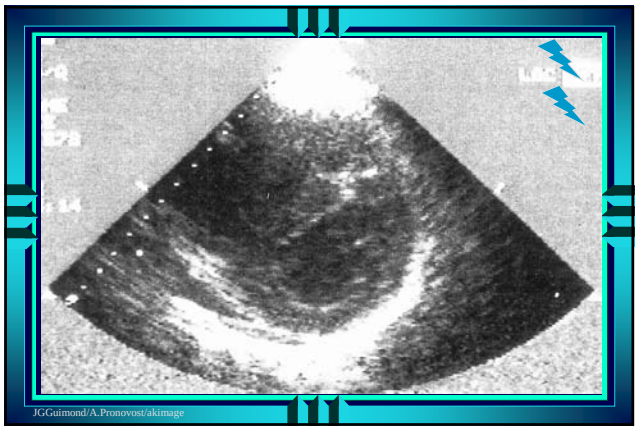


II. PIT ET HÉMODYNAMIE

5. Performance ventriculaire gauche

Pré-charge

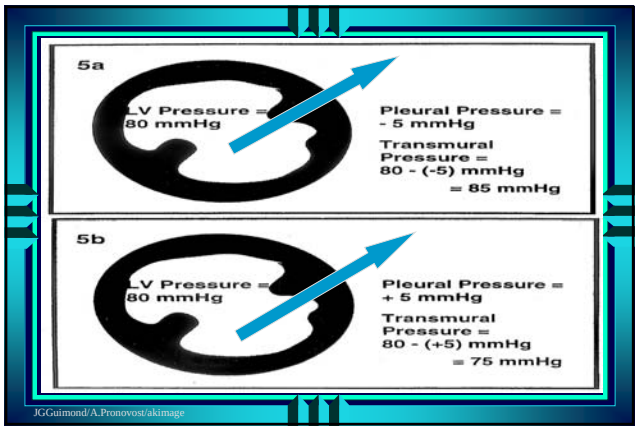
- VD
  - Retour veineux
  - Post-charge VD
    - PAP
    - RVP
- Interdépendance ventriculaire
- Fosse cardiaque
- Volume intrathoracique
- Compliance V.G.

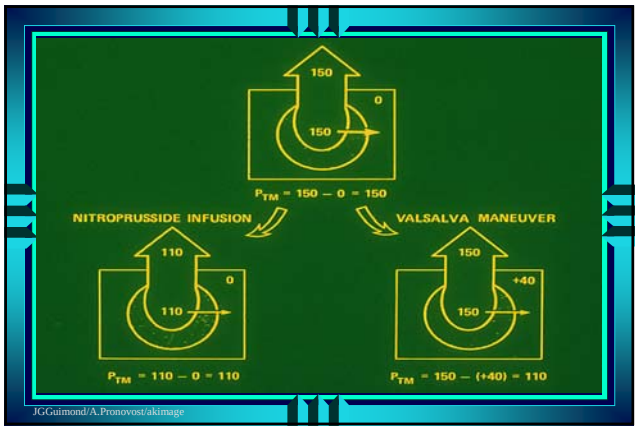
II. PIT ET HÉMODYNAMIE

5. Performance ventriculaire gauche

Post-charge

- Impédance aortique : distensibilité aortique
- Pressions artérielles systoliques + diastoliques
- PIT → PTM





III. IMPLICATIONS CLINIQUES

1. Volémie
2. Pressions de remplissage en VPP
3. Modalités ventilatoires
4. Assistance ventriculaire gauche

III. IMPLICATIONS CLINIQUES

1. Volémie

- Évaluation par réponse VPP — "SPV" / "ΔPP"
- Interactions négatives
  - Dépendance pré-charge
- Interactions positives
  - Indépendance pré-charge
  - Dépendance post-charge

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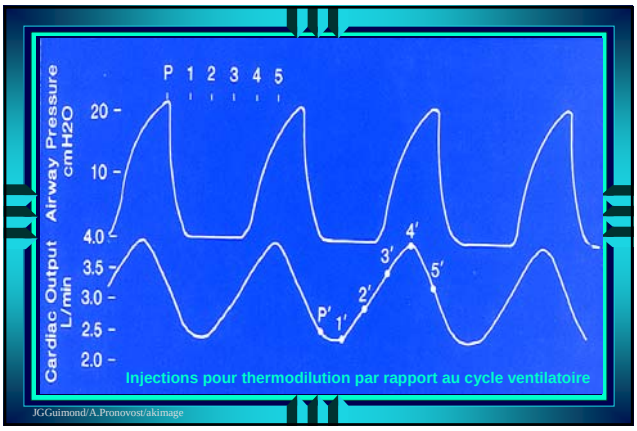

