SKR
Société de Kinésithérapie de Réanimation

STIMULATION ELECTRIQUE NEUROMUSCULAIRE EN RÉANIMATION

Pourquoi, Pour qui et Quand ?

Aldjia ABDELLAOUI, PT, PhD

aldjia.abdellaoui@inserm.fr

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CHU MONTPELLIER

PHYSIOLOGY & EXPERIMENTAL MEDICINE HEART MUSCLES MONTPELLIER

STIMULATION ELECTRIQUE NEUROMUSCULAIRE

Renforcement Musculaire

Contraction musculaire **volontaire** au cours d'un exercice avec charge ou résistance

SENM

Contraction musculaire **induite** par une SENM

STIMULATION ELECTRIQUE NEUROMUSCULAIRE

Définition et principes …

Neuromuscular electrical stimulation (NMES) involves the application of a series of intermittent stimuli to superficial skeletal muscles, with the main objective to trigger visible muscle contractions due to the activation of the intramuscular nerve branches (Hultman et al. 1983). Electrical stimuli are generally delivered using one or more active electrodes positioned in proximity to the muscle motor points (Fig. 1), and pre-programmed stimulation units. An intact motor nerve is a prerequisite for eliciting muscle contractions with NMES.

Maffiuletti et coll. 2010

POURQUOI EN USI?

- Polyneuromyopathie (dysfonction musculaire)

Plyneuromyopathie

Dysfonction musculaire

- Prolonge la durée de la VM
- Aggrave la maladie primaire
- Prolonge la durée du séjour

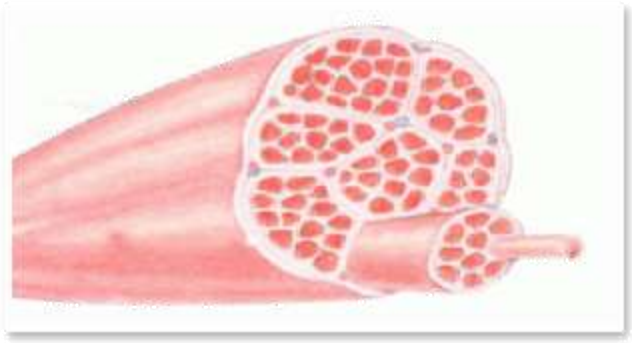
↘ PRONOSTIC VITAL…!

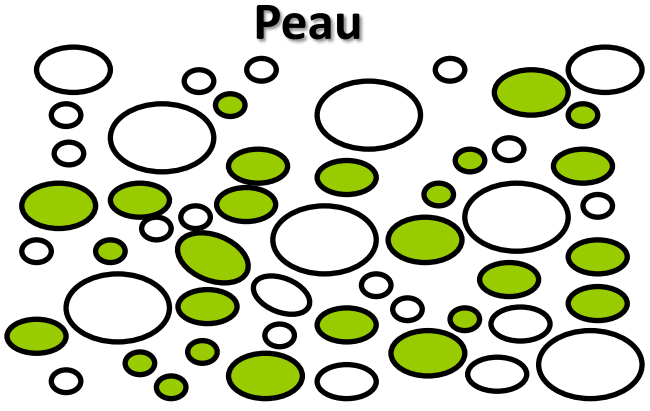
Dejonghe Bet coll. JAMA 2001
Sergers J et coll. JCC 2014

POURQUOI EN USI?

- Polyneuromyopathie (dysfonction musculaire)
- Sans sollicitation cardio-respiratoire (sans dyspnée)
- Méthode non invasive /simple
- Recrutement d'unités rapides à des bas niveaux de force

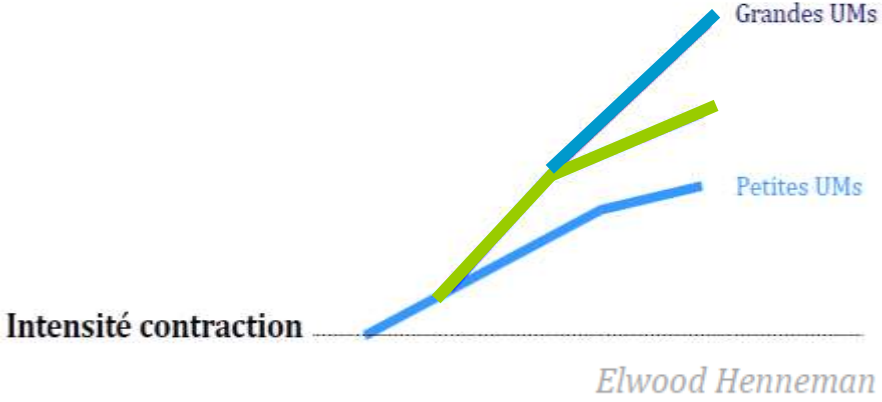
POURQUOI EN USI?

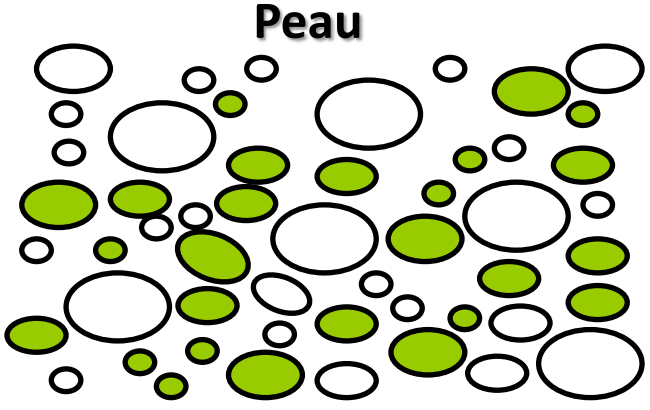




- Dispersé (quasi complet)
- Recrutement (ordonné sélectif)

POURQUOI EN USI?

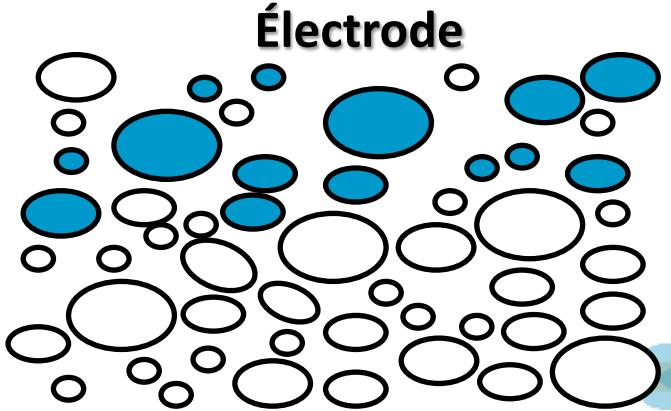




- Dispersé (quasi complet)
- Recrutement (ordonné sélectif)

POURQUOI EN USI?

- Fixe et superficiel (incomplet)
- Recrutement (désordonné non sélectif)



Maffiuletti et coll. 2010

POUR QUI?

