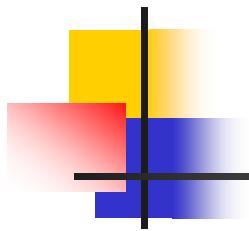


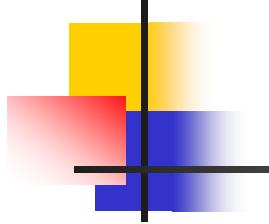
Monitorage de la fonction neuromusculaire

François Donati
18 février 2009



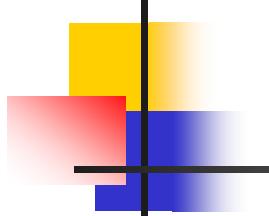
Références

- Barash, 5e édition 2005; 421-452
- Anesthesia & Analgesia, 2000; 90: S2-S6



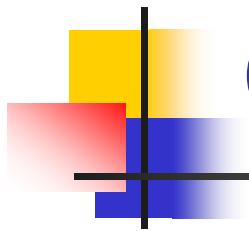
Plan

- Pourquoi?
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- Caractéristiques du bloc dépolarisant
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- Réponse des différents muscles
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- Problèmes cliniques

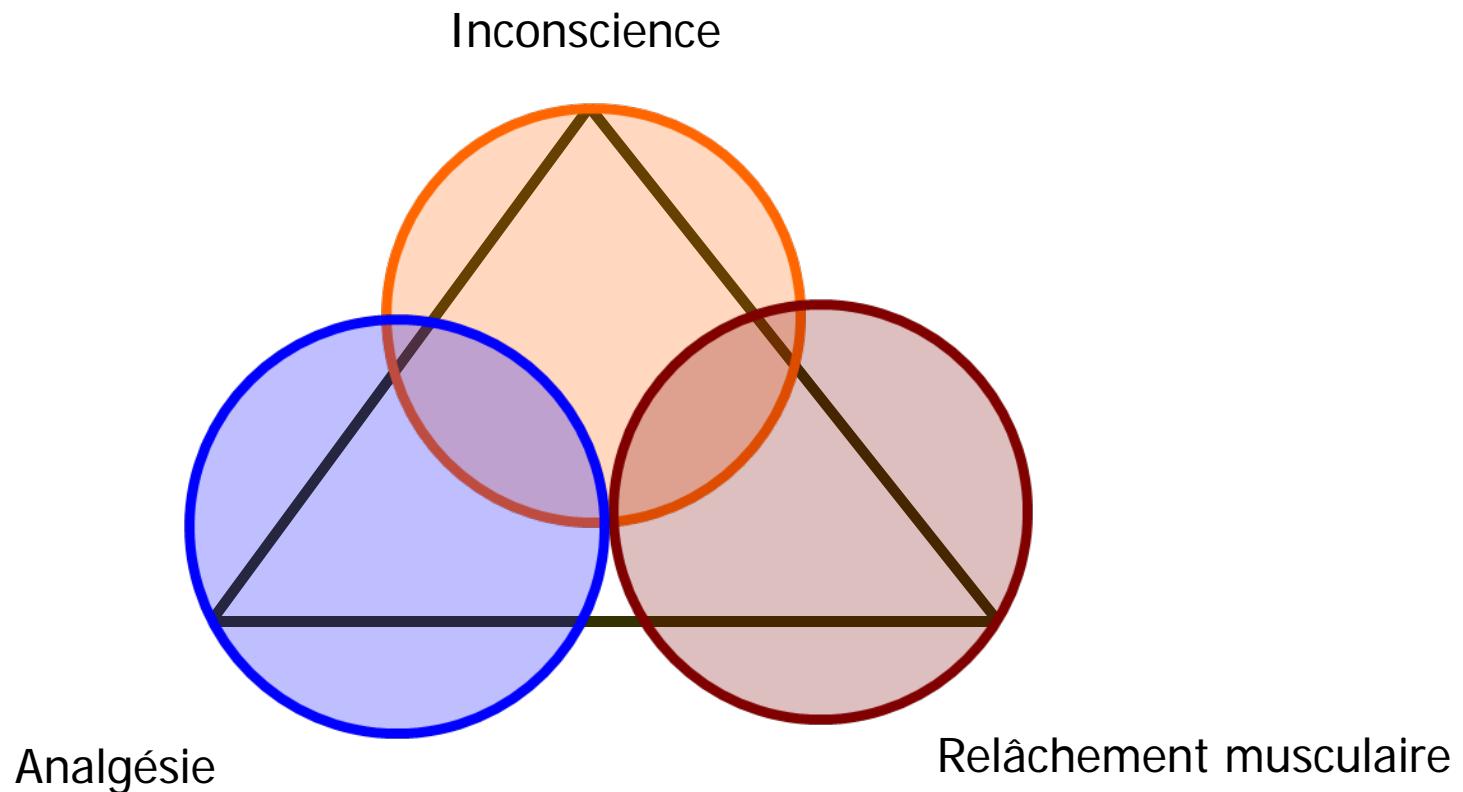


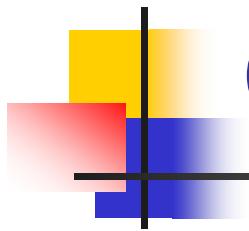
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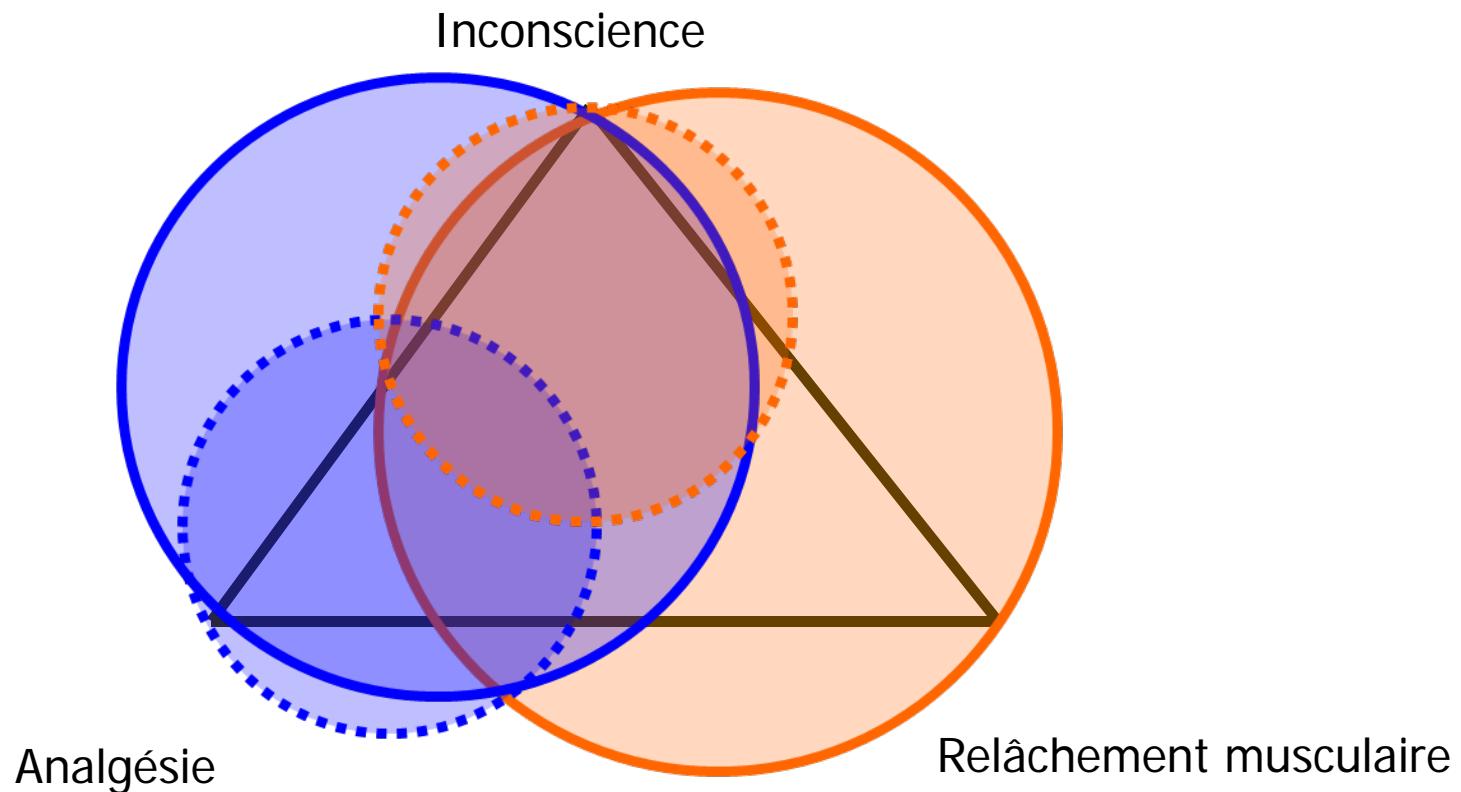


