Action du diaphragme

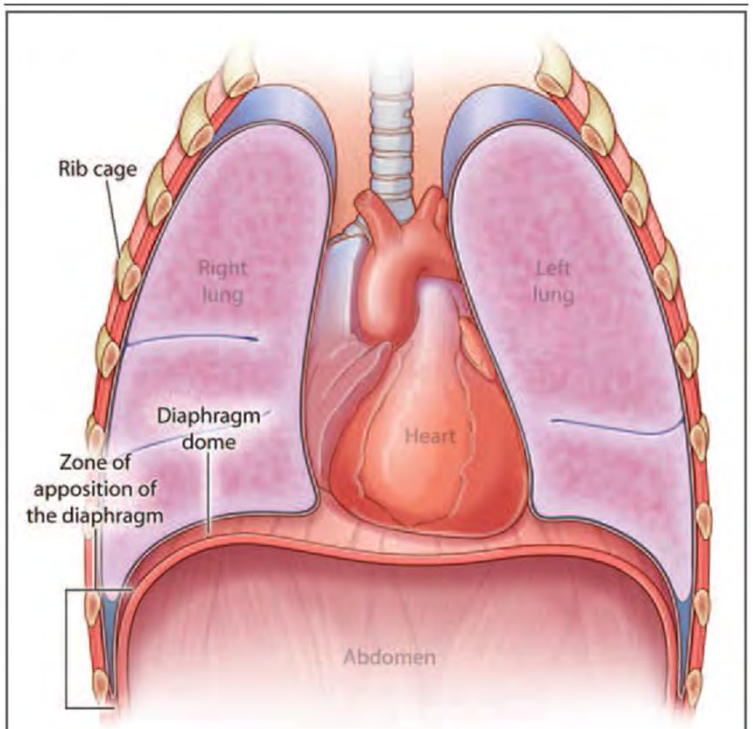


Figure 1. Anatomical Arrangement of the Diaphragm with the Rib Cage and Abdomen.

The cylindrical region of the diaphragm that apposes the lower rib cage is referred to as the zone of apposition of the diaphragm.

Dysfunction of the Diaphragm

F. Dennis McCool, M.D., and George E. Tzelepis, M.D.

N Engl J Med 2012;366:932-42.

Fonction ventilatoire du diaphragme

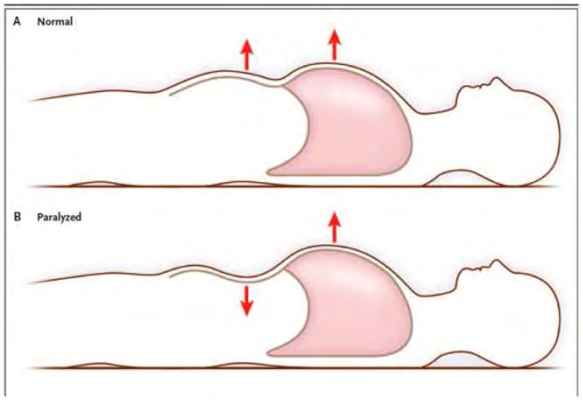
- Abaissement inspiratoire du **dôme**
- **Zone d'apposition** :
  - **Élévation** des côtes inférieures
    - Orientation axe K : BS-DD-AV
    - élévation K = mouvement vers l'extérieur.
    - Augmente dimensions latérales du thorax inférieur
  - **Transmission de la pression abdominale**
    - à la partie basse de la cage thoracique : mouvement vers le dehors.

Lynda Gaillard

Reconnaître les dysfonctions du diaphragme

- **Clinique :**
  - Dyspnée
  - Orthopnée
  - Anté-pnée : position penchée en Avant.

- **Examen :**
  - **Paradoxe** abdominal
  - Ecarter les contractions phasiques abdominales



Dysfunction of the Diaphragm

F. Dennis McCool, M.D., and George E. Tzelepis, M.D.

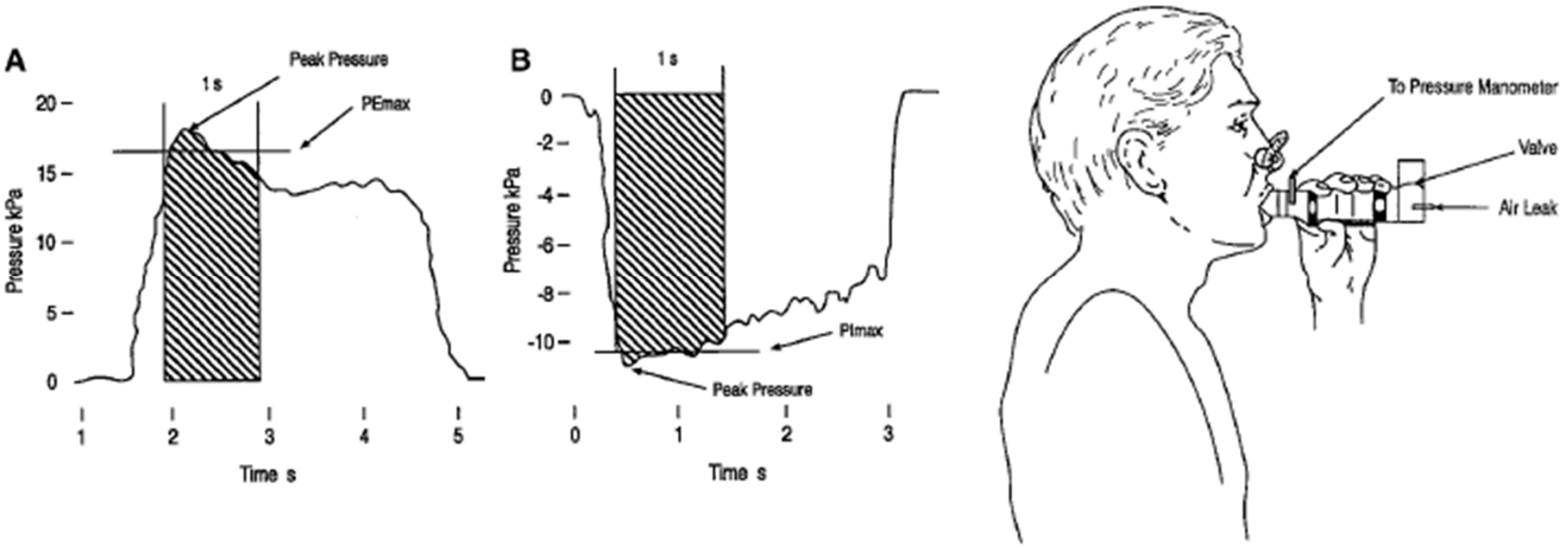
N Engl J Med 2012;366:932-42.

Reconnaître les dysfonctions du diaphragme

- Chute de la CV en position allongée
  - Seuil de 20% proposé, spécifique, peu sensible.

- Abaissement $P_I$max et SNIP
  - Concordants
  - Valeur la plus élevée à retenir en terme d'interprétation
  - Seule difficulté : compensation par les autres muscles
- Pression transdiaphragmatique.

Evaluation des Muscles respiratoires : PI – PE max



Pimax : au- delà de - 80 cmH2O chez l'homme et de - 70 cmH2O chez la femme

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Am J Respir Crit Care Med Vol 166. pp 518–624, 2002

Influence du volume pulmonaire

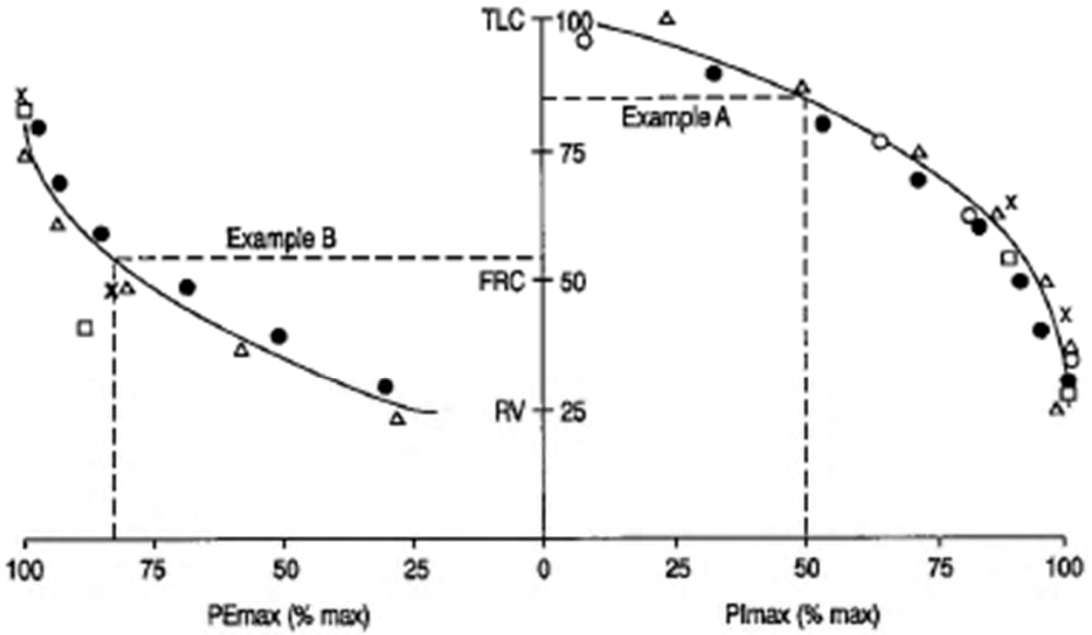

Figure 3. Relationship between maximal static respiratory pressure (Pimax, Pemax) and lung volume. Pressures are expressed as a percentage of maximum and the lung volume is expressed as a percentage of TLC. Symbols are data from different studies (39). *Example A* represents a patient with emphysema whose RV is 85% TLC, at which lung volume his predicted Pimax is only 50% of that at normal RV. Conversly, *Example B* represents a patient with lung fibrosis with TLC of 55% predicted, at which volume her Pemax is 82% maximum. Reprinted by permission from Reference 39.