- Sportif
- Sarcopénie de la personne âgée
- Maladies chroniques (BPCO, IC,…)
- Unité de Soins Intensifs
- Pédiatrie
- …

Stimulation Electrique NeuroMusculaire

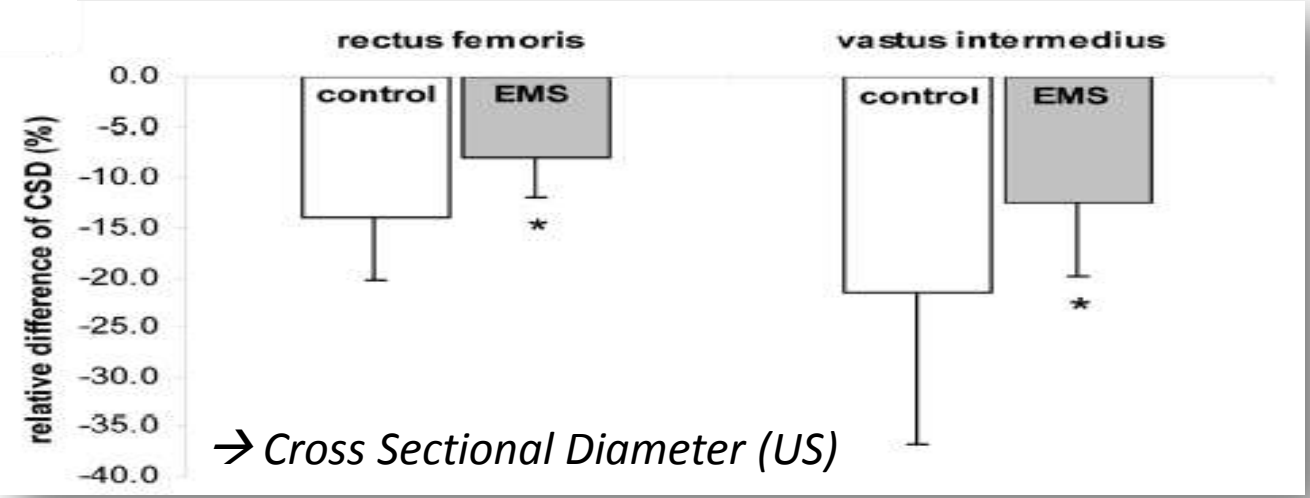
De nombreuses études …

- Autonomie
- Masse musculaire
- Force musculaire
- Tolérance à l'effort

Electrical muscle stimulation preserves the muscle mass of critically ill patients: a randomized study

2009

Vasiliki Gerovasili[1], Konstantinos Stefanidis[1], Konstantinos Vitzilaios[1], Eleftherios Karatzanos[1],



→ *Cross Sectional Diameter (US)*

Maintien de la masse musculaire

- ✓ Tous les jours pendant 7 à 8jours
- ✓ 55min par MI (45 Hz,400µs, 12s/6s)
- ✓ Quadriceps et long fibulaire

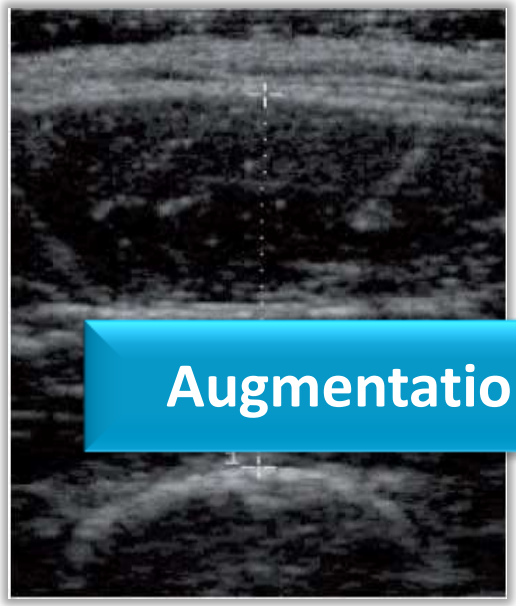
n= 13/13

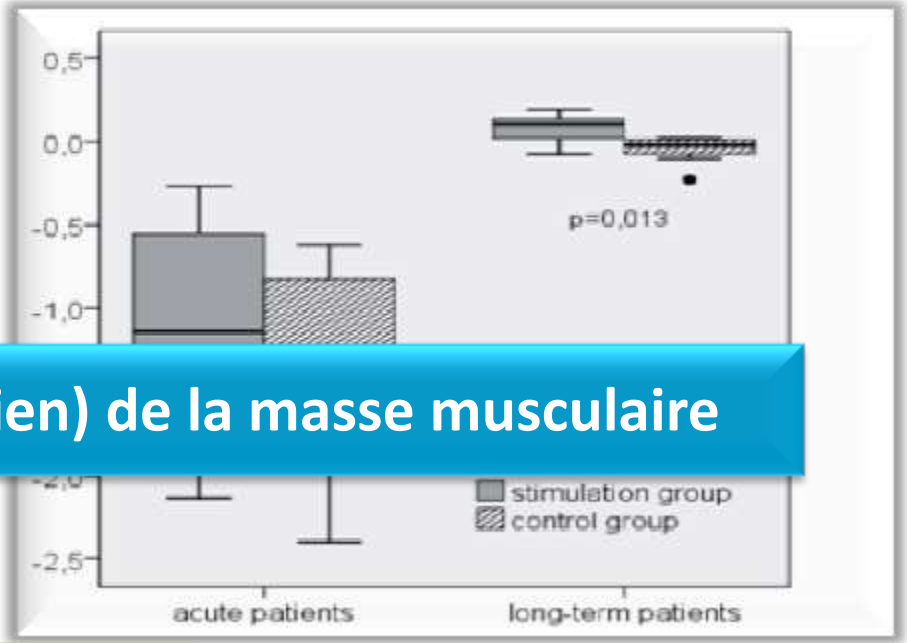
EFFECTS OF NEUROMUSCULAR ELECTRICAL STIMULATION ON MUSCLE LAYER THICKNESS OF KNEE EXTENSOR MUSCLES IN INTENSIVE CARE UNIT PATIENTS: A PILOT STUDY

J Rehabil Med 2010; 42: 593–597

Wolfgang Gruther, MSc, MD[1], Franz Kainberger, MD, PhD[3],Veronika Fialka-Moser, MD, PhD[1], and al.

→ *Epaisseur de la couche musculaire (US)*





Augmentation (maintien) de la masse musculaire

- ✓ Tous les jours pendant G1<7 jours & G2> 14 jours
- ✓ 30-60min par MI (50 Hz,350µs, 8s/24s)
- ✓ Quadriceps

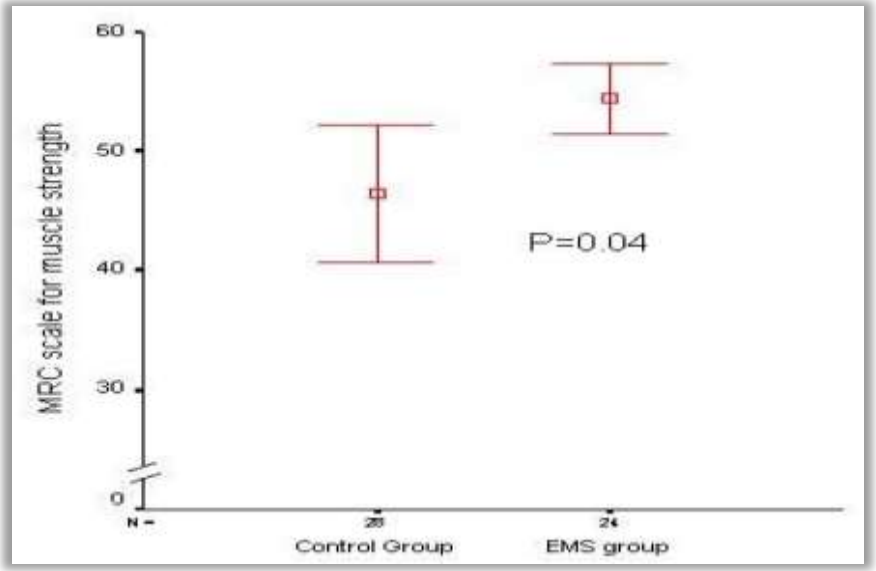
n= 8/grp

Electrical muscle stimulation prevents critical illness polyneuromyopathy: a randomized parallel intervention trial