Composantes de l'anesthésie

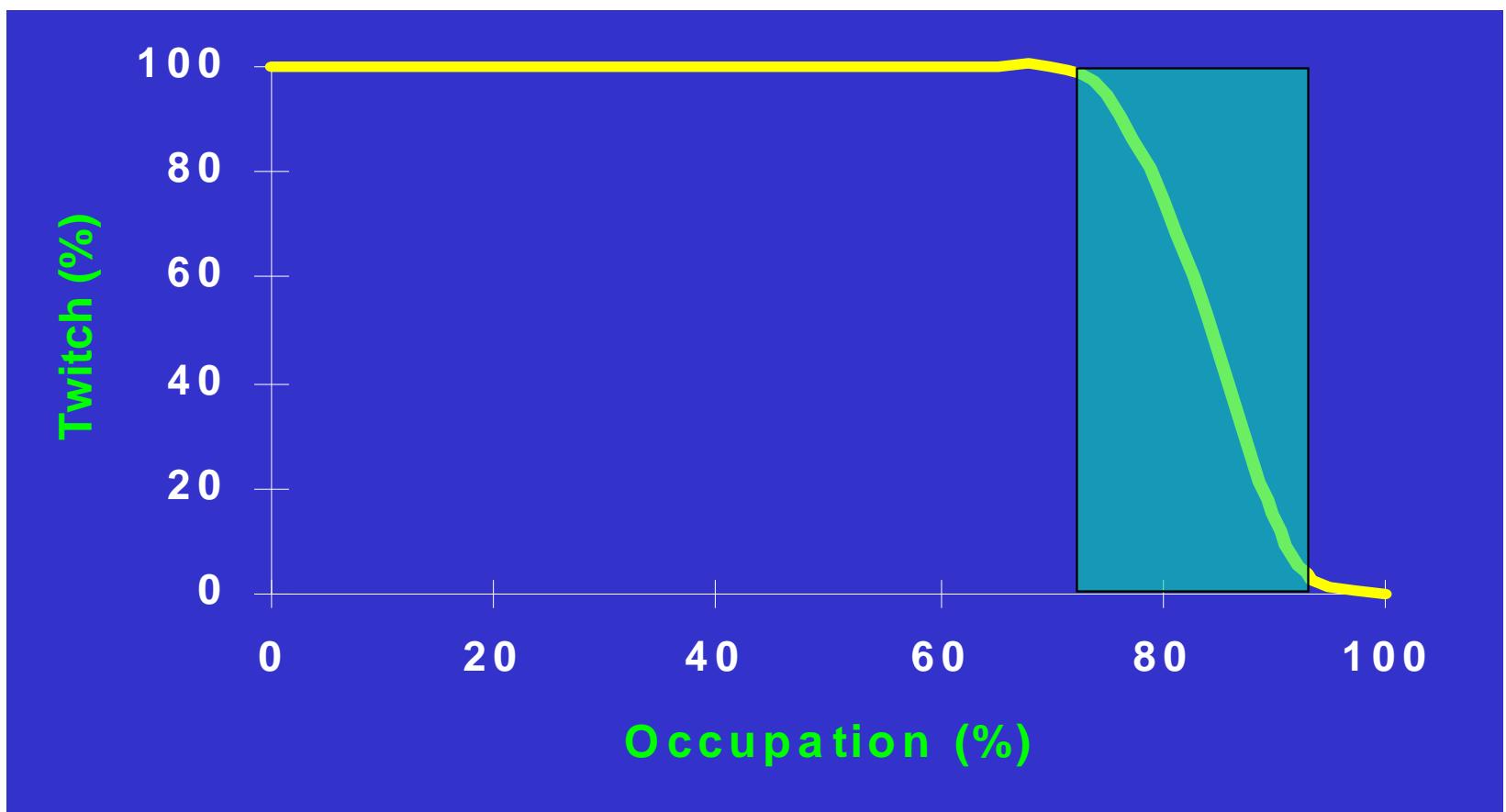




Composantes de l'anesthésie



Occupation des récepteurs



Waud BE, Waud DR. Anesthesiology 1972; 28-327

Variabilité: un exemple

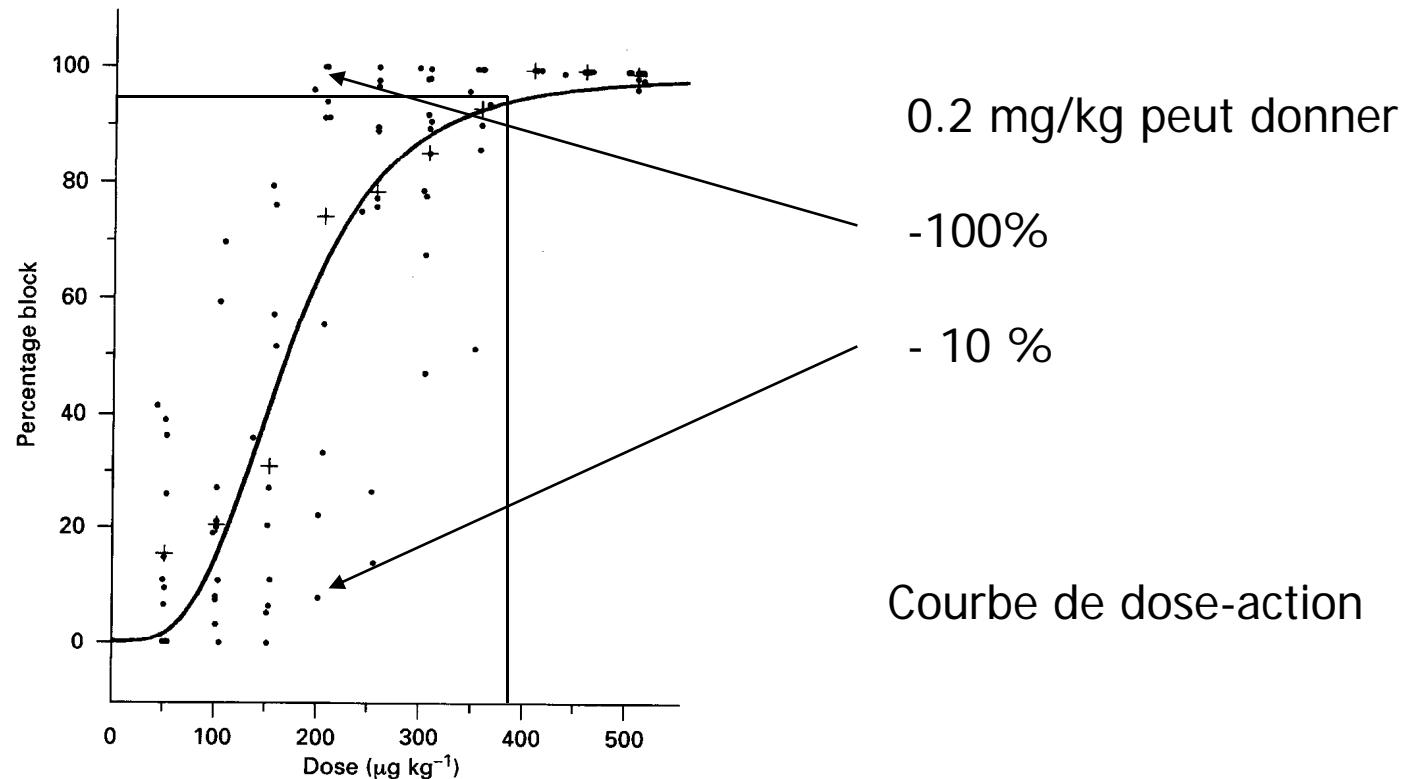
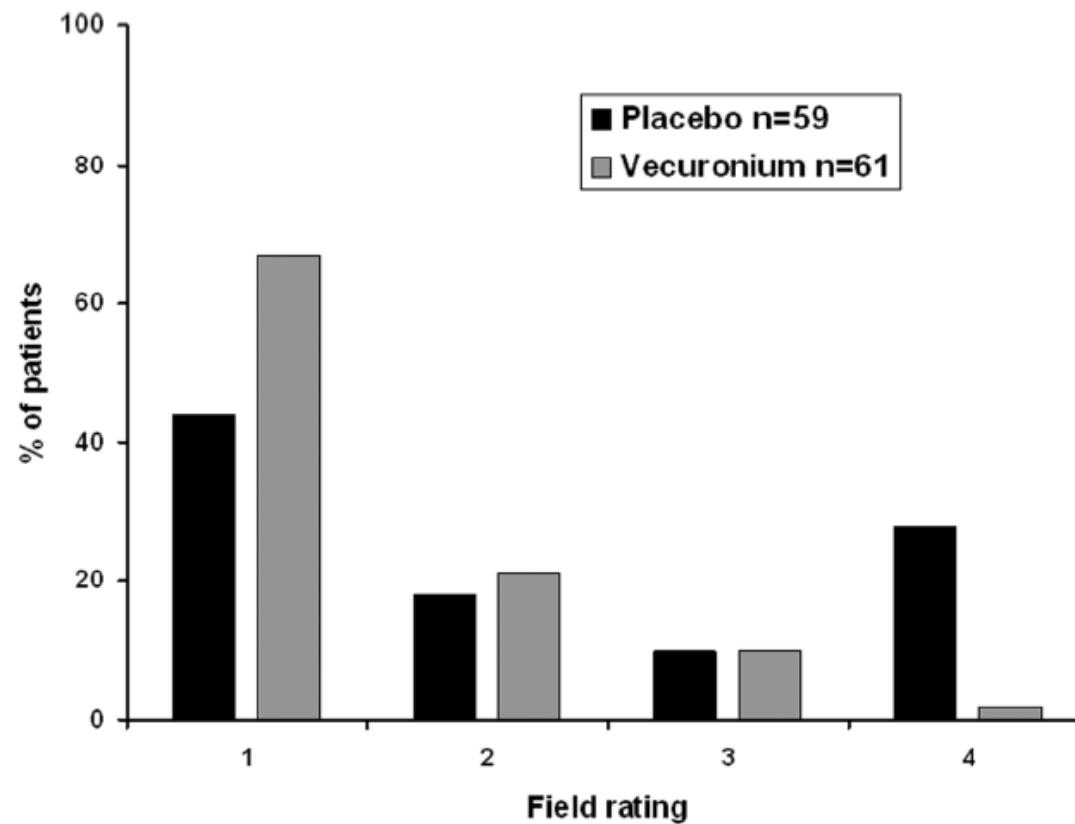