- $P_I$max au VR (ou à la CRF).
- $P_E$max à la CPT

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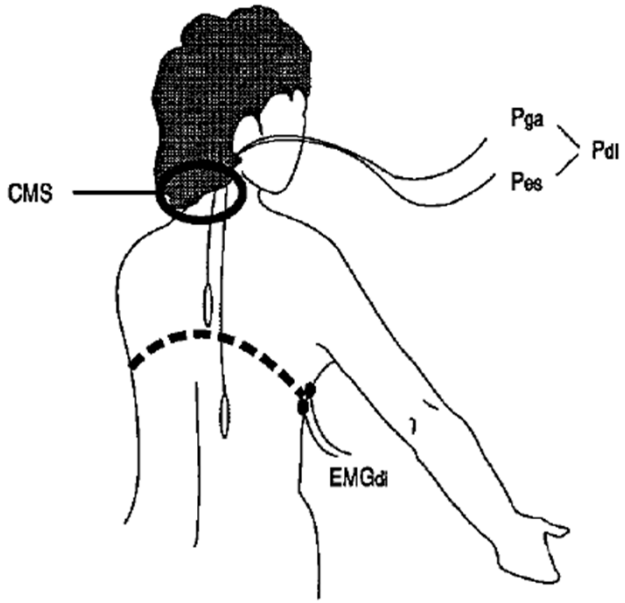
Am J Respir Crit Care Med Vol 166. pp 518–624, 2002

Pressions trans-diaphragmatiques



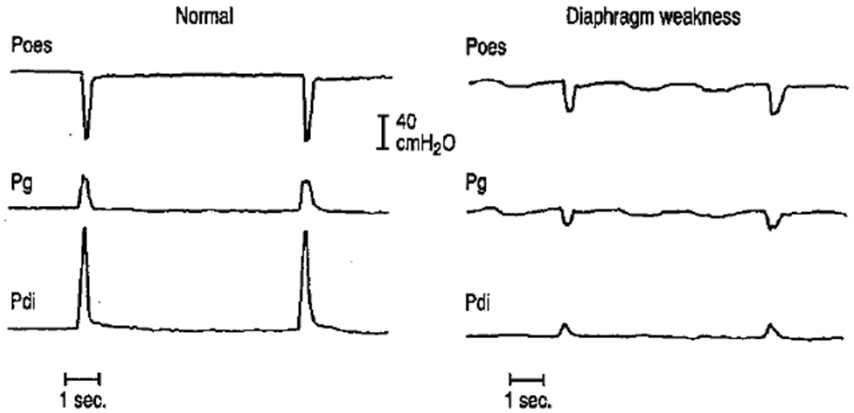


Figure 6. Esophageal (Poes), gastric (Pg), and transdiaphragmatic (Pdi) pressures measured during maximum voluntary sniffs in a normal subject and in a patient with severe diaphragm weakness. The normal subject reproducibly generates a Pdi of 120 cm H_2O (11.8 kPa), whereas the weak patient can generate only 15 cm H_2O (1.5 kPa).

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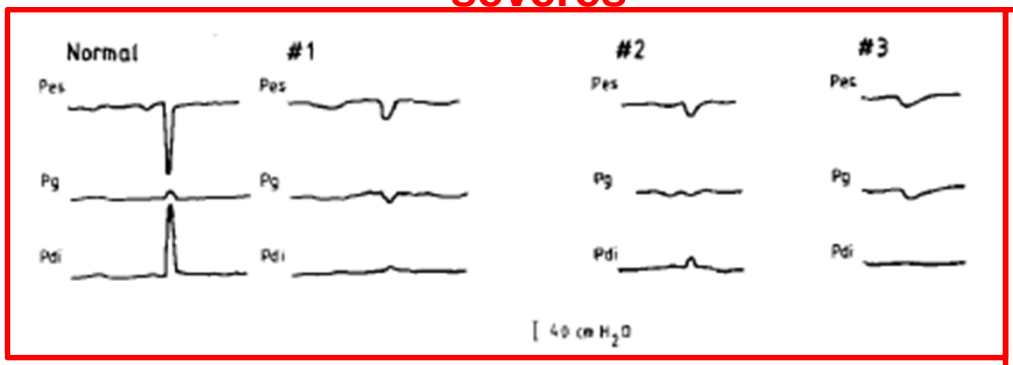
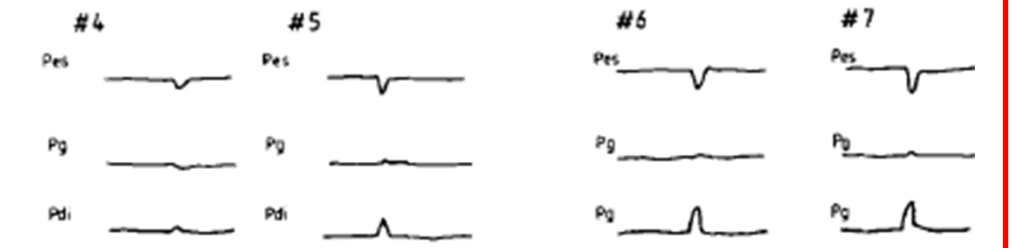
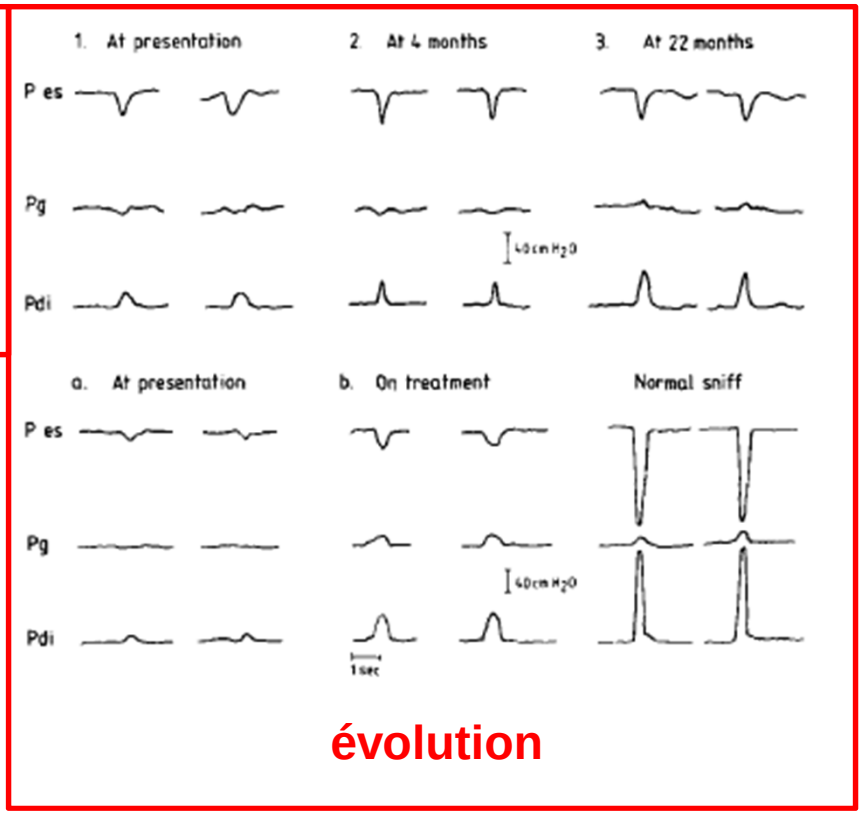
Mesure de Pdi dans les dysfonctions du diaphragme

sévères





modérées



évolution

Assessment of Diaphragm Weakness[1-3]

ANNE MIER-JEDRZEJOWICZ, CONOR BROPHY, JOHN MOXHAM, and MALCOLM GREEN

AM REV RESPIR DIS 1988; 137:877-883

Valeurs normales

TABLE 3. TRANSDIAPHRAGMATIC PRESSURES DURING MAXIMAL STATIC RESPIRATORY EFFORTS AND MAXIMAL SNIFFS

		$P_{I,di,max}$ ($cm\ H_2O$)			$P_{di,sn}$ ($cm\ H_2O$)		
	n	Mean	SD	Range	Mean	SD	Range
Men	37	108	30	52–164	148	24	112–204
Women	27	65	31	16–40	121	25	82–182
All	64	90	37	16–164	137	28	82–204

Definition of abbreviations: $P_{I,di,max}$ = maximum static transdiaphragmatic pressure; $P_{di,sn}$ = transdiaphragmatic pressure during sniff.