Critical Care 2010, **14**:R74

Christina Routsi, Vasiliki Gerovasili, Ioannis Vasileiadis, Eleftherios Karatzanos, Theodore Pitsolis, Elli Tripodaki,

	EMS group (n) (%)	Control group (n)(%)
CIPNM	3 (12.5)	11 (39.3)
No CIPNM	21 (87.5)	17 (60.7)



↘ de l'incidence de la polyneuromyopathie

↗ de la force (MRC)

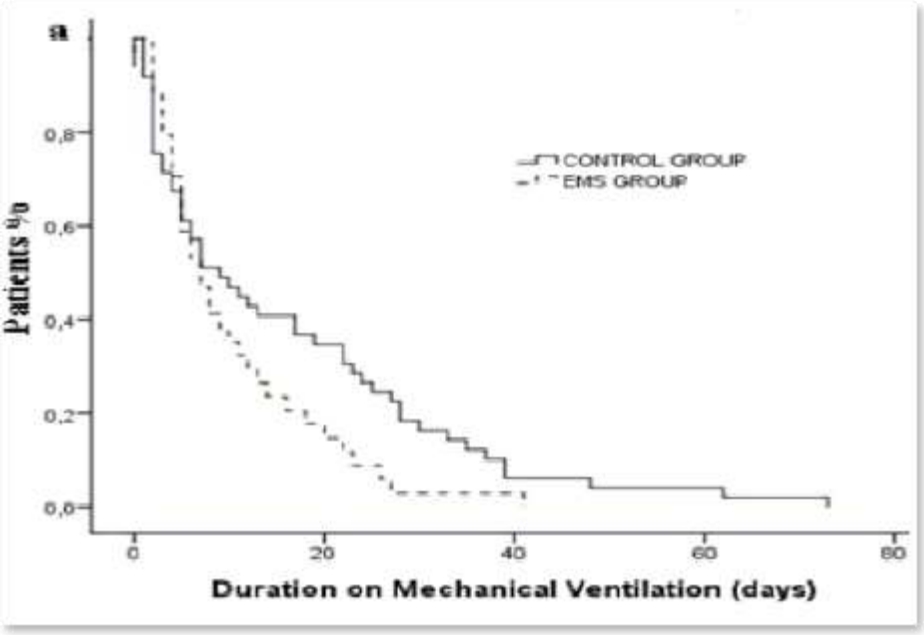
- ✓ Tous les jours
- ✓ 55 min par MI (45Hz,400µs, 12s/6s)
- ✓ Quadriceps et long fibulaire

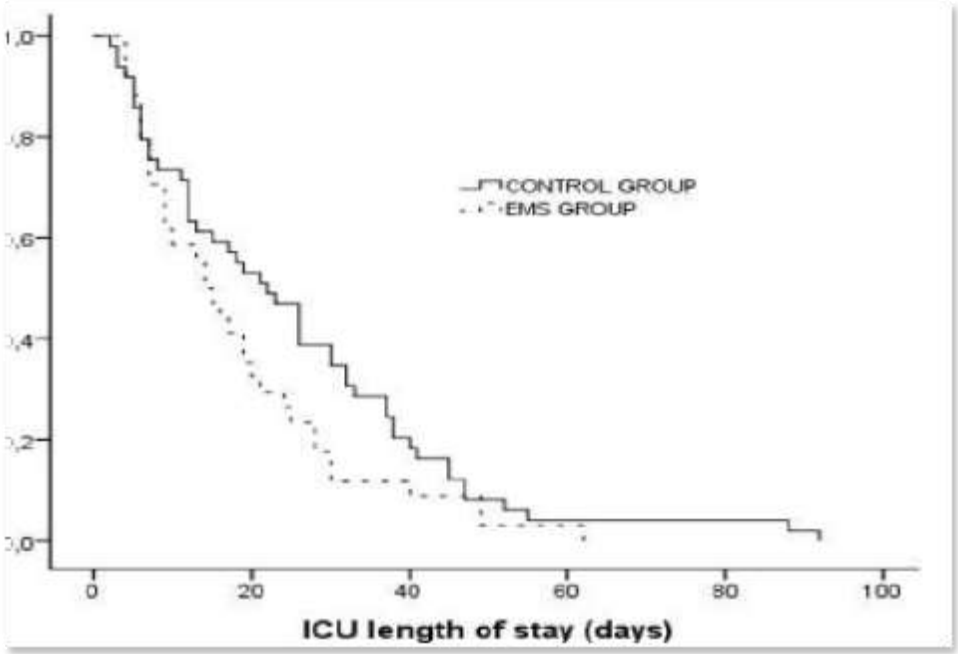
n= 24/28

Electrical muscle stimulation prevents critical illness polyneuromyopathy: a randomized parallel intervention trial

Critical Care 2010, **14**:R74

Christina Routsi, Vasiliki Gerovasili, Ioannis Vasileiadis, Eleftherios Karatzanos, Theodore Pitsolis, Elli Tripodaki,





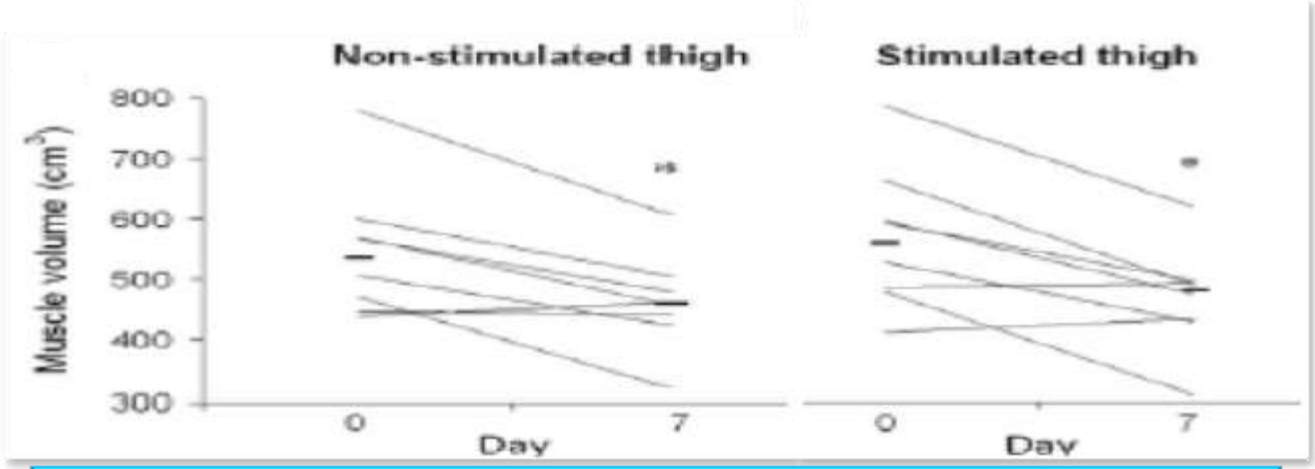
↘ durée de ventilation mécanique

↘ durée du séjour en USI

Effect of transcutaneous electrical muscle stimulation on muscle volume in patients with