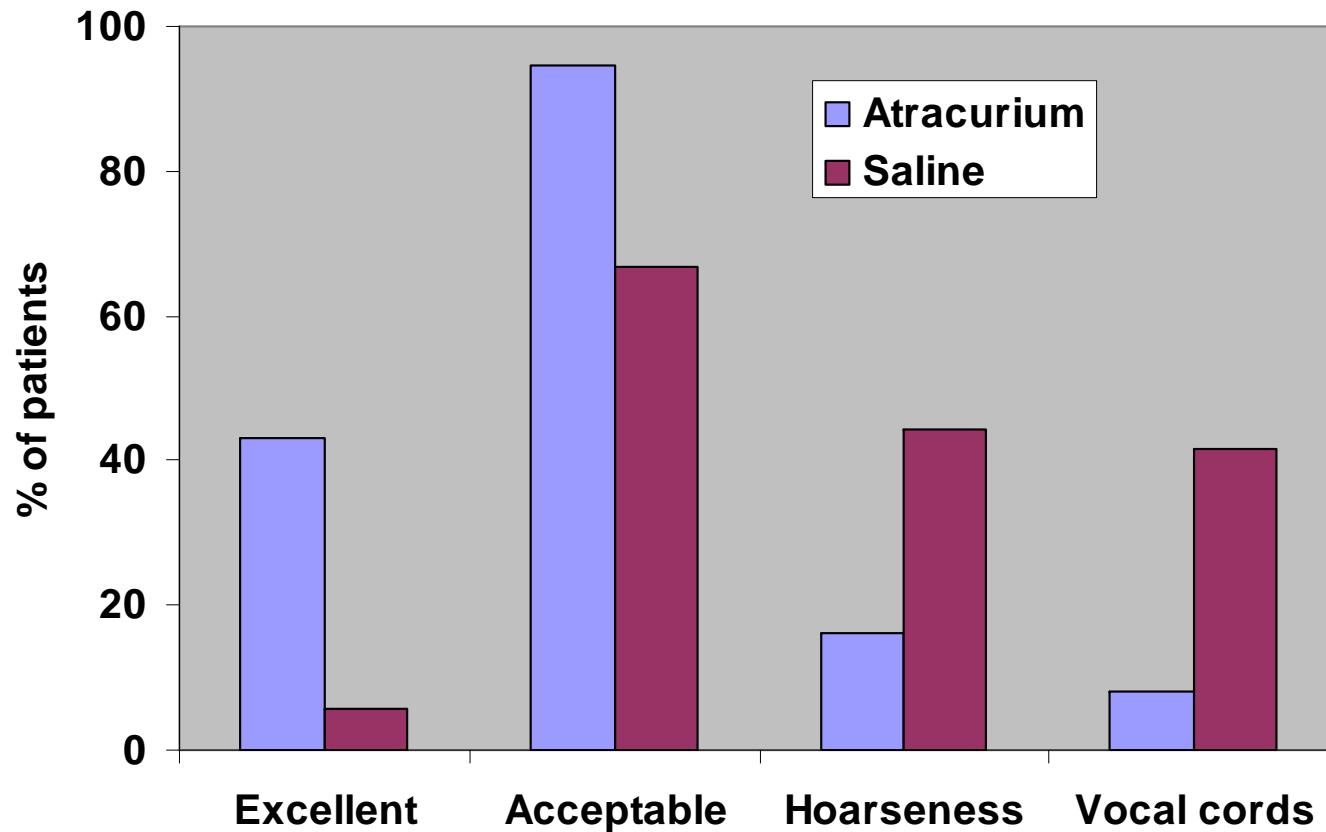
FIG. 1. Relationship between dose of suxamethonium and percentage block of the evoked isometric twitch response of adductor pollicis brevis calculated by non-linear least squares regression. (●) = Dose-response data of individual patients ($n = 120$); + = mean of the 10 dosage groups ($50\text{--}500 \mu\text{g kg}^{-1}$) studied.

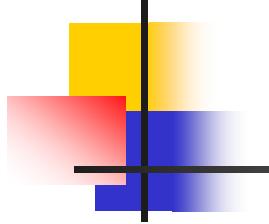
Besoin de curare



King et al. Anesthesiology 2000; 93: 1392

La curarisation diminue les lésions aux cordes vocales

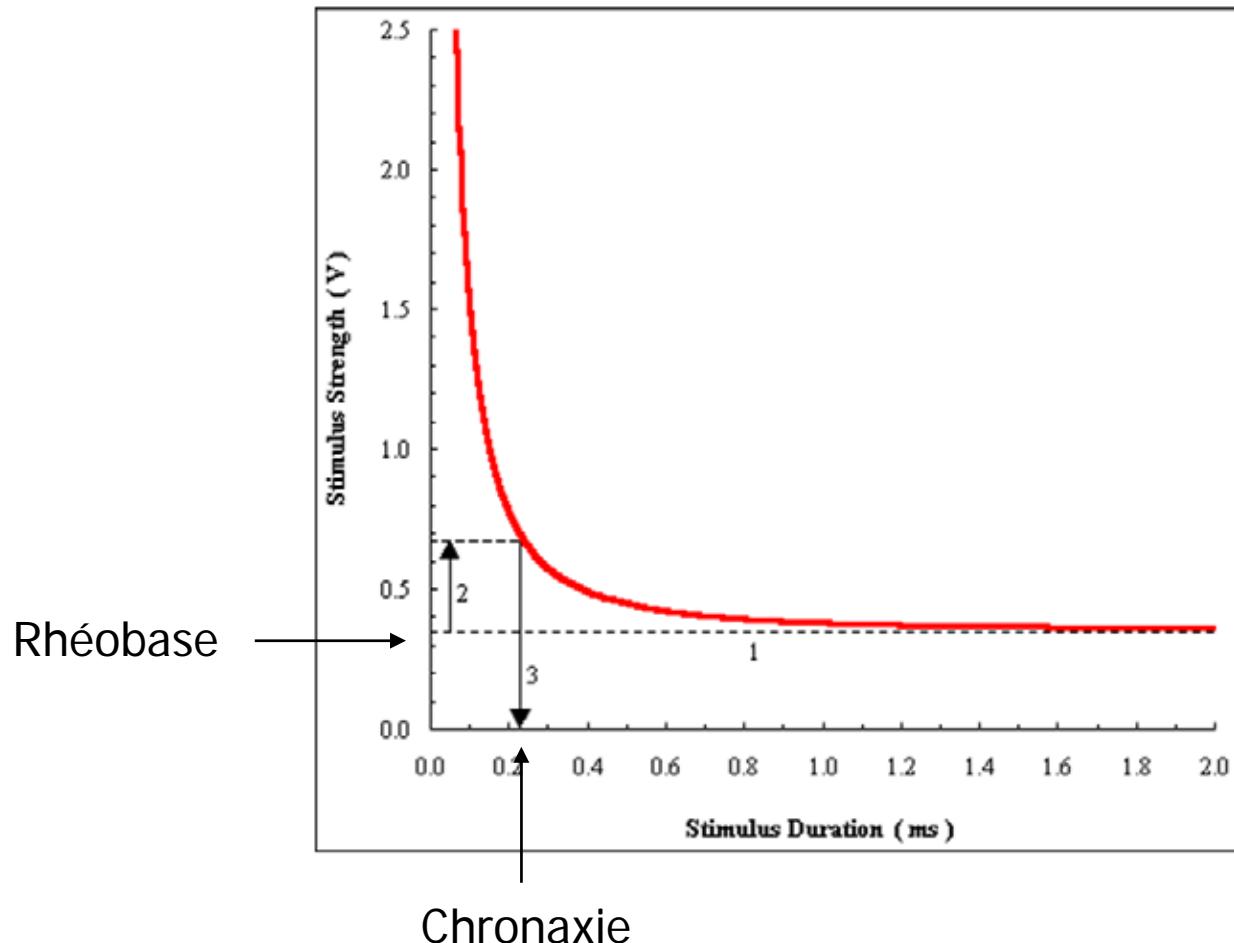


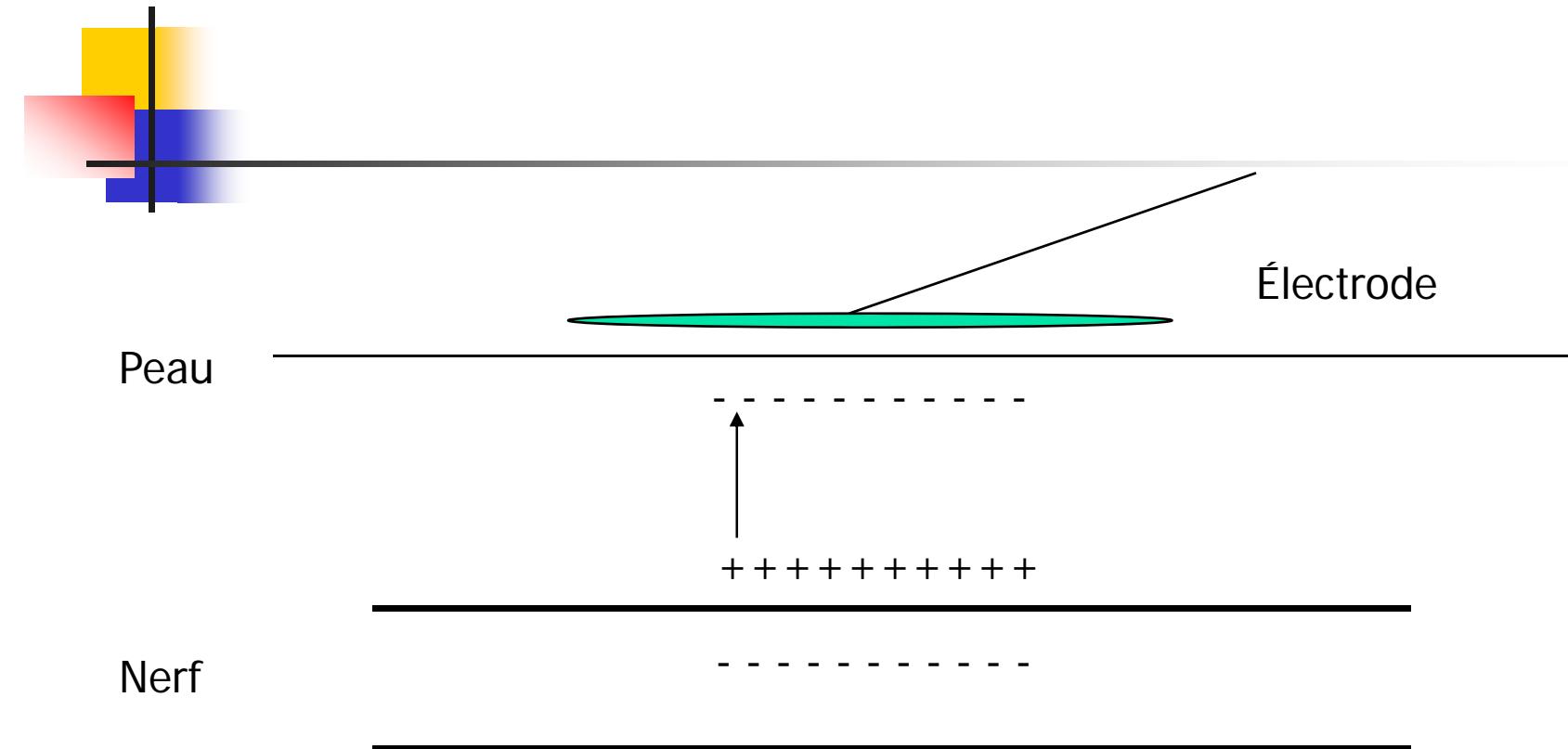


Plan

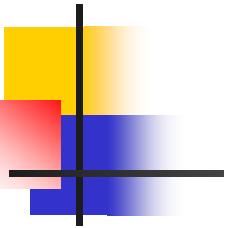
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- Problèmes cliniques