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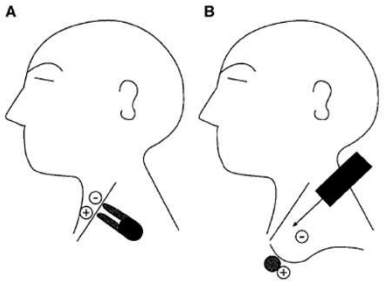
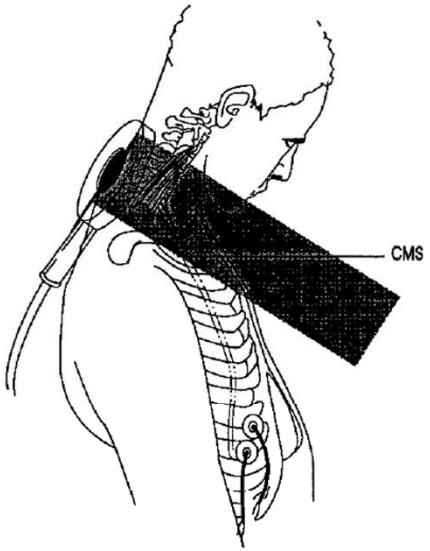
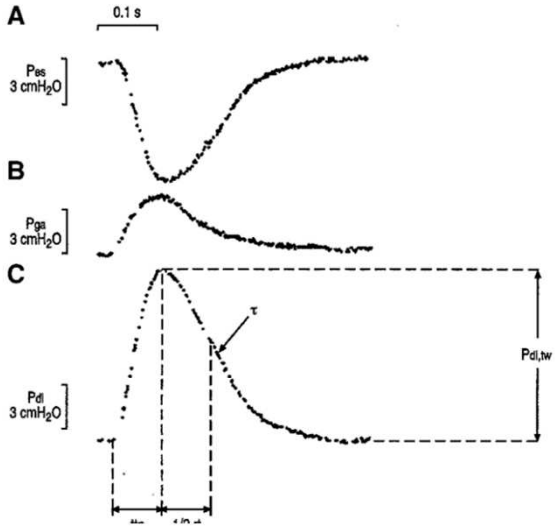
Réponse secousse unique
Twitch Pdi



Stimulation électrique



Stimulation magnétique



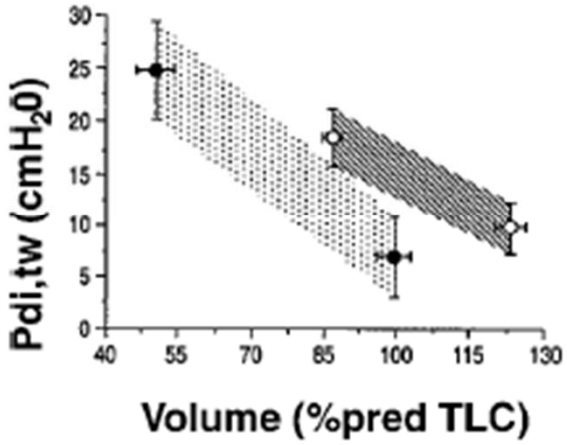


Figure 13. The effects of lung volume on twitch pressure. Shown is the marked decrease in the amplitude of transdiaphragmatic pressure (Pdi,tw) during an acute inflation from functional residual capacity to total lung capacity, both in normal volunteers (*solid circles*) and in patients with preexisting hyperinflation impairing baseline diaphragm efficacy (*open circles*). This re-

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Twitch Pdi : valeurs normales

Cervical Magnetic Stimulation: Healthy Young Volunteers

Similowski (100)	33.4	First-generation stimulator; supramaximality of PNS not always certain
Wragg (107)	36.5	Comparison CM–ES
Wragg (146)	36.5	Study of diaphragm twitch potentiation; values in the table are the unpotentiated ones
Laghi (184)	38.9	12 subjects
Hamnegard (129, 187)	17–34	
Similowski (109)	27.5	Comparison CM–ES
Laghi (108)	37.7	Comparison CM–ES

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ATS/ERS Statement on Respiratory Muscle Testing

Explorations par Pmax des dysfonctions du diaphragme

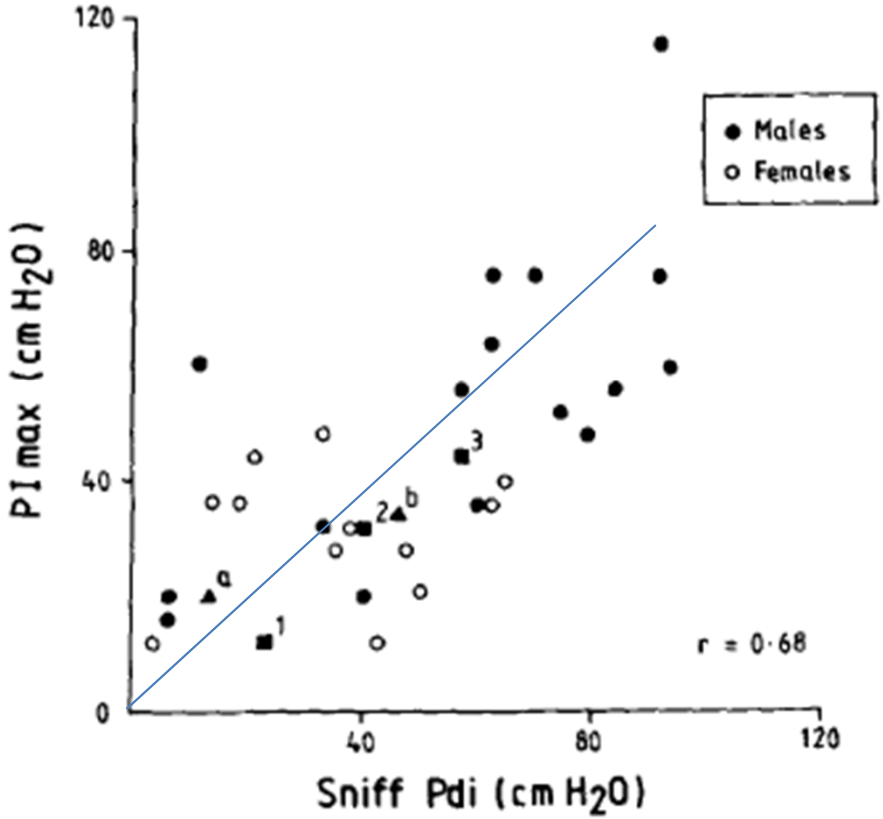


Fig. 3. Relationship between maximal static inspiratory mouth pressure (P_{I} max) and transdiaphragmatic pressure during maximal sniffs (sniff Pdi) ($y = 13.8 + 0.57x$). Symbols as in figure 1.

Assessment of Diaphragm Weakness[1-3]

ANNE MIER-JEDRZEJOWICZ, CONOR BROPHY, JOHN MOXHAM, and MALCOLM GREEN

AM REV RESPIR DIS 1988; 137:877-883

Relations symptômes – fonction dans les dysfonctions diaphragmatiques

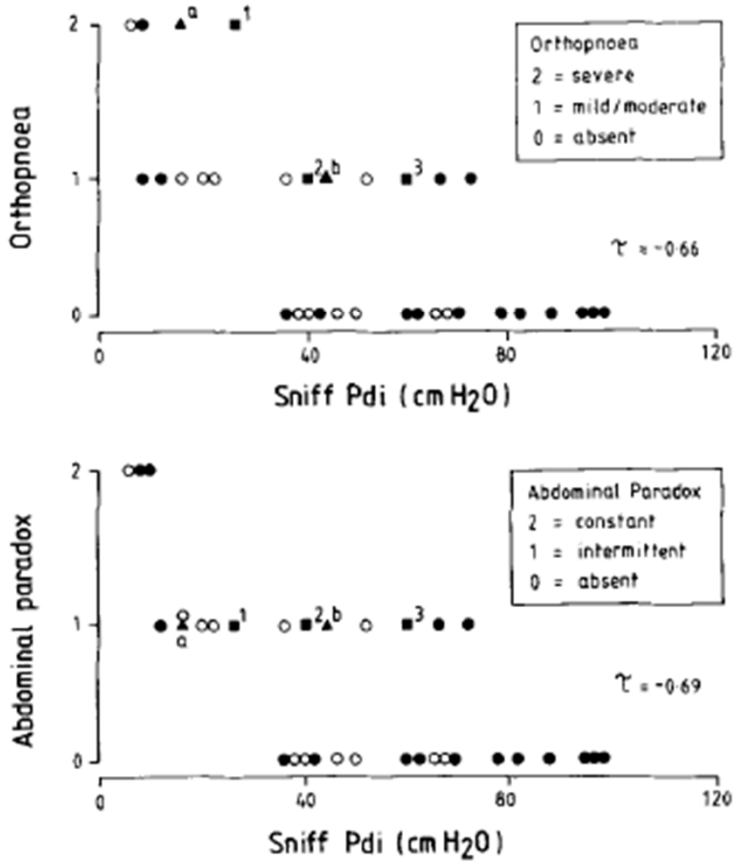


Fig. 6. Association between grade of orthopnea (*upper panel*) and degree of abdominal paradox (*lower panel*), and transdiaphragmatic pressure during maximal sniffs (sniff Pdi). Symbols as in figure 1.