Jesper B. Poulsen, MD; Kirsten Møller, MD, PhD; Claus V. Jensen, MD; Sigge Weisdorf, MD; Henrik Kehlet, MD, PhD; Anders Perner, MD, PhD

→ *Scans*



Aucun effet sur la masse musculaire

musculaire de 10% musculaire de 20%

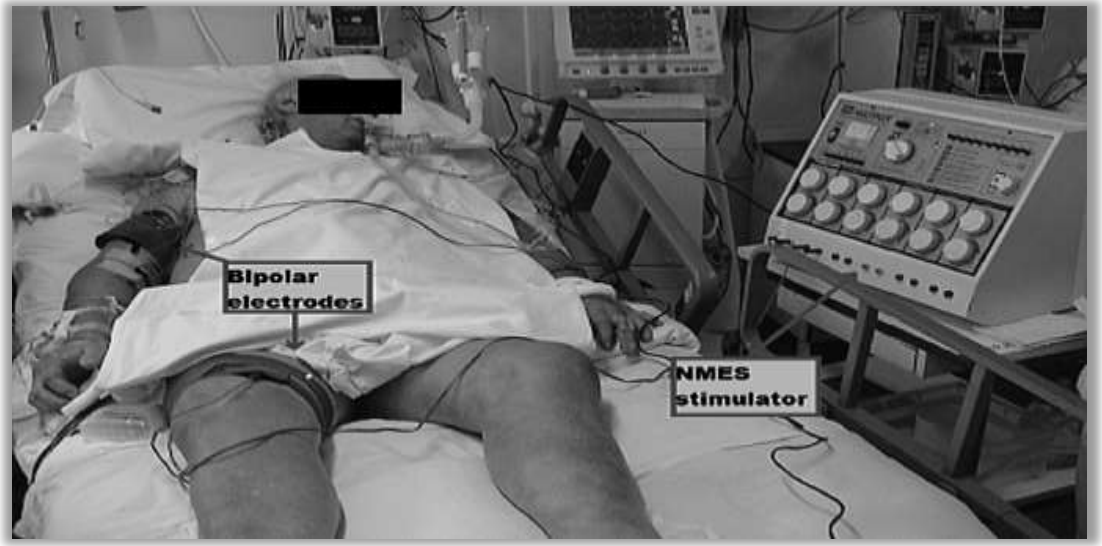
- ✓ Tous les jours pendant 7 jours (5fois)
- ✓ 60min par MI (35Hz,300µs, 4s/6s)
- ✓ Quadriceps (RCT MI)

n= 8

Muscle weakness in [redacted] requiring mechanical ventilation: Protective effect of transcutaneous neuromuscular electrical stimulation ☆

Journal of Critical Care (2012)

Pablo O. Rodriguez MD [a,b,c,*], Mariano Setten PT [a,d], Luis P. Maskin MD [a], and al.



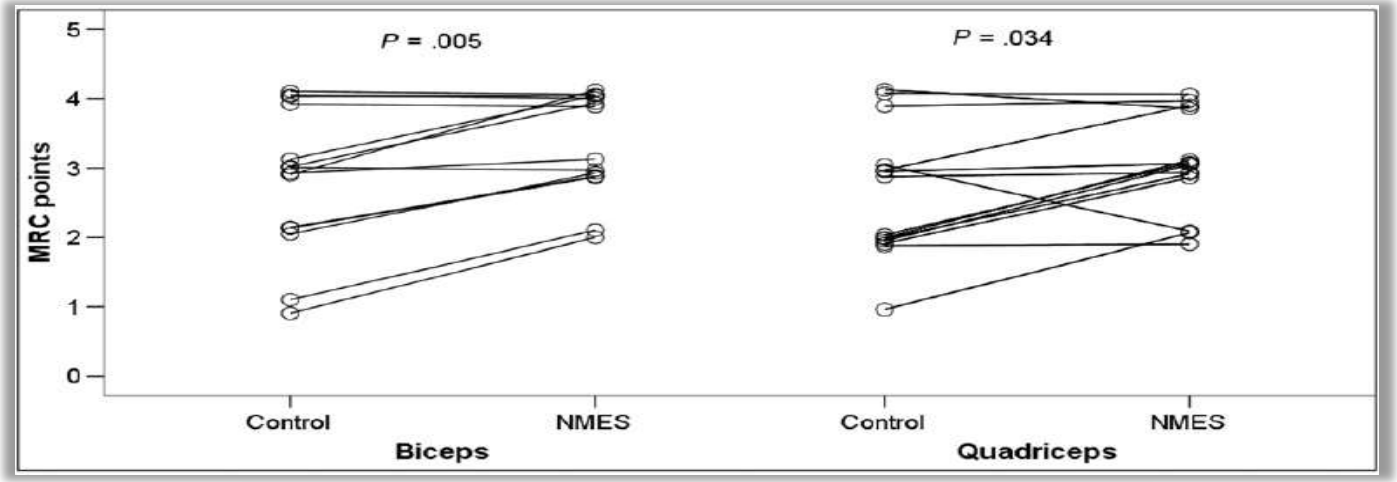
- ✓ 2 fois /jours pendant 13 jours
- ✓ 2x30min par MI (100Hz,300µs, 2s/4s)
- ✓ Quadriceps + biceps (RCT)

n= 14

Muscle weakness in [redacted] requiring mechanical ventilation: Protective effect of transcutaneous neuromuscular electrical stimulation ☆

Journal of Critical Care (2012)

Pablo O. Rodriguez MD [a,b,c,*], Mariano Setten PT [a,d], Luis P. Maskin MD [a], and al.



↗ de la force musculaire (biceps et quadriceps stimulés)

- ✓ 2 fois /jours pendant 13 jours
- ✓ 2x30min par MI (100Hz,300µs, 2s/4s)
- ✓ Quadriceps + biceps (RCT)