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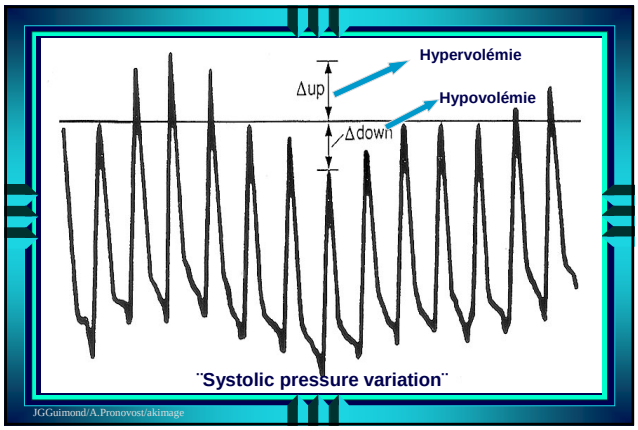

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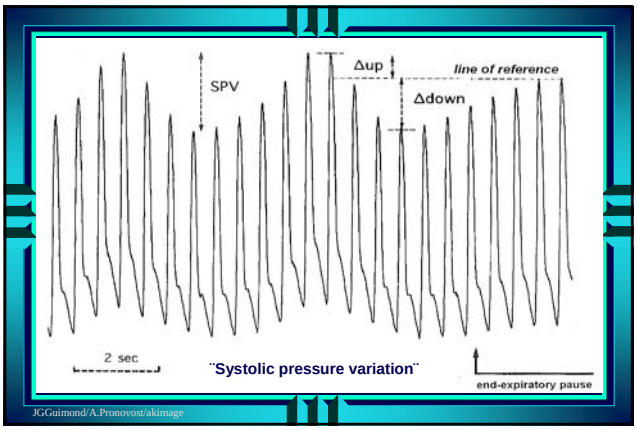

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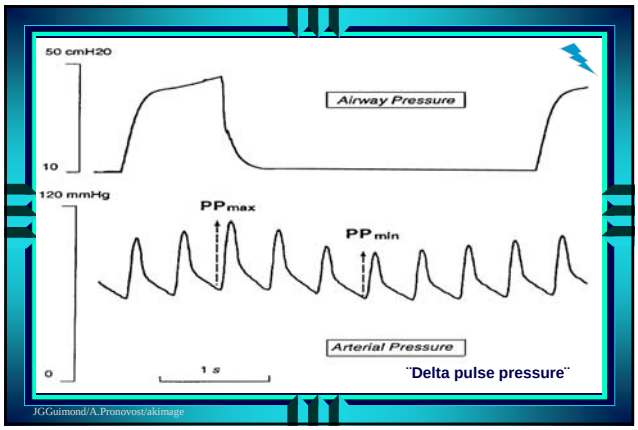

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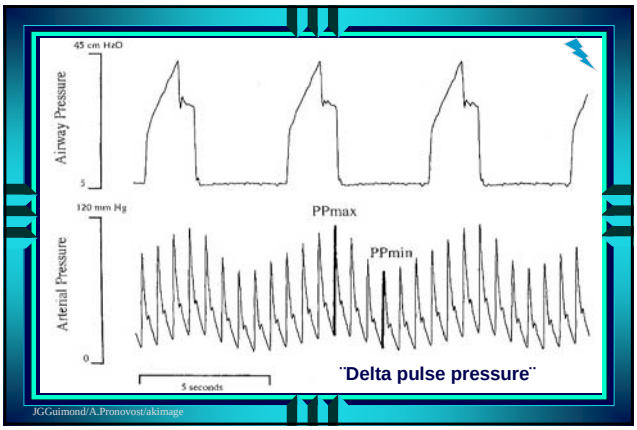