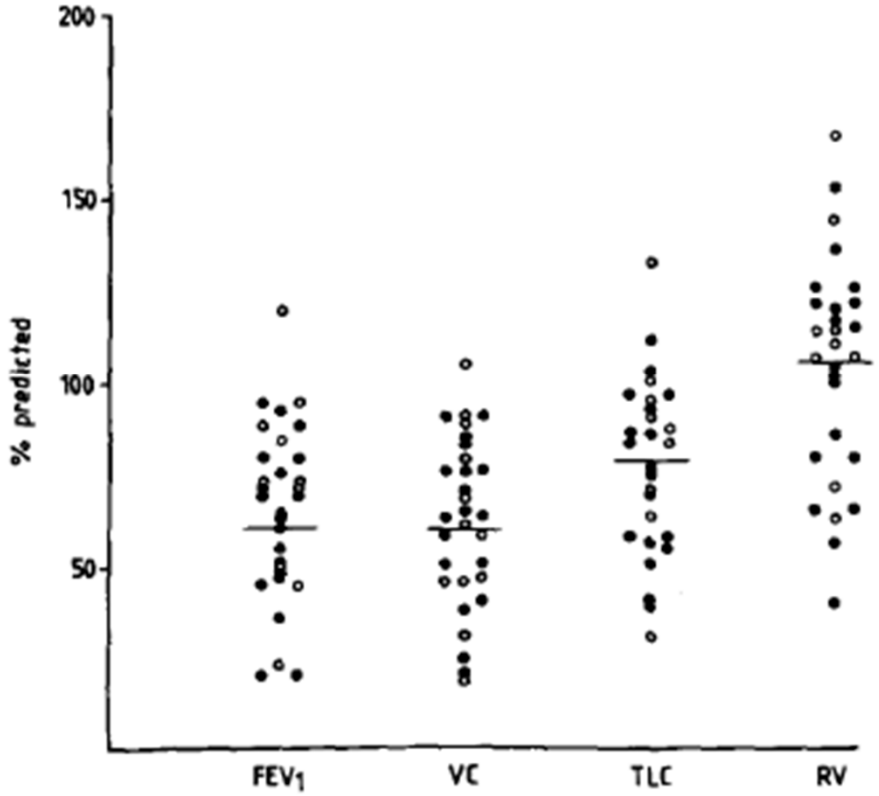
Assessment of Diaphragm Weakness[1-3]

ANNE MIER-JEDRZEJOWICZ, CONOR BROPHY, JOHN MOXHAM, and MALCOLM GREEN

AM REV RESPIR DIS 1988; 137:877-883

Explorations Fonctionnelles dans les dysfonctions du diaphragme

Fig. 9. Spirometry and subdivisions of lung volumes. Each point represents measurement in an individual patient as a percentage of the predicted value. Bars show means for the group.

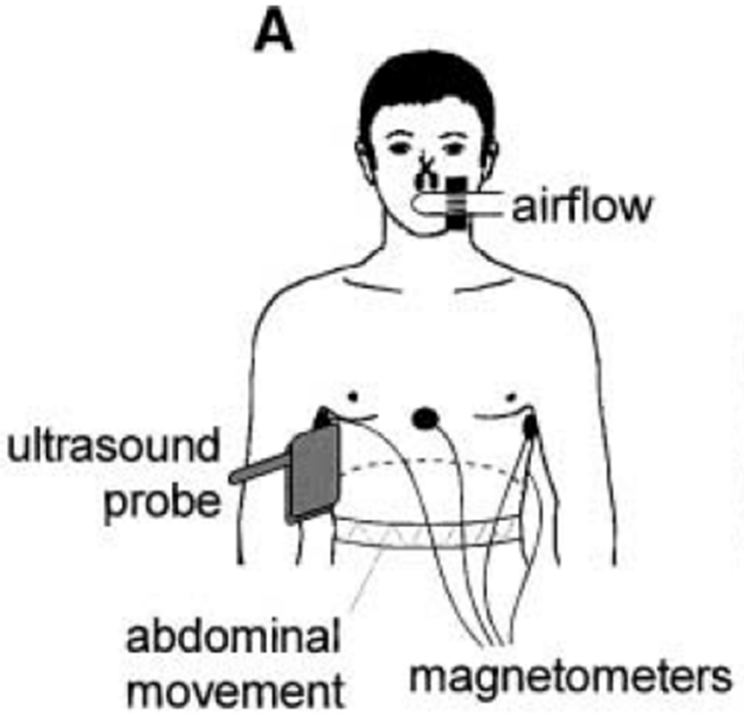


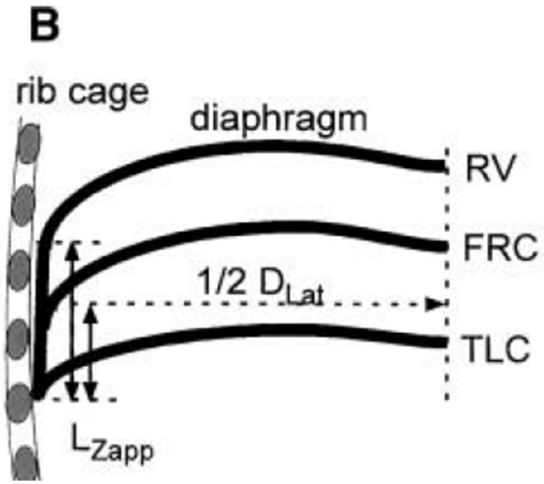
Assessment of Diaphragm Weakness[1-3]