Rhéobase et chronaxie

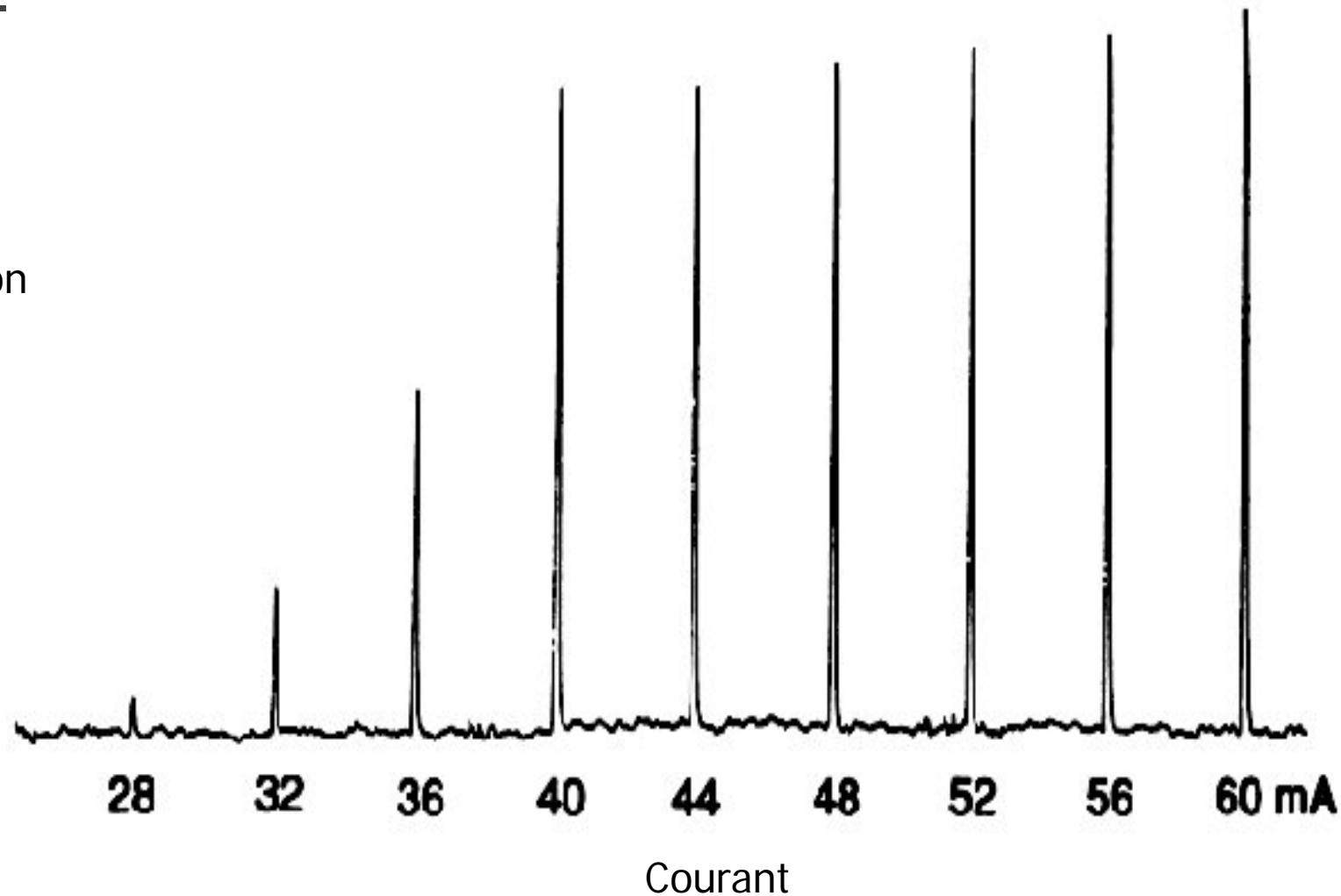


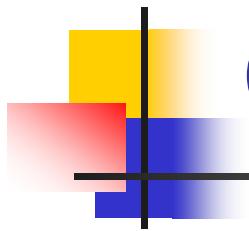


Stimulation supra-maximale

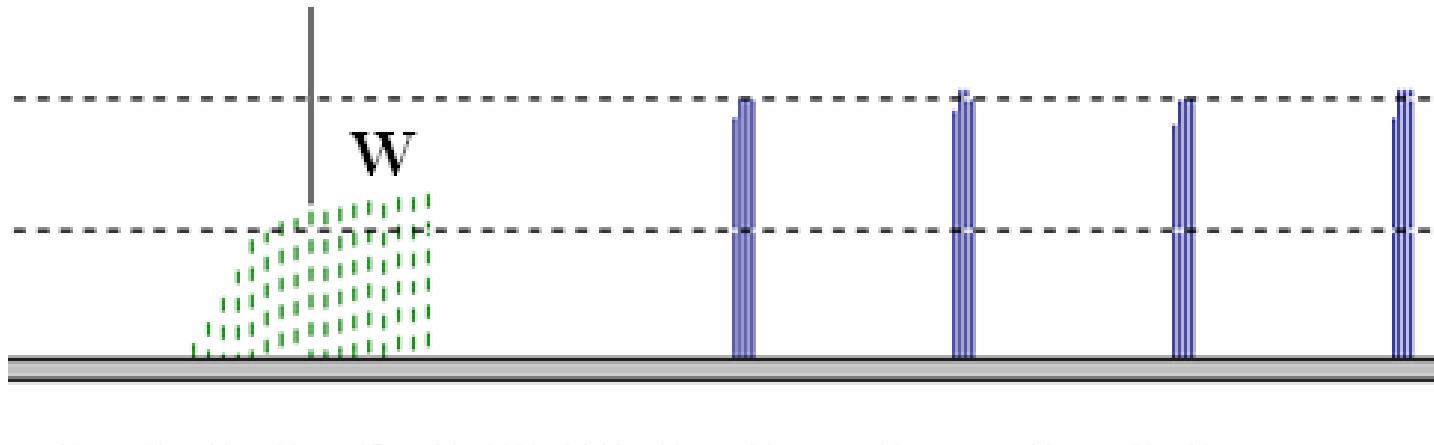


Force de contraction

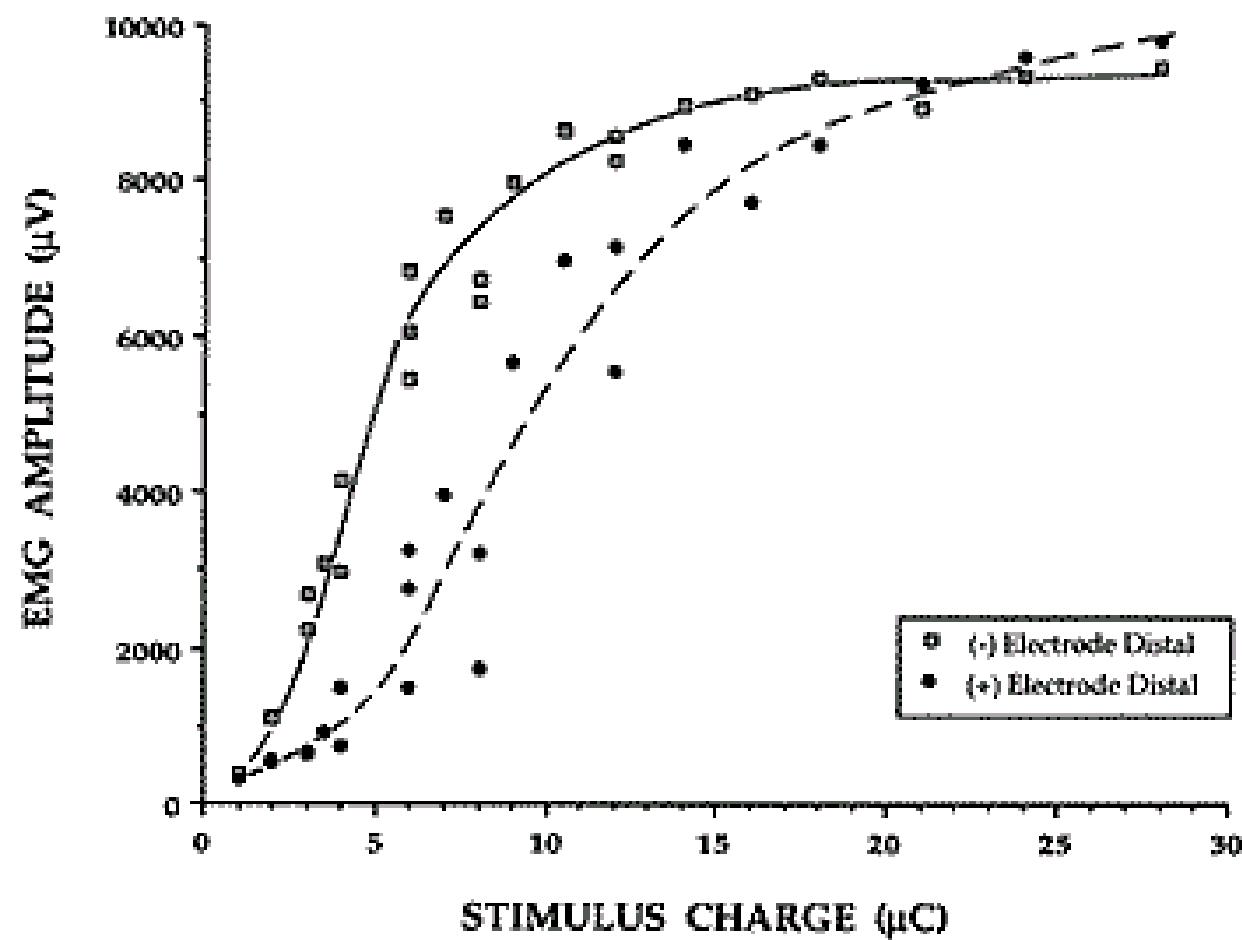




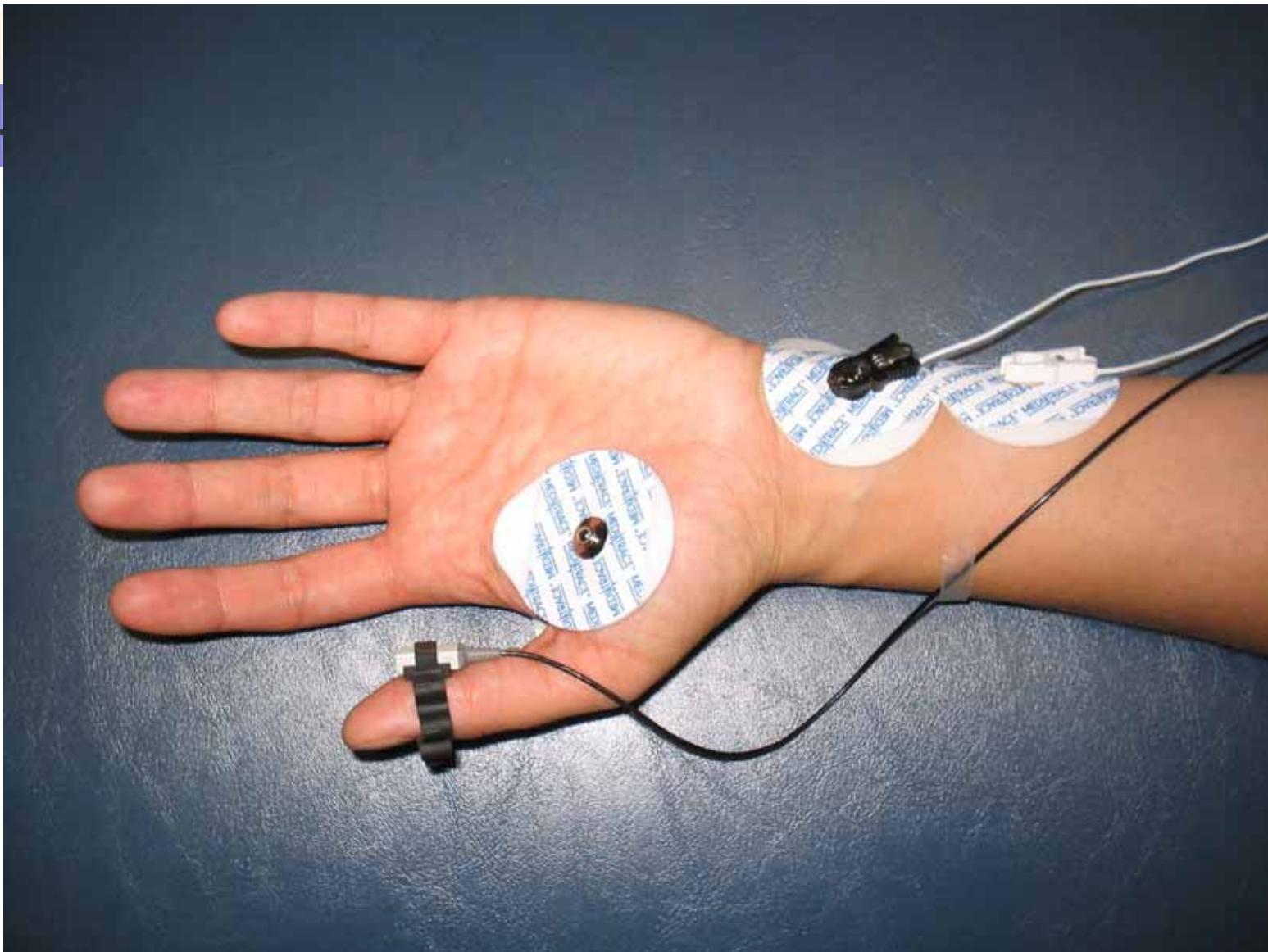
Calibration

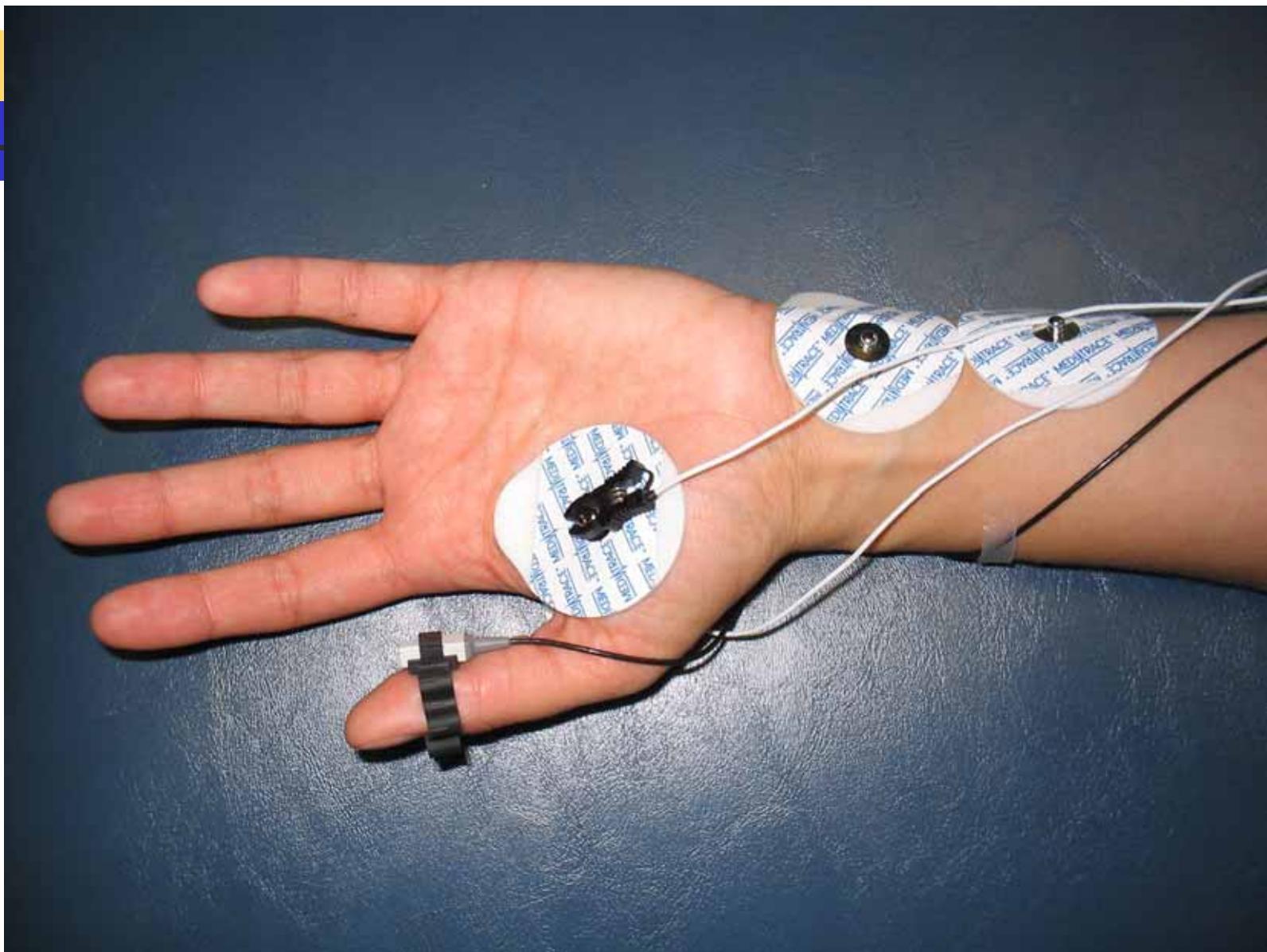


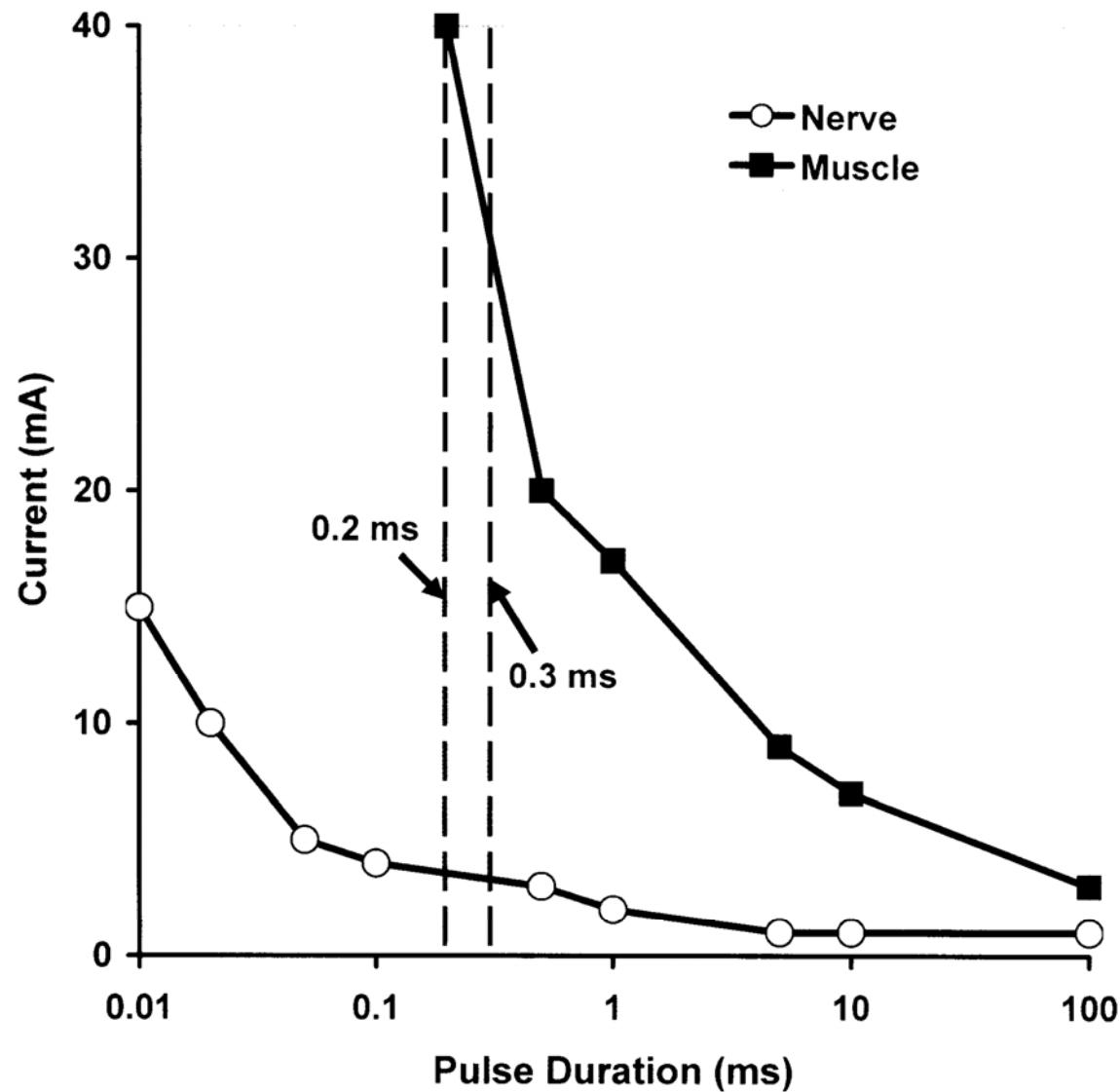
Polarité

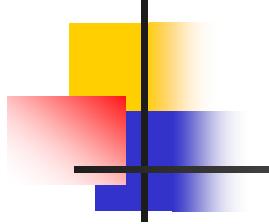


Brull et al. Anesthesiology 1995; 83: 702



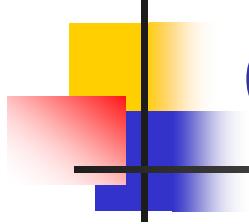