n= 14

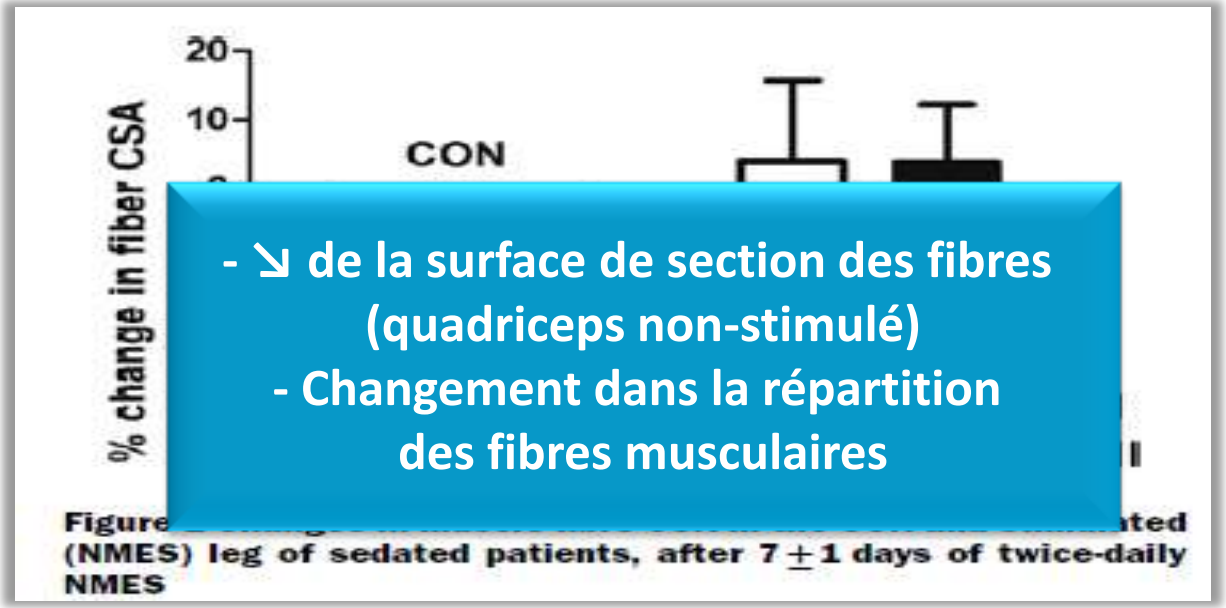
QUAND L'UTILISÉ?

- 24 à 48 heures après l'admission

Neuromuscular electrical stimulation prevents muscle wasting in critically ill comatose patients

Marlou L. Dirks*, Dominique Hansen†, Aimé Van Assche†, Paul Dendale† and Luc J. C. Van Loon*

Clinical Science (2015)



- ↘ de la surface de section des fibres (quadriceps non-stimulé)
- Changement dans la répartition des fibres musculaires

Figure … (NMES) leg of sedated patients, after 7 ± 1 days of twice-daily NMES

- ✓ 2 fois /jours pendant 7±1 jours
- ✓ 30min (100Hz,400µs, 5s/10s)
- ✓ Quadriceps (RCT)

Sédation pendant 3 jours minimum, n = 6

TAKE HOME MESSAGE

STIMULATION ELECTRIQUE NEUROMUSCULAIRE

- Ne nécessite pas la coopération du patient
- Plus efficace que l'exercice volontaire quand celui-ci est difficilement réalisable
- Recrutement d'unités rapides
- Améliore la fonction musculaire
- Préserve la masse musculaire
- Permet une reconquête plus rapide de l'autonomie

Outil de prévention et de rééducation


MERCI DE VOTRE
ATTENTION

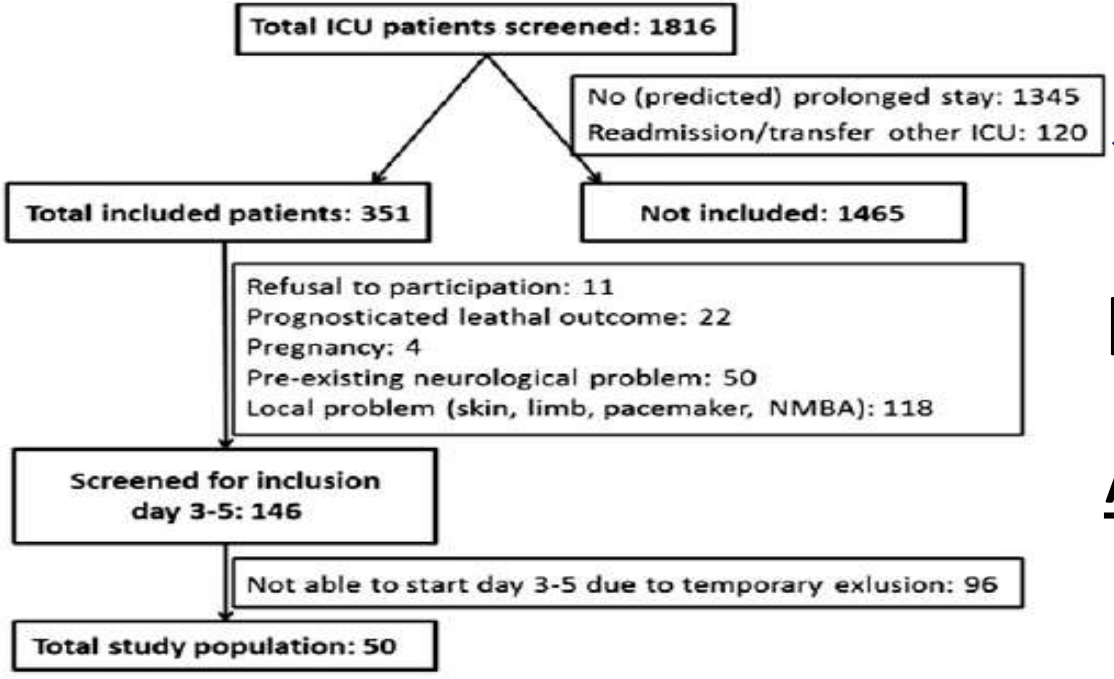
Contents lists available at ScienceDirect

Journal of Critical Care

Journal of Critical Care 29 (2014) 1082–1088

Feasibility of neuromuscular electrical stimulation in critically ill patients☆,☆☆

Johan Segers, PT, MSc [a], Greet Hermans, MD, PhD [b], Frans Bruyninckx, MD, PhD [c], Geert Meyfroidt, MD, PhD [d], Daniel Langer, PT, PhD [a], Rik Gosselink, PT, PhD [a,*]



- 50% seulement de patients répondeurs À SENM!

Main diagnosis	Responders (n = 25)	Nonresponders (n = 25)	P
Sex, male, n (%)	15 (30)	11 (22)	.258
Age, y (mean ± SD)	58 ± 13	62 ± 10	.166
Height, meter (mean ± SD)	1.70 ± 0.09	1.69 ± 0.11	.711
Weight, kg (mean ± SD)	73 ± 16	74 ± 16	.899
BMI, kg/m^2 (mean ± SD)	25.1 ± 4.3	25.9 ± 5.5	.584

L'état pro-inflammatoire de la septicémie

→Catabolisme ++

→Activation du protéasome (contenu musculaire)

→Dysfonction mitochondriale (énergie musculaire)

→Augmentation des cytokines (excitabilité musculaire)

SAS (1-7)	2 ± 1	3 ± 1	.266
Intensity, mA	65 ± 8	69 ± 13	.236
No. of sessions/patient	5 ± 4	8 ± 7	.152
Medical ICU, n (%)	6 (12)	13 (26)	.041
Edema, yes, n (%)	10 (20)	23 (46)	<.001
Corticosteroids, yes, n (%)	12 (24)	18 (36)	.114
Vasopressors, yes, n (%)	16 (32)	24 (48)	.011
Inotropes, yes, n (%)	6 (12)	8 (16)	.588
Aminoglycosides, yes, n (%)	9 (18)	6 (12)	.355
NMBA, yes, n (%)	11 (22)	12 (24)	.879