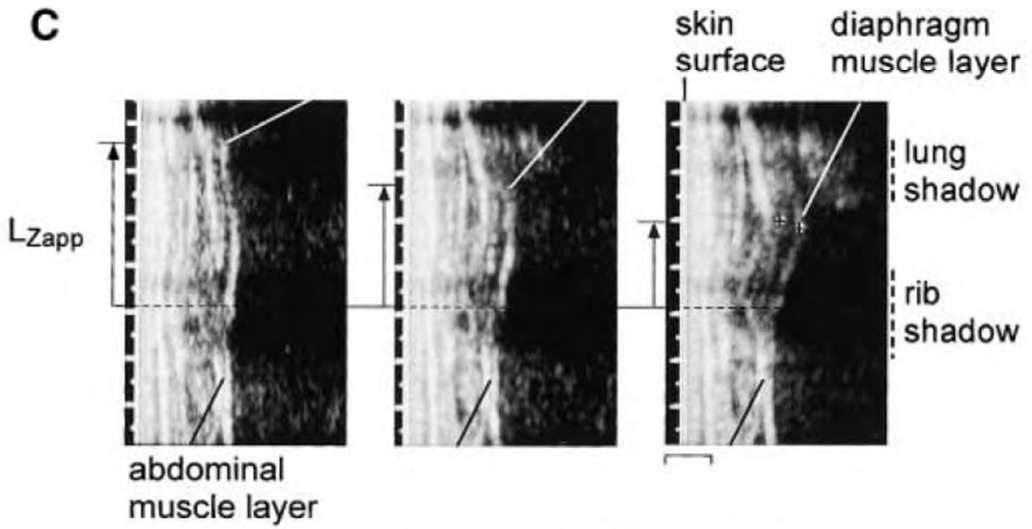
ANNE MIER-JEDRZEJOWICZ, CONOR BROPHY, JOHN MOXHAM, and MALCOLM GREEN

AM REV RESPIR DIS 1988; 137:877-883

Explorations du diaphragme







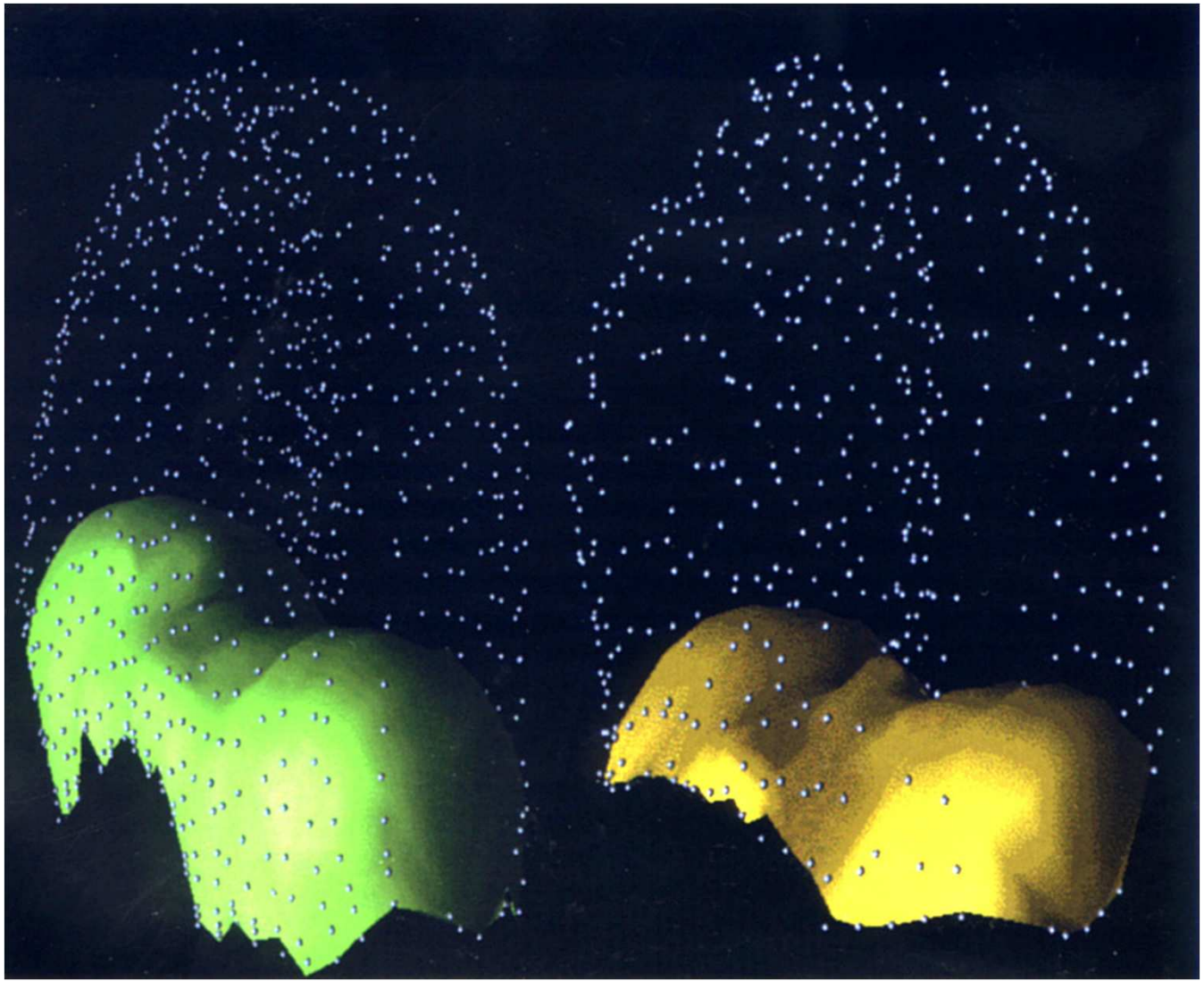
Diaphragm Length during Tidal Breathing in Patients with Chronic Obstructive Pulmonary Disease

Robert B. Gorman, David K. McKenzie, Neil B. Pride, Jane F. Tolman, and Simon C. Gandevia

Am J Respir Crit Care Med Vol 166. pp 1461–1469, 2002

similar to predicted total lung capacity. Although the diaphragm is shorter at FRC in patients with COPD, its motion and change in length during tidal breathing is similar to that in control subjects.

Imagerie 3 D du diaphragme



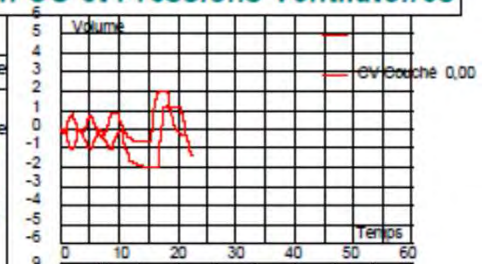
CHU Grenoble

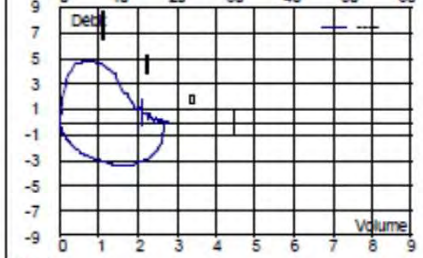
Laboratoire EFCR: Pr R Tamisier: 04 76 76 88 87
Clinique de Physiologie : Pr JL Pépin
Dr S Launois, Dr B Wuyam, Dr N Sivanko, Dr R Guzun

Nom :	[redacted]	Sexe :	M	Médecin Presc. :	2427
Prénom :	[redacted]	Age :	59	Médecin trait. :	
Numéro Identité :	4426	Taille(cm) :	180	Date examen :	27/03/2014
Date de naissance :	15/03/1955	Poids(Kg) :	78	Opérateur :	EFR1

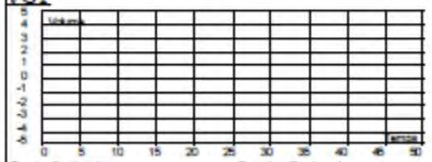
Pléthysmographie Complète avec Diffusion CO et Pressions Ventilatoires

	Norme	Pré Mes.	Pré %Norme	Post Mes.	Post Dif. Pré%	Post %Norme
				CV Couché	0,00	
	Norme	Mes.	%Norme	Mes.	Dif. Pré%	%Norme
CV(L)	4,68	3,24	69	2,73	-16	58
VRI(L)	—	1,26	—	1,27	1	—
VRE(L)	1,23	0,92	75	0,30	-68	24
CI(L)	3,45	2,32	67	2,43	5	70
CE(L)	—	1,98	—	1,46	-26	—
PI 1s(cmH2O)	103,00	69,97	68	—	—	—
PI Pk(cmH2O)	—	77,74	—	—	—	—
PE 1s(cmH2O)	143,00	107,07	75	—	—	—
PE Pk(cmH2O)	—	131,73	—	—	—	—
SNIP max(cmH2O)	111,50	58,61	53	—	—	—
CVF(L)	4,49	2,77	62	—	—	—
VEMs(L)	3,54	2,28	64	—	—	—
VEMs/CVF(%)	76,58	82,24	107	—	—	—
VEMs/CV(%)	76,58	70,31	92	—	—	—
DEP(L/S)	8,66	4,80	55	—	—	—
DEM(L/S)	3,65	2,91	80	—	—	—
D25(L/S)	1,82	1,03	56	—	—	—
D50(L/S)	4,64	3,78	81	—	—	—
D75(L/S)	7,65	4,79	63	—	—	—
VIMs(L)	—	2,21	—	—	—	—
CVF ins(L)	—	2,71	—	—	—	—
DIP(L/S)	—	3,30	—	—	—	—
D50Ex/In(%)	—	118,93	—	—	—	—
VGT(L)	3,65	—	—	—	—	—
VR(L)	2,43	—	—	—	—	—
CPT(L)	7,30	—	—	—	—	—
CV (cpt)(L)	4,68	—	—	—	—	—
VR/CPT(%)	36,98	—	—	—	—	—
VI(L)	4,68	—	—	—	—	—
VA(L)	7,30	—	—	—	—	—
DLCO cor(mL/mmHg/Mi)	30,01	—	—	—	—	—
DLCO(mL/mmHg/Mi)	30,01	—	—	—	—	—
KCO cor(mL/mmHg/Mi)	4,11	—	—	—	—	—
VR' sb(L)	2,42	—	—	—	—	—
TA(%)	—	—	—	—	—	—
Hb(gr/100ml)	14,60	—	—	—	—	—

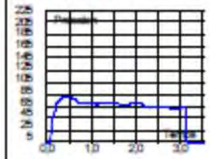




VGT



Pression Inspiratoire



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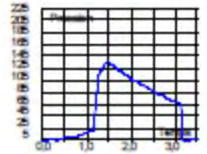
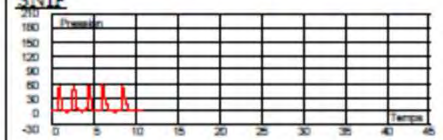