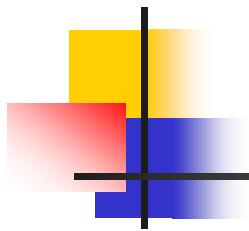
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- Caractéristiques du bloc dépolarisant
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Caractéristiques du bloc non dépolarisant

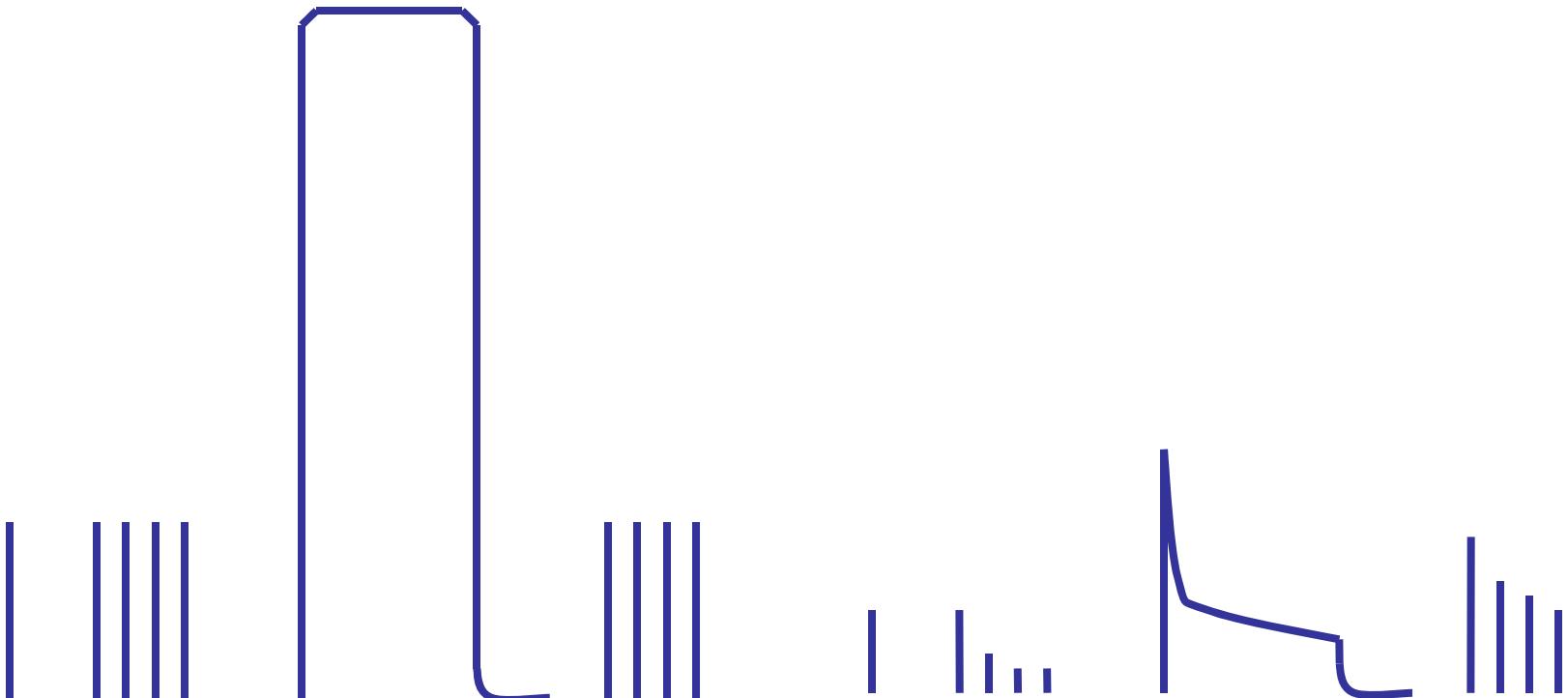
- Épuisement au train-de-quatre
- Épuisement à la stimulation tétanique
- Facilitation post-tétanique
- Antagonisme du bloc par les anti-cholinestérasiques



Bloc non-dépolarisant

Normal

Bloc

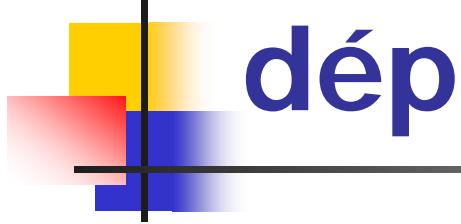