Main diagnosis	Responders (n = 25)	Nonresponders (n = 25)	P
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Height, meter (mean ± SD)	1.70 ± 0.09	1.69 ± 0.11	.711
Weight, kg (mean ± SD)	73 ± 16	74 ± 16	.899
BMI, kg/m^2 (mean ± SD)	25.1 ± 4.3	25.9 ± 5.5	.584
Admission category:			.093
– Abdominal/pelvic surgery (n)	4 (16%)	3 (12%)	
– Cardiac surgery (n)	2 (8%)	4 (16%)	
– Gastrointestinal/hepatic disorder (n)	8 (32%)	2 (8%)	
APACHE II score (0-70)	25 ± 8	27 ± 6	.578
GCS (0-15)	7 ± 3	9 ± 3	.216
S5Q (0-5)	2 ± 1	3 ± 2	.162
SAS (1-7)	2 ± 1	3 ± 1	.266
Intensity, mA	65 ± 8	69 ± 13	.236
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L'œdème :

→Augmentation de la distance entre l'électrode/muscle ++

Electrical muscle stimulation preserves the muscle mass of critically ill patients: a randomized study

Vasiliki Gerovasili[1], Konstantinos Stefanidis[1], Konstantinos Vitzilaios[1], Eleftherios Karatzanos[1],

Baseline characteristics of critically ill patients randomly assigned to the EMS group or the control group (mean ± SD)

	EMS group	Control group	P
Age (years)	59 ± 23	56 ± 19	NS
Gender (male/female)	6/7	8/5	
APACHE II admission	19 ± 3	18 ± 6	NS
SOFA admission	10 ± 3	8 ± 3	NS
SAPS 3 admission	66 ± 9	61 ± 14	NS
Mechanical ventilation (days, n)	9 ± 2 (4-10), 13	9 ± 3 (6-10), 12	
Reasons of ICU admission (n)			
Sepsis	5	5	
Trauma	4	3	
Neurologic (including cerebrovascular)	2	4	
Other	2	1	
Sedation (days, n)	5 ± 4, 9	6 ± 4, 11	
Vasopressors (days, n)	5 ± 4, 10	5 ± 4, 10	
Hyperglycemia (days, n)	4 ± 3, 11	4 ± 3,10	
Glucocorticoids (n)	4	4	
Neuromuscular blockers (n)	2	2	
Aminoglycosides (n)	6	7	
Sepsis developed (n)	9	10	

Hyperglycemia was defined as blood glucose level >140 mg/dl

EFFECTS OF NEUROMUSCULAR ELECTRICAL STIMULATION ON MUSCLE LAYER THICKNESS OF KNEE EXTENSOR MUSCLES IN INTENSIVE CARE UNIT PATIENTS: A PILOT STUDY

J Rehabil Med 2010; 42: 593–597

Wolfgang Gruther, MSc, MD[1], Franz Kainberger, MD, PhD[3], Veronika Fialka-Moser, MD, PhD[1], and al.

	Acute patient group		Long-term patient group	
	SG	CG	SG	CG
Sex male/female, *n*	7/1	8/1	7/1	4/4
Age, years, mean (SD)	52 (10)	48 (12)	61 (10)	64 (8)
Height, m, mean (SD)	1.77 (0.08)	1.8 (0.06)	1.78 (0.08)	1.67 (0.1)
Weight, kg, mean (SD)	80 (15)	88 (19)	91 (17)	79 (19)
Body surface, m^2, mean (SD)	2 (0.2)	2.1 (0.3)	2.2 (0.3)	1.9 (0.3)
Days before stimulation, mean (SD)	3 (2)	4 (2)	33 (15)	27 (15)
MLT at baseline, mean (SD) [range]	28.9 (6.6) [20.6]	32.9 (9.7) [23.1]	18.4 (4.2) [13.6]	18.6 (5.9) [15.7]
MLT after 4 weeks, mean (SD) [range]	18.3* (3.2) [9.7]	20.1† (5.4) [16.4]	19.3‡ § (3.8) [12.4]	18 (5.8) [16.1]
Individual differences (baseline – after 4 weeks), mean	–10.6	–12.8	0.09	–0.04
% changes from baseline	–36.7	–38.9	4.9	–3.2
Main diagnosis, *n*				
Polytrauma	3	4	2	1
Cardiovascular disease	2	2	1	1
Transplantation	2	1	2	2
Pneumonia	0	1	1	2
Cancer	1	1	2	2

Electrical muscle stimulation prevents critical illness polyneuromyopathy: a randomized parallel intervention trial

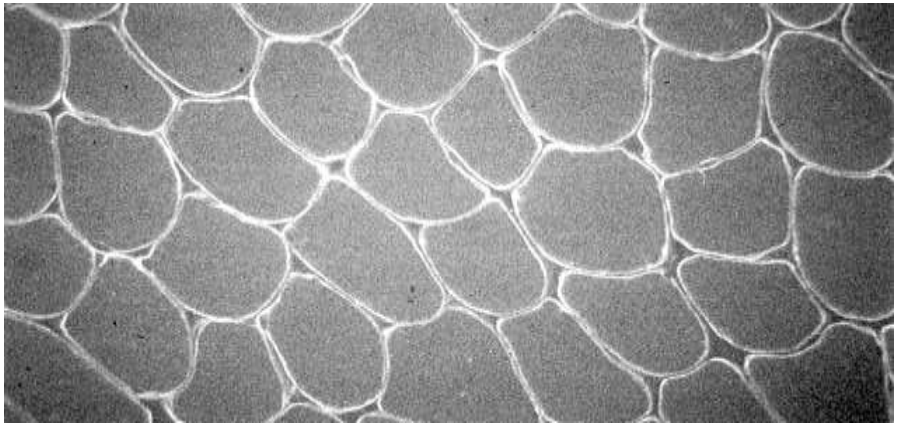
Critical Care 2010, **14**:R74

Christina Routsi, Vasiliki Gerovasili, Ioannis Vasileiadis, Eleftherios Karatzanos, Theodore Pitsolis, Elli Tripodaki,

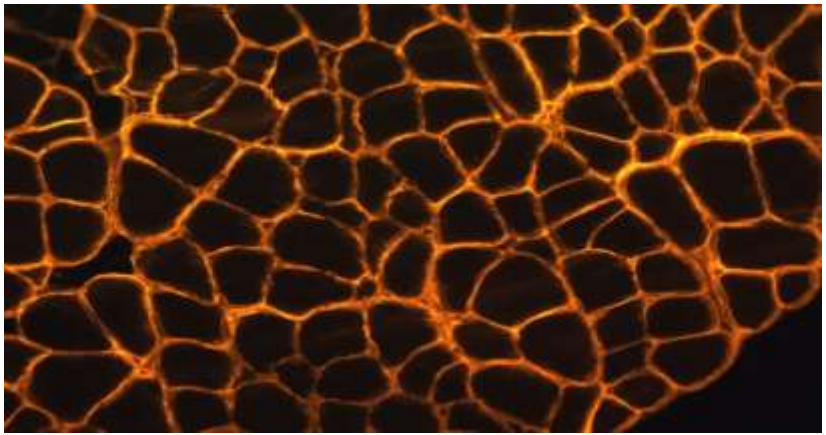
	EMS group (n = 68)	Control group (n = 72)
Age, years	61 ± 19	58 ± 18
Gender M/F	46/22	49/23
Severity of illness at ICU admission		
APACHE II score	18 ± 4	18 ± 5
SOFA score	9 ± 3	9 ± 3
SAPS III score	61 ± 13	60 ± 14
Diagnostic category at admission		
Sepsis/septic shock, n(%)	11 (16.2)	14 (19.4)
Trauma, n(%)	12 (17.6)	14 (19.4)
Post-surgical, n(%)	13 (19.1)	12 (16.7)
Brain injury, n(%)	24 (25.3)	23 (31.9)
Respiratory failure, n(%)	2 (2.9)	4 (5.6)
Other, n(%)	6 (8.8)	5 (6.9)
Duration of sedation, days	12 ± 10	12 ± 11
Sepsis/septic shock, n(%)	54 (77)	58 (80)
Aminoglycoside use, days	5 ± 8	8 ± 11
Corticosteroids use, days	6 ± 9	5 ± 8
Neuromuscular blocking agents use, days	1 ± 2	3 ± 5