SNIP



Commentaires

SAO2 ASSIS 92%
SAO2 COUCHE 92%

Dysfonction uni ou bilatérale du diaphragme

Table 1. Comparison of Bilateral and Unilateral Diaphragmatic Paralysis.*

Diagnostic Tools and Treatment	Bilateral Diaphragmatic Paralysis	Unilateral Diaphragmatic Paralysis
Presentation	Dyspnea at rest, unexplained dyspnea, exercise limitation, orthopnea, dyspnea when bending, constitutional symptoms, dyspnea when entering water, respiratory failure, prolonged mechanical ventilation	Asymptomatic, unexplained dyspnea; exercise limitation, incidental radiographic finding
History	Neck or shoulder pain, chest or neck surgery, neck injury, manipulation of the cervical spine, neuromuscular disease	Neck or shoulder pain, chest or neck surgery, neck injury, manipulation of the cervical spine, neuromuscular disease
Examination	Abdominal paradox	No abdominal paradox
Laboratory tests		
Vital capacity (% of predicted value)	<50	>70
Decline in supine vital capacity (%)	30–50	10–30
MIP (% of predicted value)	<30	>60
Fluoroscopy	Not helpful	Sniff test positive
Thickening of diaphragm on inspiration†	No change	No change
Pdi max (cm of water)	<40	>70
Twitch Pdi (cm of water)	<20	<10
Complications	Frequent hypoventilation during sleep, atelectasis, pneumonia, respiratory failure	Occasional hypoventilation during sleep, atelectasis
Treatment		
Observation period for recovery (yr)	1.5–3	1.5–3
Treatment for coexisting conditions	Yes	Yes
Reversal of metabolic disturbance	Yes	Yes
NIPPV	Often indicated	Usually not indicated
Plication of diaphragm	Not indicated	May be helpful
Phrenic pacing	Yes, in patients with high SCI	No

Contrôle neuro-musculaire & dysfonctions du diaphragme

Dysfonctions Neurogènes (Personage & Turner)

Dysfonctions myogènes

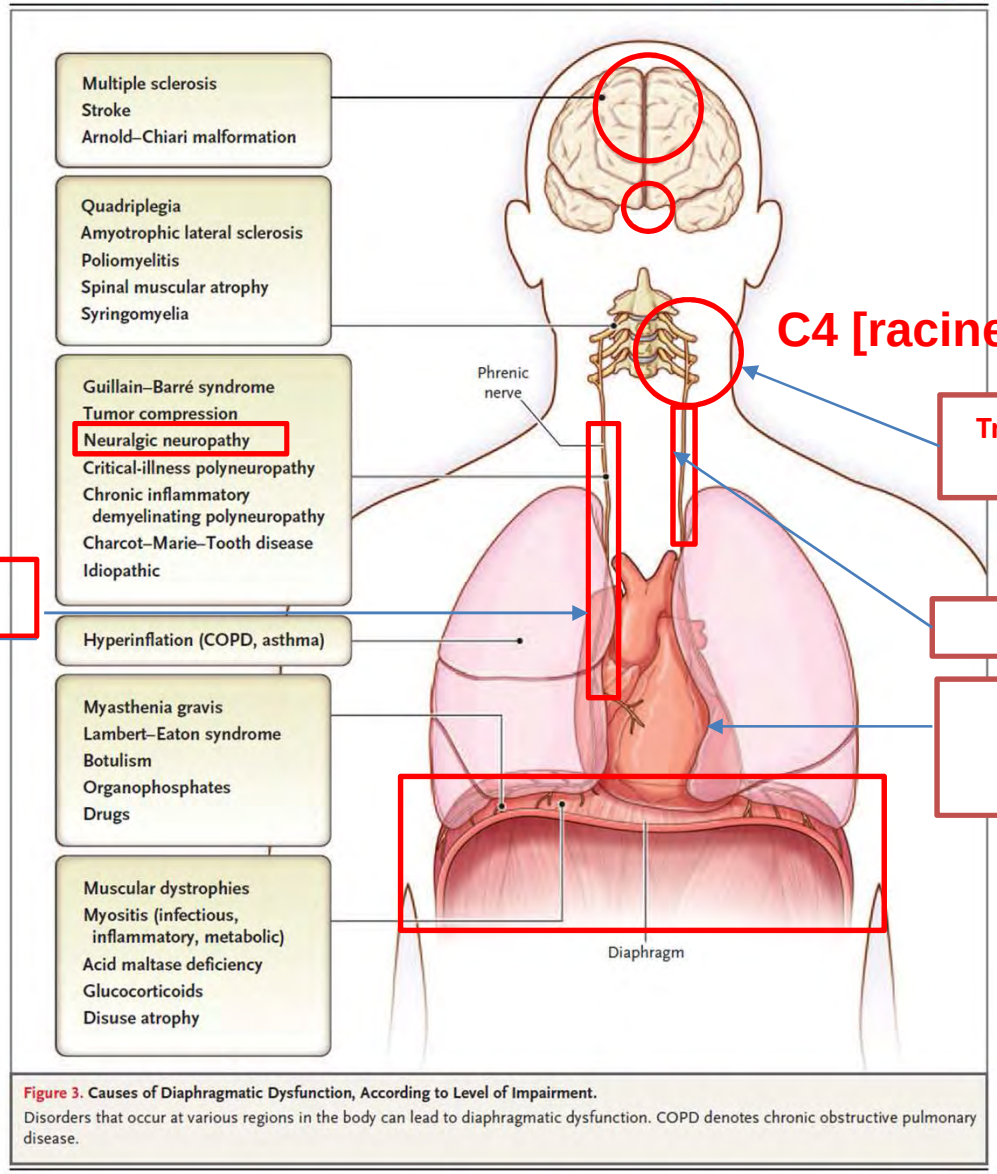


Figure 3. Causes of Diaphragmatic Dysfunction, According to Level of Impairment.
Disorders that occur at various regions in the body can lead to diaphragmatic dysfunction. COPD denotes chronic obstructive pulmonary disease.

Diabète

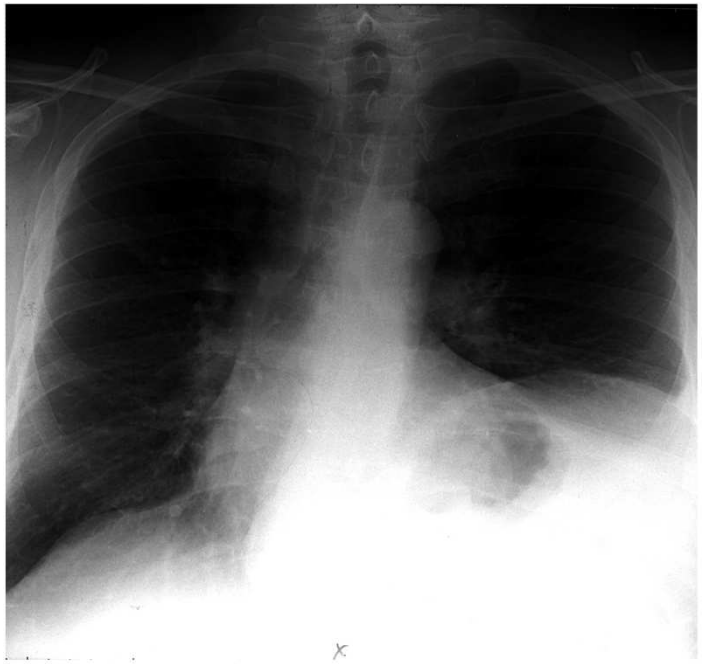
C4 [racine principale] – C6

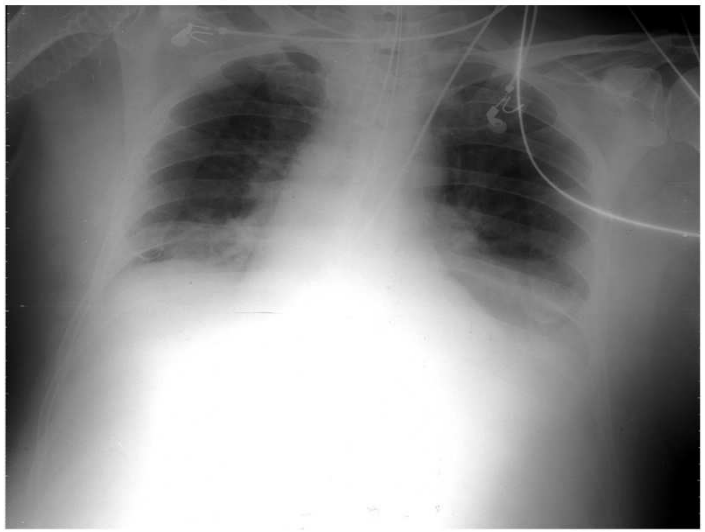
Traumatisme / élongation
Arhrose cervicale

Pose jugulaire / Xie

Thermo abalation
Fx accesoires WPW
foyers ectopiques FA

Dysfonctions diaphragmatiques iatrogène





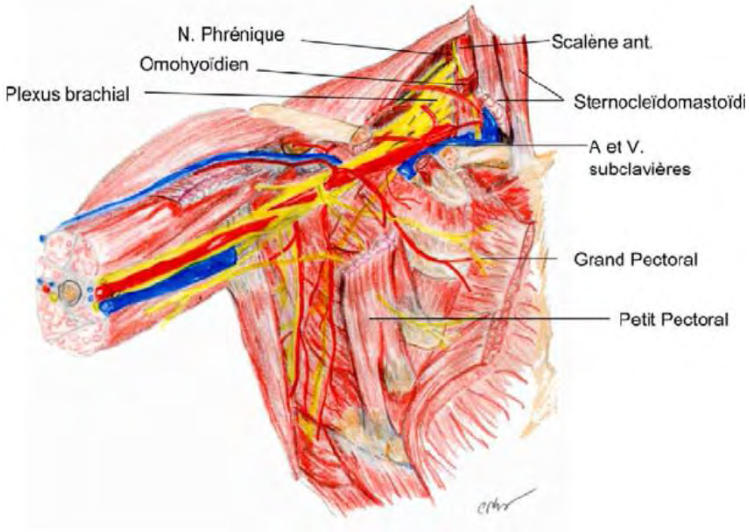
Bloc scalène chirurgie de la coiffe des rotateurs

Electrothérapie pour FA.