Plan

 Pourquoi?

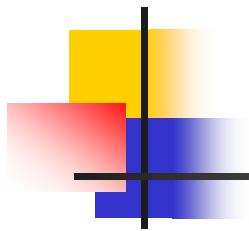
 Stimulateurs

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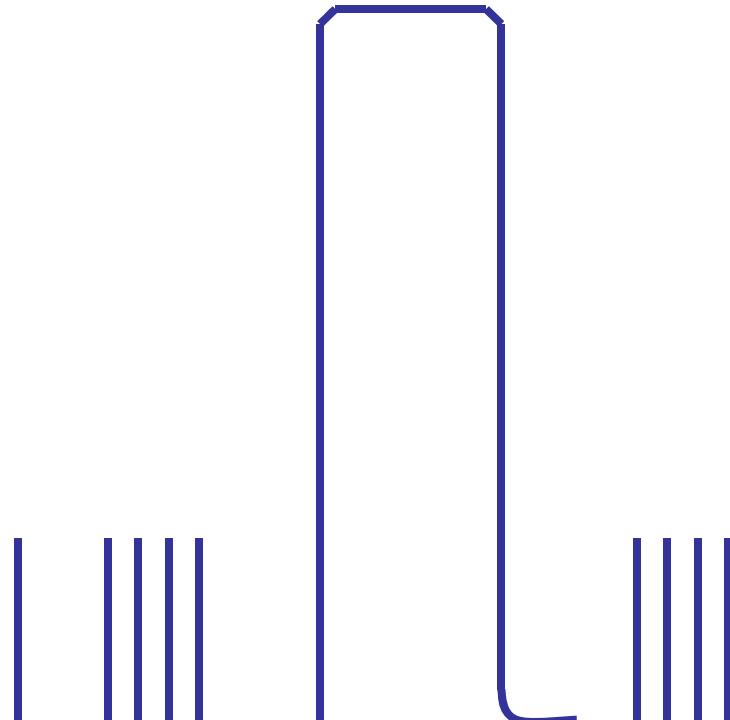
Caractéristiques du bloc dépolarisant

- Pas d'épuisement au train-de-quatre
- Pas d'épuisement à la stimulation tétanique
- Pas de facilitation post-tétanique
- Potentialisation par les anti-cholinestérasiq

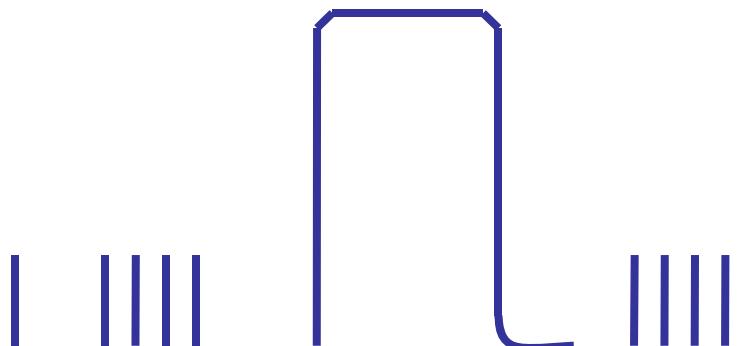


Bloc dépolarisant

Normal



Bloc

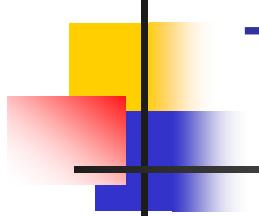


Plan

Pourquoi?