ATROPHIE MUSCULAIRE (QUADRICEPS)

- ✓ Diminution de la surface transversale des fibres
- ✓ Irrégularité des tailles de fibres



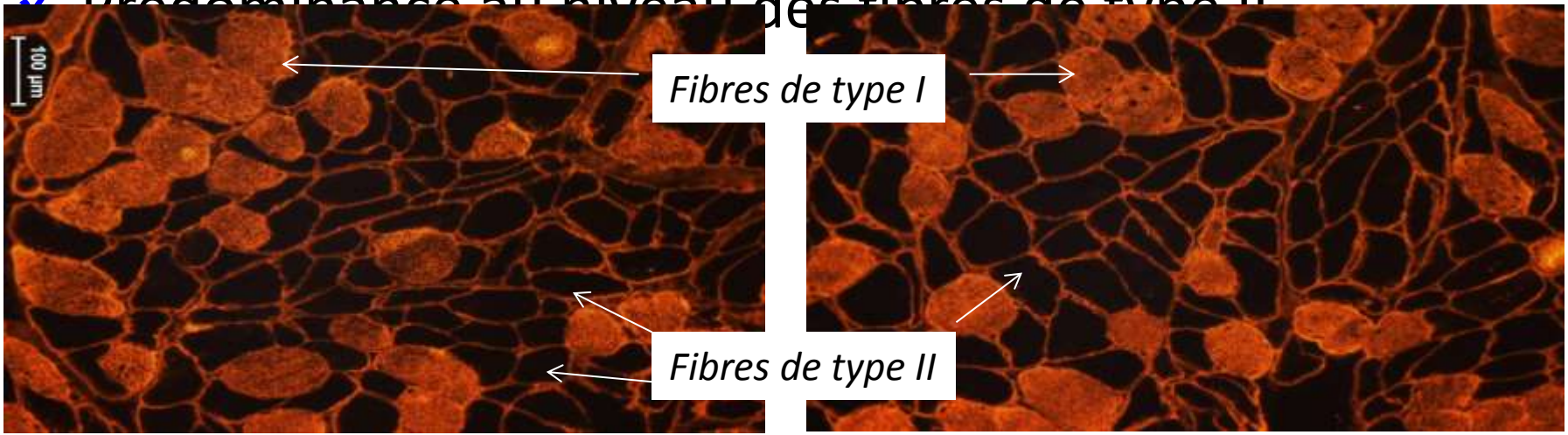
Sujet sain
De Jonghe et coll 2002



Patient BPCO en USI
Abdellaoui et coll, données non publiées

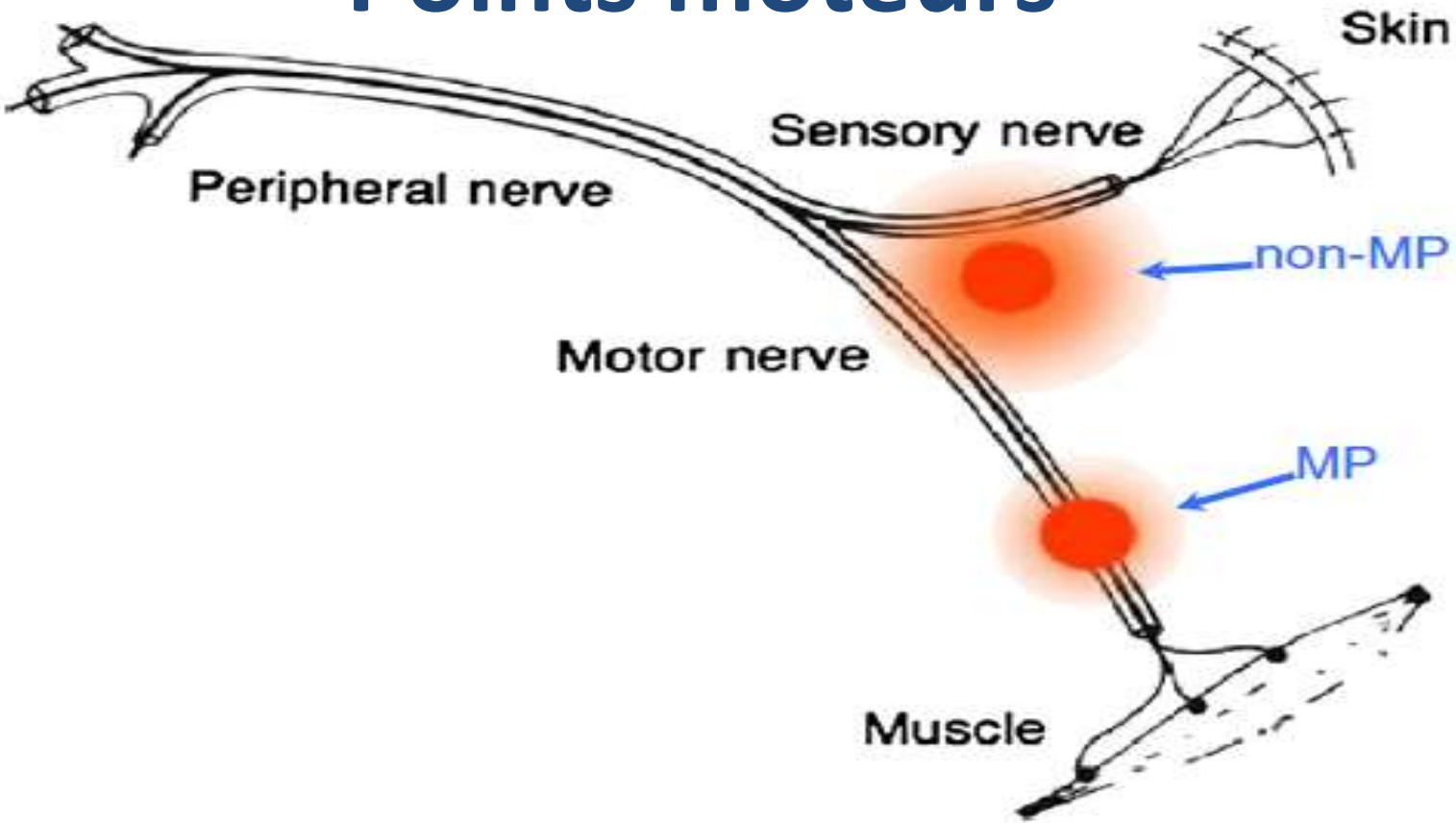
ATROPHIE MUSCULAIRE (QUADRICEPS)