VV jugulaire

Post opératoire

Manipulations vertébrales



VNI définitive

Anomalies du sommeil & dysfonctions du diaphragme

- REM sleep : diaphragme seul actif.
- Episodes d'**hypoventilation** (désaturations prolongés) au cours du REM associés à dysfonction diaphragmatique.
- Utile au **dépistage** en pratique pneumologique.
- Si sévères, adaptation : REM disparait. Autres muscles suppléent.
- Si modérées, anomalies absentes ?

Dysfonction unilatérale & sommeil

TABLE 1 Clinical features of patients

Patient	Sex	Age yrs	BMI kg·m^{-2}	UDP	MRC	ESS	Paradox	Sleeping side	Comorbidities
1	M	53	26.8	Right	1	18	Yes	Left	None
2	F	64	28.8	Right	2	10	Yes	None	Ulcerative colitis
3	M	58	28.7	Right	2	16	Yes	Left	None
4	M	76	28.4	Right	4	13	Yes	Left	Gastro-oesophageal reflux, chronic anaemia
5	M	59	29.6	Right	2	6	Yes	Left	Coronary artery disease
6	F	62	29.6	Right	2	3	No	Left	None
7	F	47	32.5	Right	3	14	No	Left	Depression
8	F	44	22.9	Right	4	17	No	None	Depression
9	F	57	30.9	Left	4	21	Yes	Right	Diabetes mellitus
10	M	41	31.8	Right	2	9	Yes	Left	None
11	M	61	25.8	Right	3	7	Yes	Left	None

BMI: body mass index; UDP: unilateral diaphragm paralysis or severe weakness; MRC: Medical Research Council dyspnoea scale; ESS: Epworth Sleepiness Scale; paradox: thoracoabdominal paradox by inspection and analysis of traces of oesophageal and gastric pressure swings; sleeping side: preferred sleeping position; M: male; F: female.

TABLE 2 Results of respiratory muscle function tests for patient and control groups

	UDP	Control	p-value
Tw *Pdi*, bilateral	17.3±5.0	26.2±5.5	0.001
Tw *Pdi*, weak side	3.3±1.7	10.4±1.9[#]	<0.001
Tw *Pdi*, strong side	11.2±2.2	13.4±3.3[¶]	0.083
Sniff *Pdi*	71.0±40.2	136.7±39.9	0.001
Sniff *Poes*	63.6±34.5	112.7±39.5	0.006
Sniff *Pnasal*	56.2±31.3	99.6±43.6	0.014
PI,max	49.4±29.8	110.0±43.7	0.001
PE,max	96.8±33.7	118.4±50.9	0.253
Cough *Pgas*	186.1±50.8	202.7±63.2	0.504
Tw T10	43.7±33.5[+]	35.3±11.0	0.444

Sleep-disordered breathing in unilateral diaphragm paralysis or severe weakness

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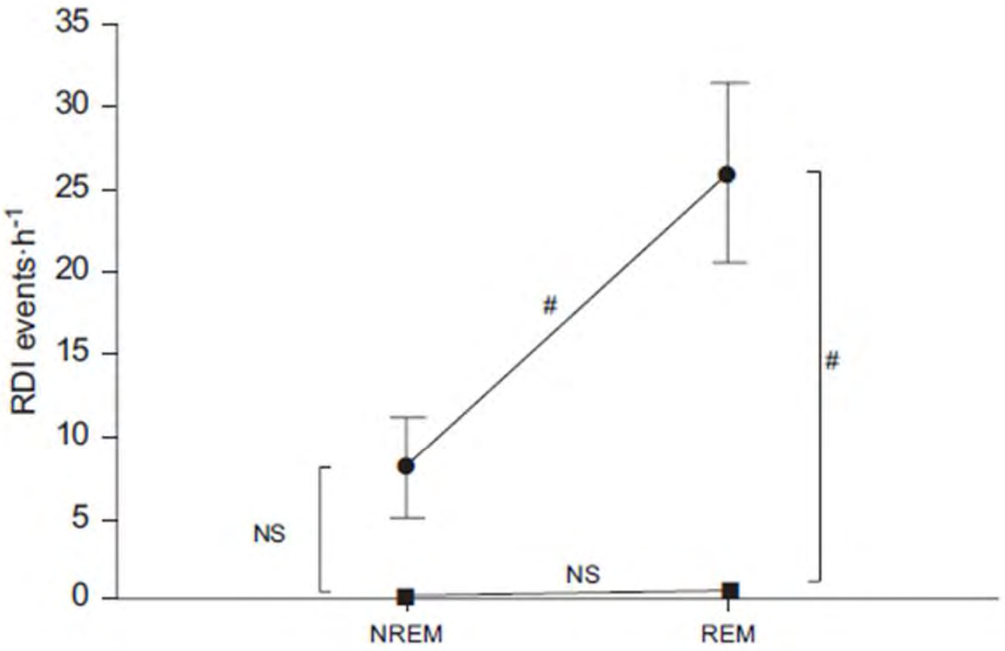
Eur Respir J 2008; 32: 1479–1487

Paralysie diaphragme & sommeil



Sleep-disordered breathing in unilateral diaphragm paralysis or severe weakness

J. Steier*, C.J. Jolley*, J. Seymour*, S. Kaul*, Y.M. Luo#, G.F. Rafferty*, N. Hart*, M.I. Polkey" and J. Moxham*

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FIGURE 1. Mean ± SEM respiratory disturbance index (RDI) for patient (●) and control groups (■). There was a significant increase in RDI in rapid eye movement (REM) sleep compared with non-REM (NREM) sleep in patients with unilateral diaphragm paralysis. The intergroup difference was significant for REM sleep. NS: nonsignificant. #: $p<0.0001$.

Paralysie diaphragme & exercice

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF 16 PATIENTS WITH DIAPHRAGM PARALYSIS

Patient No.	UDP/BDP	Diagnosis	Symptoms (*months*)*	Age (*years*)	Weight (*kg*)	Height (*cm*)
1	LUDP	Neuralgic amyotrophy	4	34	101	188
2	LUDP	Neuralgic amyotrophy	12	43	97	180
3	LUDP	Neuralgic amyotrophy	5	58	106	170
4	RUDP	Neuralgic amyotrophy	13	69	89	168
5	RUDP	Neuralgic amyotrophy	9	79	75	171
6	RUDP	Neuralgic amyotrophy	19	69	101	181
7	RUDP	Neuralgic amyotrophy	5	52	85	179
8	RUDP	Neuralgic amyotrophy	2	29	111	176
9	BDP	Neuralgic amyotrophy	20	53	87	177
10	BDP	Neuralgic amyotrophy	27	42	69	184
11	BDP	Postsurgical	5	54	71	169
12	BDP	Neuralgic amyotrophy	13	61	86	176
13	BDP	Neuralgic amyotrophy	13	66	113	175
14	BDP	Neuralgic amyotrophy	10	51	69	175
15	BDP	Neuralgic amyotrophy	36	41	105	189
16	BDP	Postsurgical	20	46	89	181

Definition of abbreviations: BDP = bilateral diaphragm paralysis; LUDP/RUDP = left/right unilateral diaphragm paralysis.
* Symptom duration was determined from the time from onset of the symptoms.