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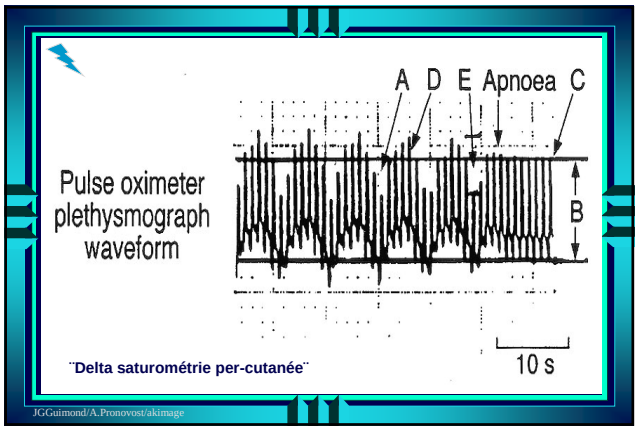

¨Delta saturométrie per-cutanée¨

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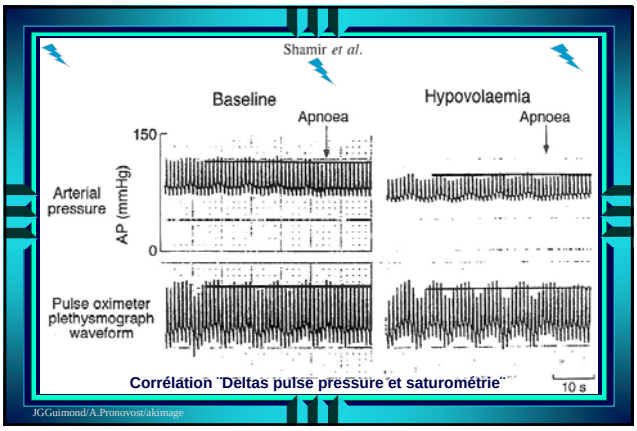

Corrélation ¨Deltas pulse pressure et saturométrie¨

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III. IMPLICATIONS CLINIQUES

2. Pressions de remplissage et VPP

- Pressions absolues ↓ VS ↑ VPP
- Pressions trans-murales varient à l' inverse
- Reflet variable volémie
  - Compliance, PIT
- Effets marqués VPP
  - Zones West
  - Hypovolémie
- Déconnection VPP pour évaluer la volémie

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Zones de West sans PEEP-position assise

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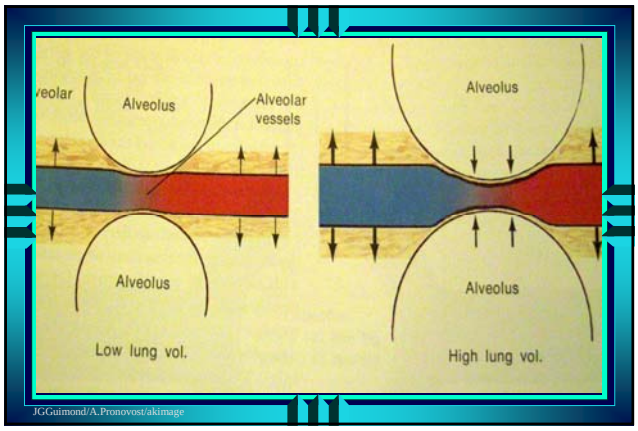

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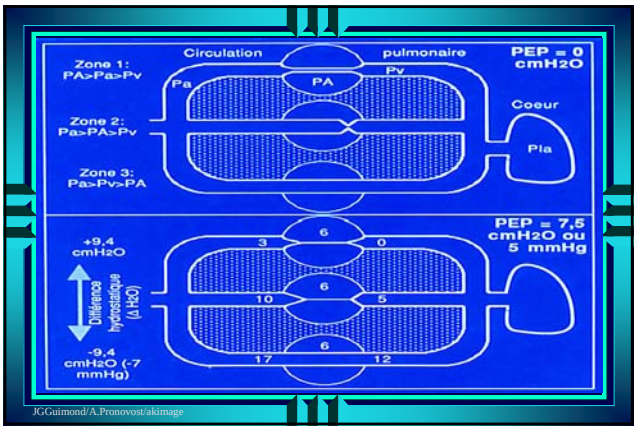