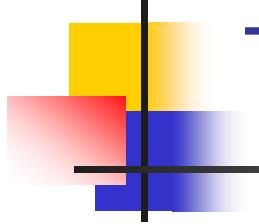
Stimulateurs

- Caractéristiques du bloc non-dépolarisant
- Caractéristiques du bloc dépolarisant
- Techniques de mesure
- Modes de stimulation
- Réponse des différents muscles
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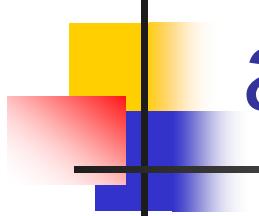
Techniques de mesure

- Visuelle et tactile
- Force (MMG)
- Électromyographie (EMG)
- Accéléromyographie (AMG)
- Déplacement (KMG)
- Phonomyographie (PMG)



Techniques de mesure

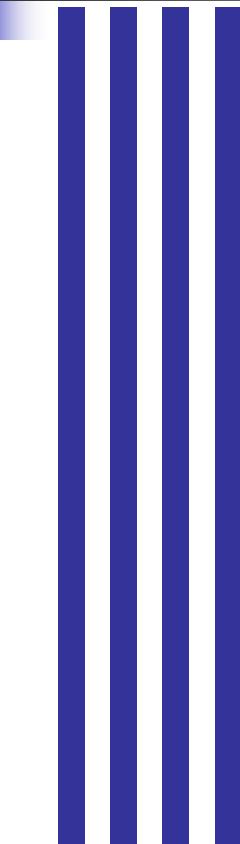
- Visuelle et tactile
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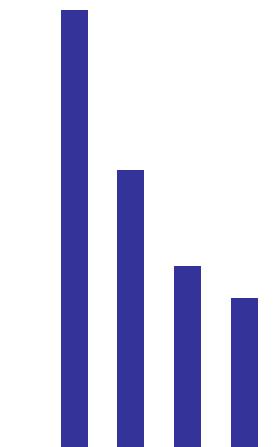
Évaluation tactile ou visuelle avec train-de-quatre

- Il est facile de compter le nombre de réponses du train-de-quatre
- Renverse: 2-4 twitches
- Difficile de détecter une curarisation profonde
- Difficile de détecter un épuisement (fade)

Quelques définitions



T_c



T_1

T_4

$$T_1/T_c = 50\% = 0.5$$

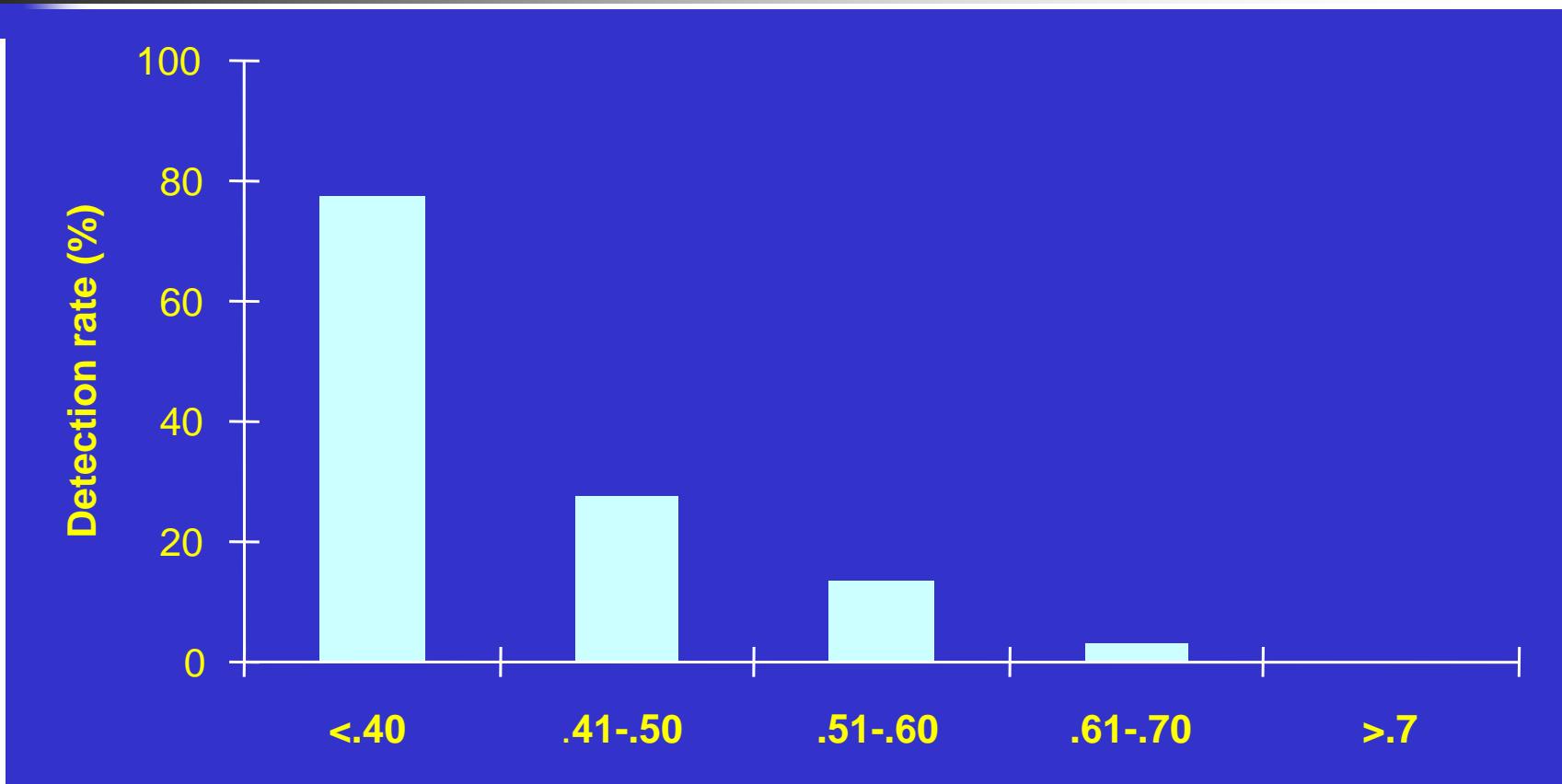
$$\text{Bloc} = 50\% = 0.5$$

$$T_4/T_1 = 0.2/0.5 = 0.4 = 40\%$$

$$\text{TOF ratio} = T_4/T_1$$

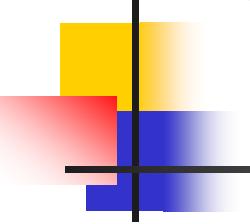
Il est difficile de détecter un T4/T1 >

0.4



Actual TOF Ratio

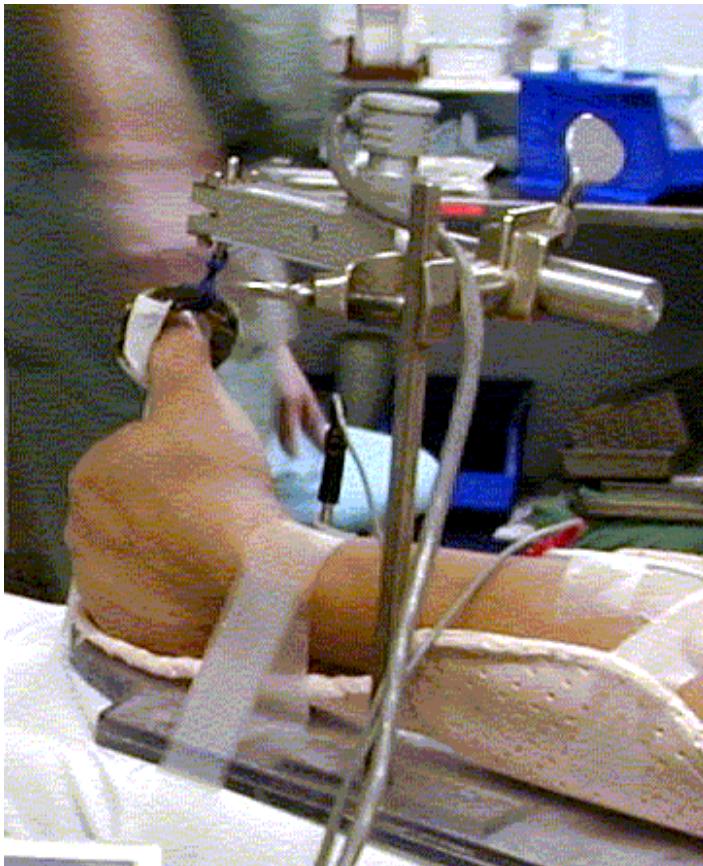
Drenk et al. Anesthesiology 1989; 70: 578-581