Effect of Severe Isolated Unilateral and Bilateral Diaphragm Weakness on Exercise Performance

Nicholas Hart, Annabel H. Nickol, Derek Cramer, Simon P. Ward, Frédéric Lofaso, Neil B. Pride, John Moxham, and Michael I. Polkey

Am J Respir Crit Care Med Vol 165. pp 1265–1270, 2002

Paralysie diaphragme & exercice

TABLE 2. LUNG VOLUMES AND CARBON MONOXIDE TRANSFER MEASUREMENTS IN EIGHT CONTROL SUBJECTS, EIGHT PATIENTS WITH UNILATERAL DIAPHRAGM PARALYSIS, AND EIGHT PATIENTS WITH BILATERAL DIAPHRAGM PARALYSIS

	Control Subjects	UDP	BDP
VC, %pred	111.8 ± 14.5	77.4 ± 7.2*	71.5 ± 18.0*
TLC, %pred	101.6 ± 11.3	81.4 ± 9.9*	82.0 ± 10.0*
FRC, %pred	99.9 ± 18.0	82.3 ± 16.3*	94.6 ± 11.8
D_{L-CO}, %pred	98.3 ± 9.5	83.5 ± 11.0*	79.1 ± 15.1*
D_L/VA, %pred	101.9 ± 9.3	114.7 ± 18.7	109.5 ± 12.5

TABLE 3. VOLITIONAL ASSESSMENT OF INSPIRATORY MUSCLE STRENGTH AND NONVOLITIONAL ASSESSMENT OF DIAPHRAGM FUNCTION IN EIGHT PATIENTS WITH UNILATERAL DIAPHRAGM PARALYSIS AND EIGHT PATIENTS WITH BILATERAL DIAPHRAGM PARALYSIS

Patient No.	ΔPgas/ΔPes	Pdi_{max} ($cm\ H_2O$)	Pes_{max} ($cm\ H_2O$)	Left TwPdi ($cm\ H_2O$)	Right TwPdi ($cm\ H_2O$)	BAMPS ($cm\ H_2O$)
1	0.99	104.8	137.2	0.0	8.5	9.3
2	−0.56	106.5	126.7	2.3	9.0	8.5
3	0.60	90.9	104.9	0.0	7.5	8.0
4	0.29	102.3	106.5	10.0	0.0	12.0
5	0.50	74.7	90.5	5.8	0.0	6.2
6	−0.68	56.7	53.3	10.5	2.0	11.5
7	−1.45	57.6	74.6	12.6	1.3	13.2
8	0.62	102.0	109.2	12.2	0.0	13.6
Average	−0.12	86.9	100.4	6.7	3.5	10.3
SD	0.83	21.1	27.2	5.4	4.1	2.7
9	1.07	12.5	54.6	1.6	1.6	3.7
10	0.78	25.2	108.8	3.2	3.3	6.1
11	1.50	0.0	27.4	0.0	0.0	0.0
12	1.01	10.7	38.3	0.0	0.0	0.0
13	1.00	0.0	23.8	0.0	0.0	0.0
14	1.04	21.3	53.8	0.0	0.0	0.0
15	1.80	0.0	88.8	0.0	0.0	0.0
16	0.90	0.0	37.7	0.0	0.0	0.0
Average	1.14	8.7	54.2	0.6	0.6	1.2
SD	0.34	10.4	30.1	1.2	1.2	2.4

Definition of abbreviations: BAMPS = TwPdi after bilateral anterior magnetic phrenic nerve stimulation; Left/Right TwPdi = twitch transdiaphragmatic pressure after magnetic stimulation of the left/right phrenic nerve; Pdi_{max} = maximum transdiaphragmatic pressure during maximum inspiratory effort; Pes_{max} = maximum negative esophageal pressure generated during maximum inspiratory effort; ΔPgas/ΔPes = change in gastric pressure normalized for the change in esophageal pressure during resting breathing.

Paralysie diaphragme & exercice

TABLE 4. EXERCISE DATA FROM EIGHT CONTROL SUBJECTS, EIGHT PATIENTS WITH UNILATERAL DIAPHRAGM PARALYSIS, AND EIGHT PATIENTS WITH BILATERAL DIAPHRAGM PARALYSIS

	Control Subjects	UDP	BDP
Age, years	50.4 ± 9.8	54.1 ± 7.9	51.8 ± 8.8
Ex TLim, seconds	670.9 ± 122.6	511.8 ± 190.4	455.8 ± 181.4*
HR max, beats · minute^{-1}	175.4 ± 10.8	150.0 ± 18.6*	145.0 ± 25.1*
$\dot{V}_E$ peak, L · minute^{-1}	114.1 ± 26.8	83.5 ± 17.5*	68.7 ± 23.6*
Sa_{O_2} peak, %	96.8 ± 2.3	95.4 ± 2.3	94.8 ± 3.2
$\dot{V}_{O_2}$ peak, L · minute^{-1}	2.69 ± 0.63	2.66 ± 0.55	2.35 ± 0.59
$\dot{V}_{O_2}$ peak/$\dot{V}_E$ peak	0.024 ± 0.002	0.032 ± 0.005*	0.035 ± 0.005*

Paralysie diaphragme & endurance

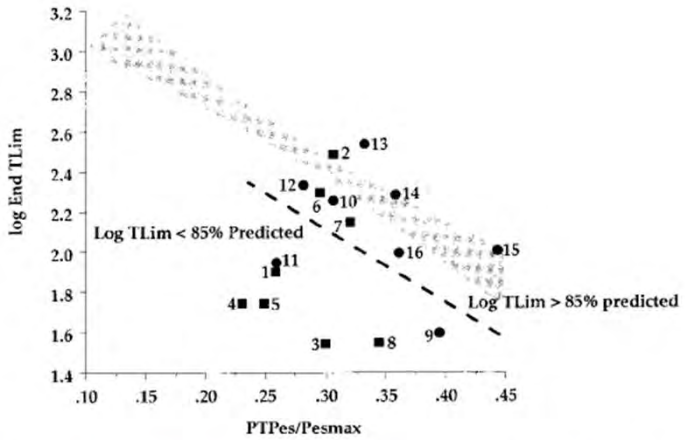


Figure 1. Log endurance time (log End TLim) versus the load/capacity ratio (PTPes per total breath cycle/Pes_{max}) in patients with unilateral diaphragm paralysis (*squares*) and bilateral diaphragm paralysis (*circles*). The shaded area shows the log End TLim plotted against PTPes per total breath cycle/Pes_{max} in healthy subjects (9); a log End TLim less than 85% predicted for the PTPes/Pes_{max} when compared with the normal values indicates a reduced RME.

TABLE 6. EXERCISE DATA FOR NINE PATIENTS WITH PRESERVED RESPIRATORY MUSCLE ENDURANCE, SEVEN PATIENTS WITH REDUCED RESPIRATORY MUSCLE ENDURANCE, AND EIGHT CONTROL SUBJECTS

	Control Subjects	Preserved RME	Reduced RME
Age, years	50.4 ± 9.8	52.3 ± 10.6	53.7 ± 17.8
Ex TLim, seconds	670.9 ± 122.6	501.6 ± 202.7	460.9 ± 164.0*
HR max, beats · minute^{-1}	175.4 ± 10.8	148.6 ± 2.4*	146.1 ± 18.8*
$\dot{V}_E$ peak, L · minute^{-1}	114.1 ± 26.8	80.9 ± 22.0*	70.0 ± 20.7*
Sa_{O_2} peak, %	96.8 ± 2.3	94.7 ± 2.6	95.6 ± 3.0
$\dot{V}_{O_2}$ peak, L · minute^{-1}	2.69 ± 0.63	2.58 ± 0.39	2.41 ± 0.78
$\dot{V}_{O_2}$ peak/$\dot{V}_E$ peak	0.024 ± 0.002	0.033 ± 0.005*	0.034 ± 0.005*

Dysfonction diaphragmatique & exercice

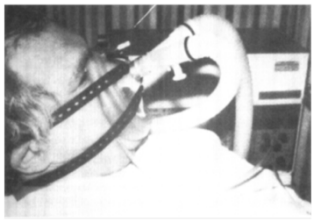
- **Condition physique globale** peu affectée.
- Baisse de la ventilation au maximum de l'effort
  - Conséquences sur l'élimination du CO2 ?
  - **Sensations respiratoires** très modifiées ?
- Compensation par les autres muscles
  - ½ diaphragme restant
  - Obliques
  - Intercostaux et muscles du cou.

En pratique

- Documenter la réalité de la paralysie.
- Apprécier sa **sévérité** :
  - Baisse de la CV et chute de la CV en position horizontale
  - Sommeil
  - Hypoventilation alvéolaire diurne.
- **Surveillance**
  - CV assis couchée Pmax SNIP Gaz tous les 3 mois
  - **Prolongée** : Récupération tardive possible : 18 à 24 mois.
- Pdi : reconnaissance médico-légale, doute diagnostique.

En pratique

- Eviter prise de poids
- VNI dans les formes sévères



- Réhabilitation (?).
- Ré-entraînement sélectif muscles respiratoires (?).

- Plicature : toujours différée.

Tableau 2 Résultats fonctionnels à court et long terme des séries de la littérature rapportant des patients traités par plicature diaphragmatique pour une éventration.

Auteurs	Résultats immédiats	Résultats tardifs		
	Amélioration des symptômes	Nombre de patients	Délai	Amélioration dyspnée (%)
McNamara et al. [1]	92 %	/	/	/
Wright et al. [24]	100 %	7	4 à 56 mois	100
Graham et al. [10]	100 %	6	5 à 7 ans	100
Ribet et Linder [4]	100 %	11	3 mois à 18 ans	100
Simanski et al. [25]	100 % ↘ dyspnée 25 % sevrage	7	11 à 114 mois	100
Higgs et al. [26]	95 %	15	7 à 14 ans (moyenne 7)	87
Mouroux et al. [27]	100 % 100 % sevrage	6	> 5 ans	100
Freeman et al. [28]	100 %	/	/	/
Versteegh et al. [11]	100 %	17	4,9 ans (1,2—8,7)	100