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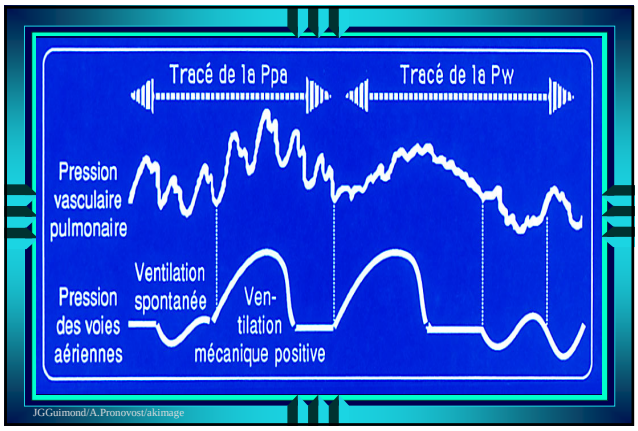
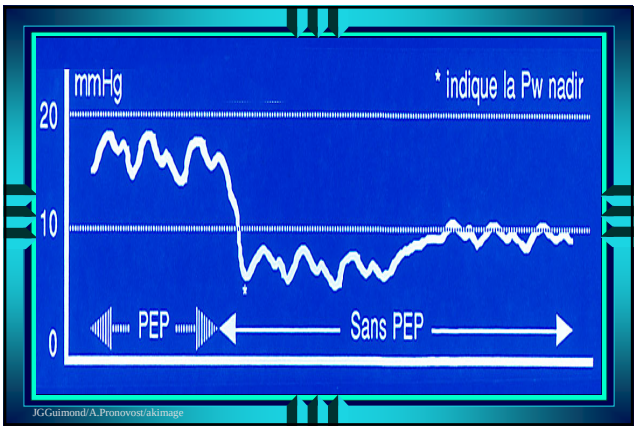
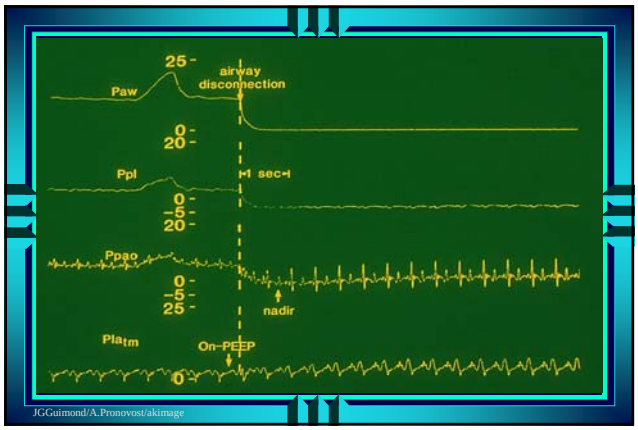
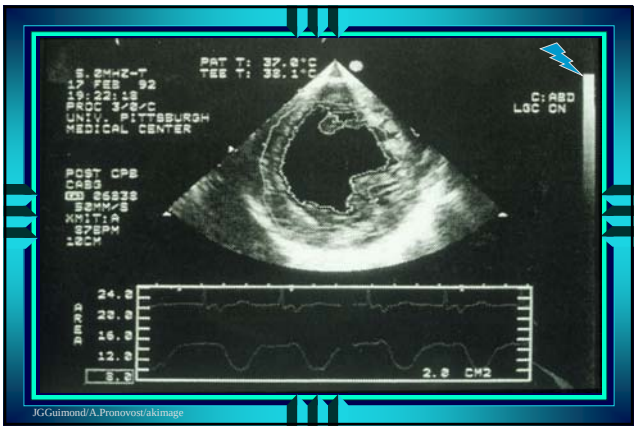

Tracé de la Ppa
Tracé de la Pw
Pression vasculaire pulmonaire
Pression des voies aériennes
Ventilation spontanée
Ven-tilation mécanique positive
JGGuimond/A.Pronovost/akimage


mmHg
* indique la Pw nadir
20
10
0
PEP
Sans PEP
JGGuimond/A.Pronovost/akimage


25
airway disconnection
Paw
0
-20
Ppl
1 sec
0
-5
-20
Ppao
0
-5
-25
nadir
Platm
On-PEEP
0
JGGuimond/A.Pronovost/akimage