- ✓ Diminution de la surface transversale des fibres
- ✓ Irrégularité des tailles de fibres
- ✓ Prédominance au niveau des fibres de type II



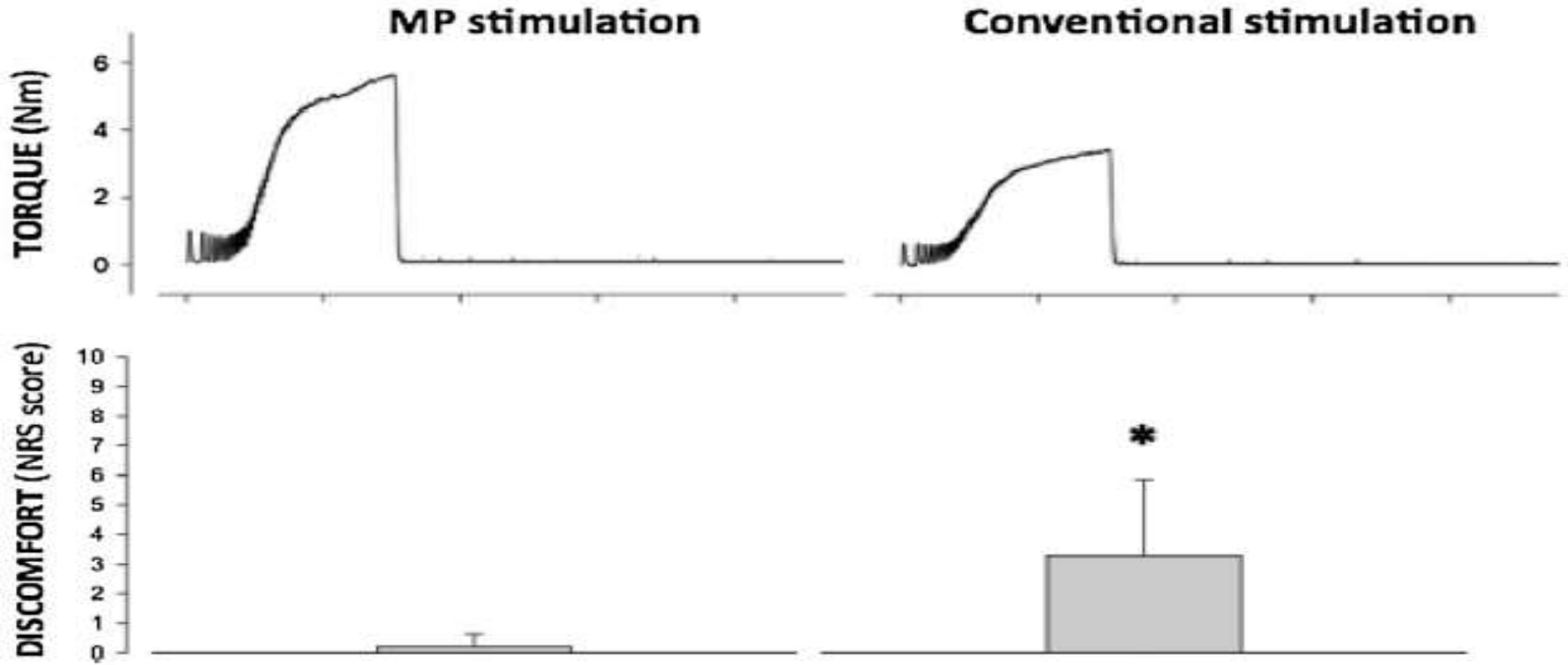
Abdellaoui et coll, données non publiées

Points moteurs



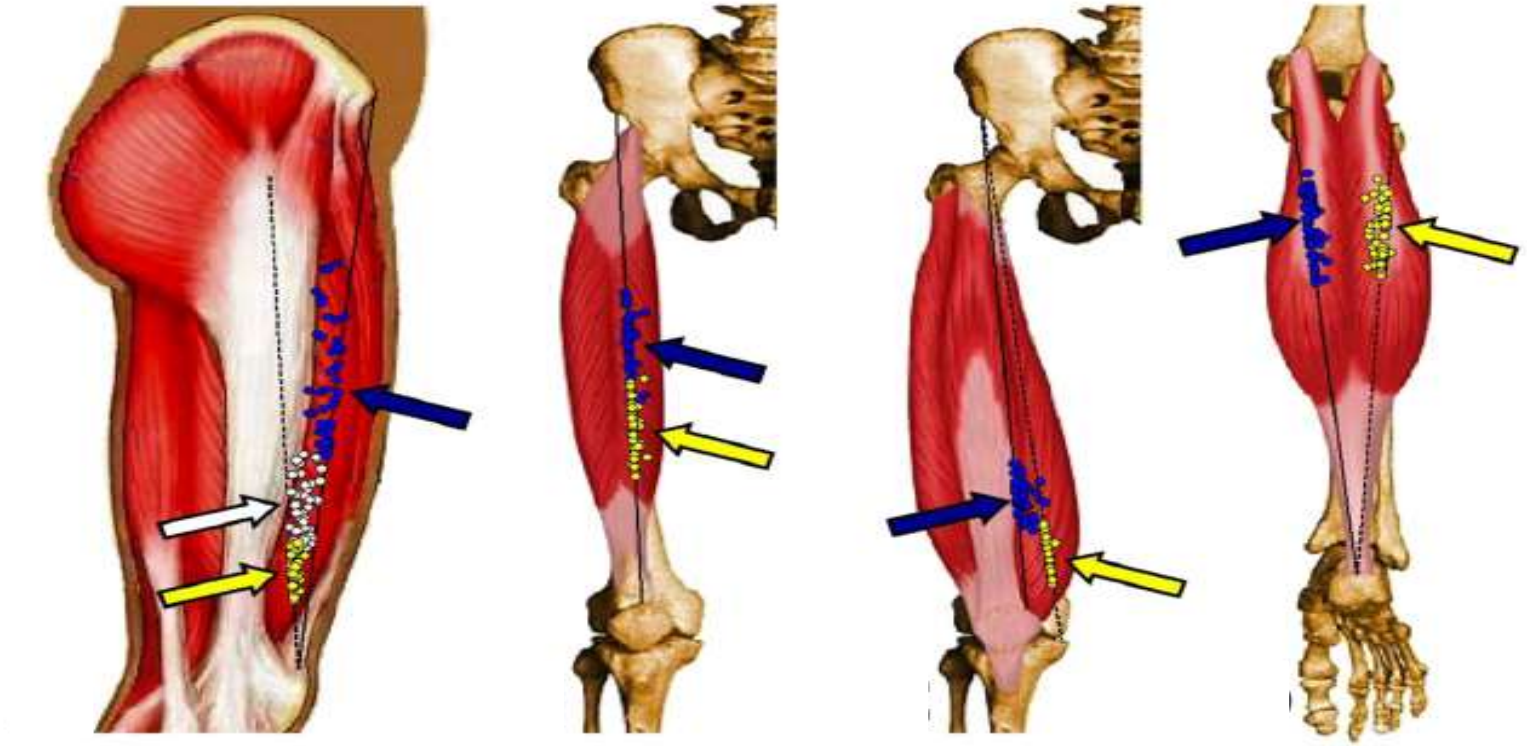
Gobbo et coll 2014

Points moteurs



Gobbo et coll 2011

Points moteurs



✓ Chez 53 sujets sains