PAT T: 37.0°C
TEE T: 36.1°C
UNIV. PITTSBURGH
MEDICAL CENTER
POST CPB
CABG
C:ABD
LOC ON
24.0
20.0
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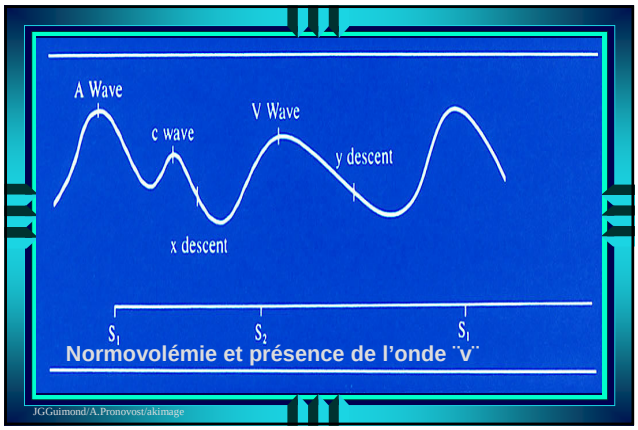
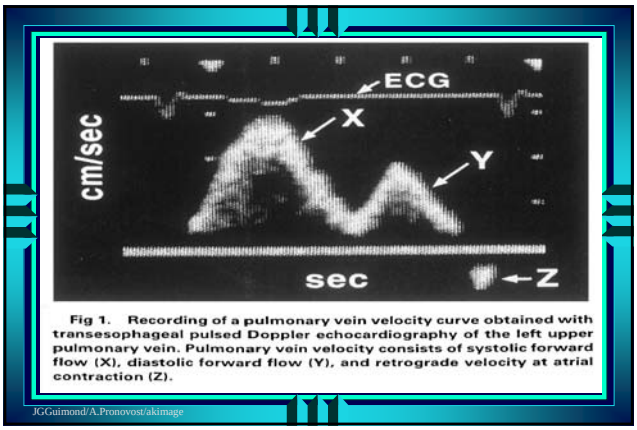

A Wave
c wave
V Wave
y descent
x descent
S1
S2
S1
Normovolémie et présence de l'onde ¨v¨
JGGuimond/A.Pronovost/akimage


ECG
X
Y
cm/sec
sec
Z
Fig 1. Recording of a pulmonary vein velocity curve obtained with transesophageal pulsed Doppler echocardiography of the left upper pulmonary vein. Pulmonary vein velocity consists of systolic forward flow (X), diastolic forward flow (Y), and retrograde velocity at atrial contraction (Z).
JGGuimond/A.Pronovost/akimage

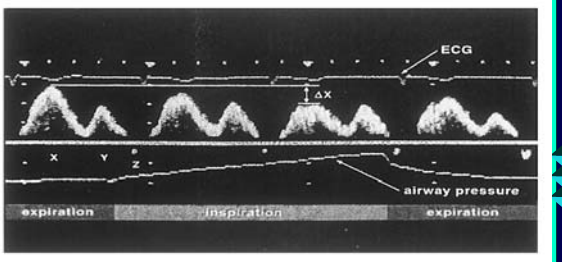


Fig 2. Recording of a pulmonary vein velocity curve obtained with transesophageal pulsed Doppler echocardiography of the left upper pulmonary vein during mechanical ventilation. Δ X represents the respiratory variation of the X wave. Airway pressure curve is shown at the bottom and electrocardiogram at the top of the figure.

III. IMPLICATIONS CLINIQUES

3. Modalités ventilatoires

- Dépendance pré-charge
  - Minimiser PIT
  - Maximiser RV

  → VS-AI, VPC, VOI, ↓ PEEP
- Dépendance post-charge
  - Maximiser PIT
  - Minimiser RV

  → A/C, ↑ PEEP
- Distinguer effets VPP
  vs hypoxémie / hypercarbie

III. IMPLICATIONS CLINIQUES

4. Assistance ventriculaire gauche

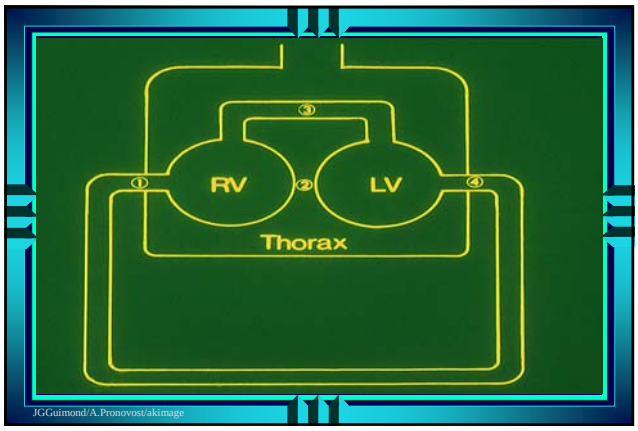
- VPP bénéfique
  - Indépendance pré-charge
  - Dépendance post-charge
- VPP NI : CPAP, BIPAP
- VPP I : VM + PEEP
- VPP I par HFJV synchrone

Table 5. Treatment of acute cardiogenic PE

- Resuscitate – ABC
- Treat precipitating cause
- Oxygen
- Morphine
- Diuretic
- CPAP
- Venodilator
- Inotrope
- Ventilation
- Adjust therapy according to progress

Table 1. Randomized controlled trials evaluating noninvasive ventilation in acute cardiogenic pulmonary edema

Author year	*Technique*	*Positive pressure (cm H_2O)*	*# Patients (NIV Control)*	*Intubation failure rates (NIV Control)*	*Other outcomes*
Rasanen 1985	CPAP	10	20/20	35%/65%	↓ RR, HR, BP, $PaCO_2$, and ↑ PaO_2 within 10 minutes of CPAP
Lin 1991	CPAP	12.5	25/30	28%/60%	Lower RR, BP and higher PaO_2 in CPAP than control group over 3 hour study
Bersten 1991	CPAP	10	19/20	0%/35%	CPAP group: lower RR, HR, $PaCO_2$, and higher pH and PaO_2 at 30 minutes, shorter ICU LOS
Lin 1995	CPAP	12.5	50/50	16%/36%	CPAP group: significant ↓ in BP, HR, RR, and ↑ in PaO_2 over 6 hour study
Mehta 1997	CPAP vs BiPAP	CPAP: 10 BiPAP: 15/5	13 CPAP/ 14 BiPAP	8% CPAP/ 7% BiPAP	BiPAP improved $PaCO_2$, vital signs, dyspnea more rapidly than CPAP



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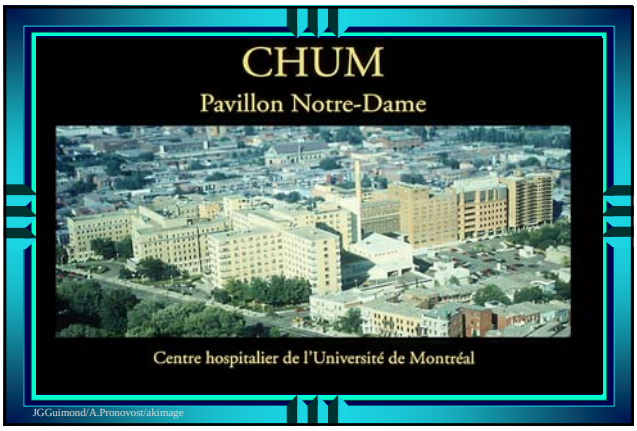

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III. IMPLICATIONS CLINIQUES

3. Effets à distance de la VPP

- Pressions intra-crâniennes
- Perfusion splanchnique

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Table 2. Normal intracranial pressure (ICP) group (mean ± SD)

PEEP (cm H_2O)	MAP (mm Hg)	ICP (mm Hg)	CPP (mm Hg)
0	91.9 ± 10.4	7.6 ± 4.0	83.6 ± 10.4
5	92.2 ± 11.8	8.3 ± 4.4	83.6 ± 11.3
10	91.2 ± 9.7	9.5 ± 5.2[a]	81.6 ± 10.9
15	94.3 ± 9.2	9.1 ± 4.2[a]	86.3 ± 9.4

PEEP, positive end-expiratory pressure; MAP, mean arterial pressure; ICP, intracranial pressure; CPP, cerebral perfusion pressure.

[a] $p < .05$ as compared with PEEP = 0.

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Table 3. High intracranial pressure (ICP) group (mean ± SD)

PEEP (cm H_2O)	MAP (mm Hg)	ICP (mm Hg)	CPP (mm Hg)
0	106.5 ± 14.9	18.8 ± 4.1	89.3 ± 9.1
5	109.5 ± 11.7	19.7 ± 5.4	89.5 ± 8.1
10	108.5 ± 14.7	21.0 ± 5.3	89.2 ± 11.7
15	112.7 ± 18.7	22.0 ± 6.9	90.7 ± 14.6

PEEP, positive end-expiratory pressure; MAP, mean arterial pressure; CPP, cerebral perfusion pressure.

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