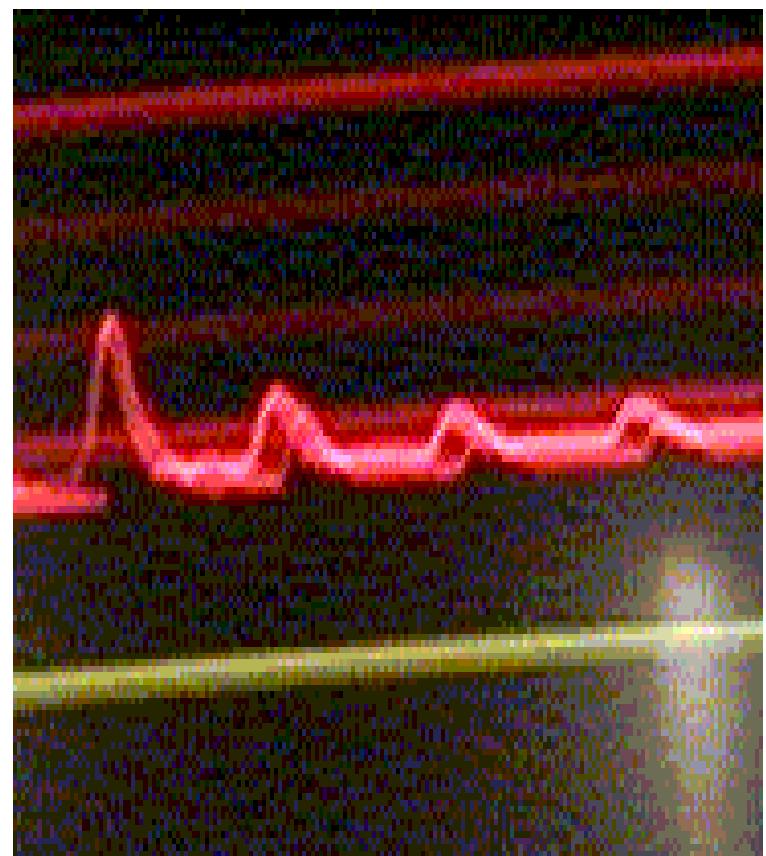
Techniques de mesure

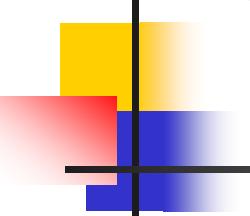
- Visuelle et tactile
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- Accélérométrie (AMG)
- Déplacement
- Phonomyographie (PMG)

Force (MMG)



Force (système-maison)

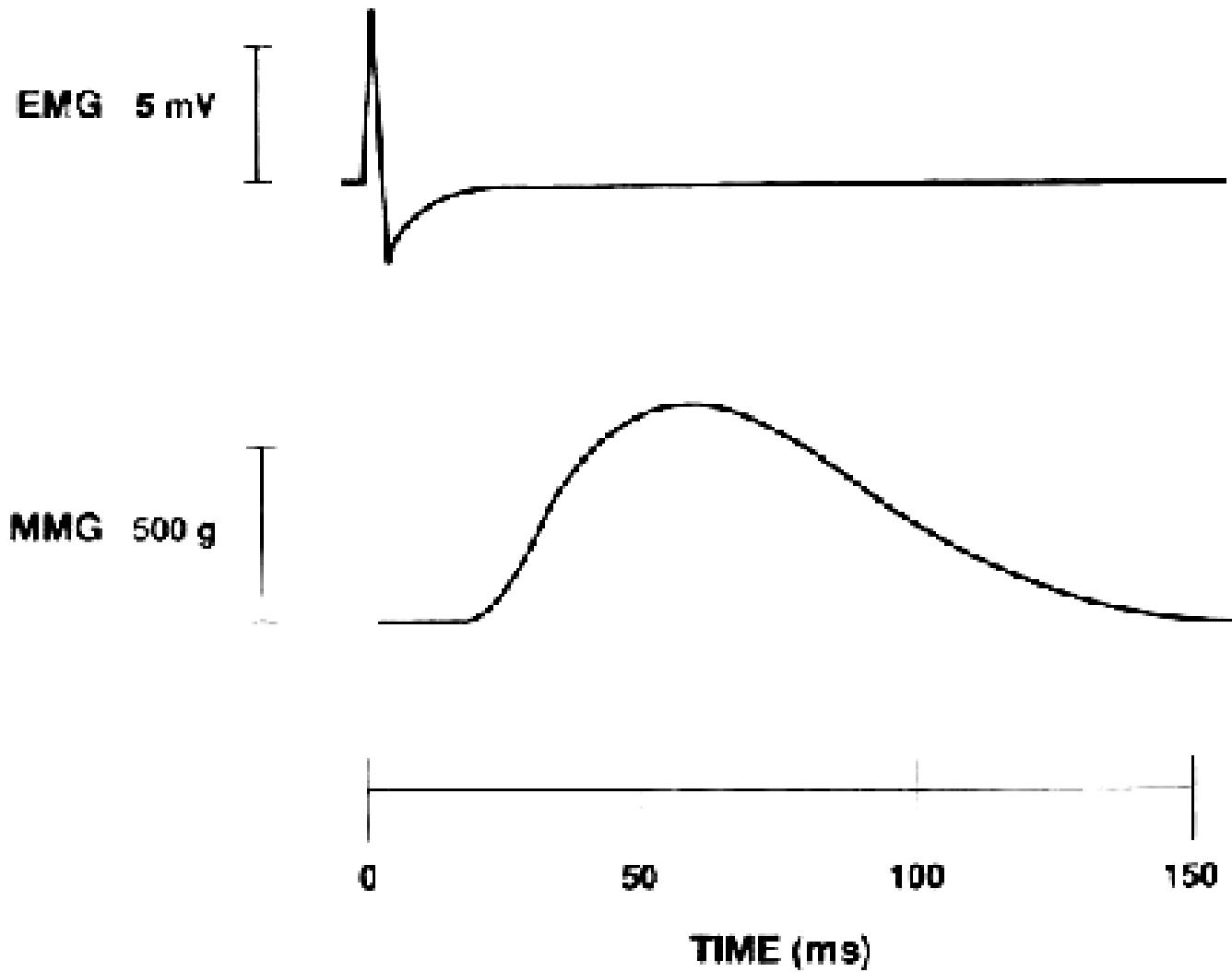




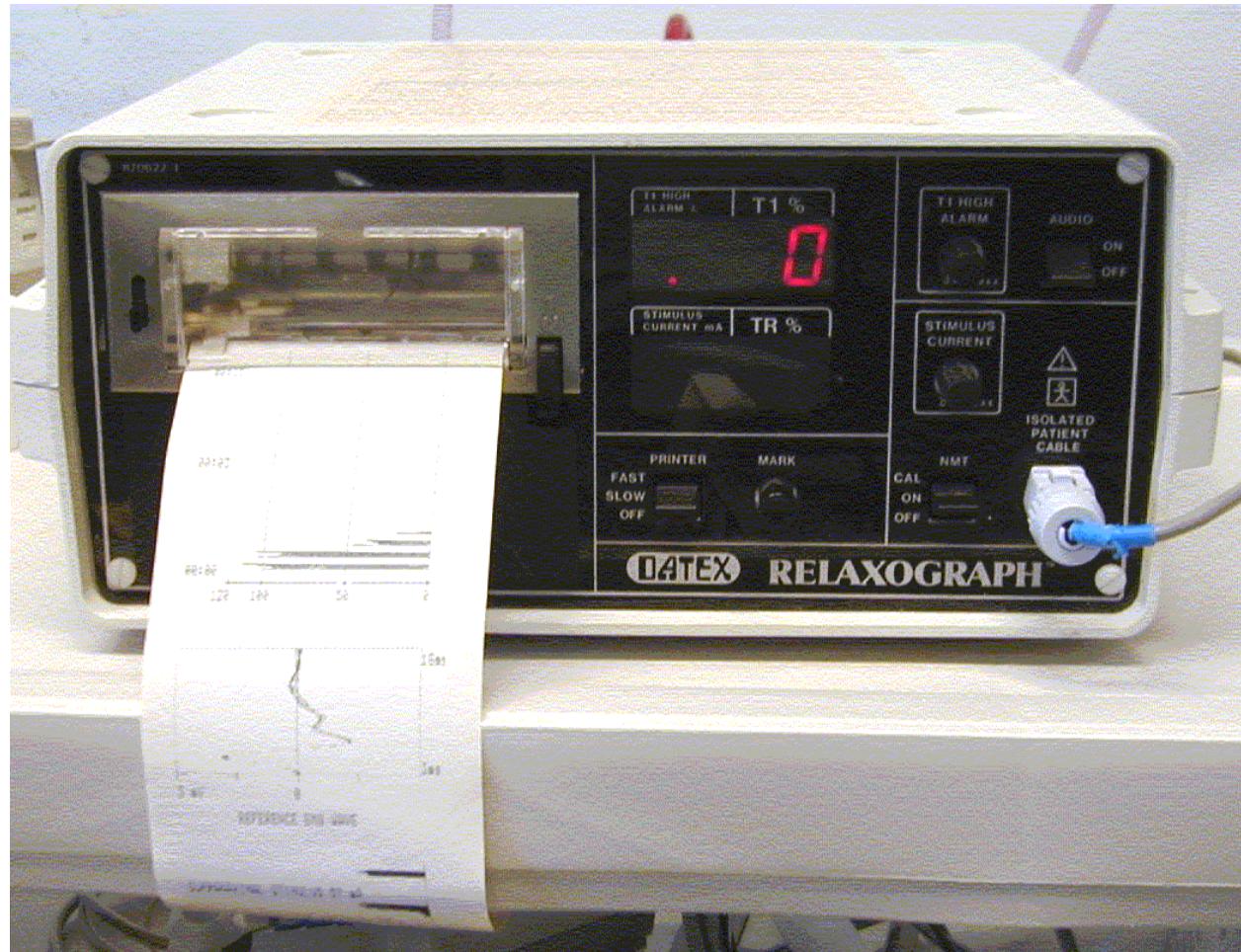
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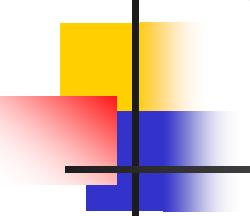
- Visuelle et tactile
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Comparaison EMG - MMG



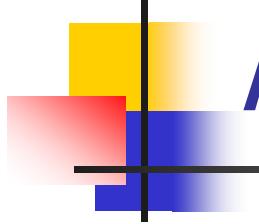
EMG





Techniques de mesure

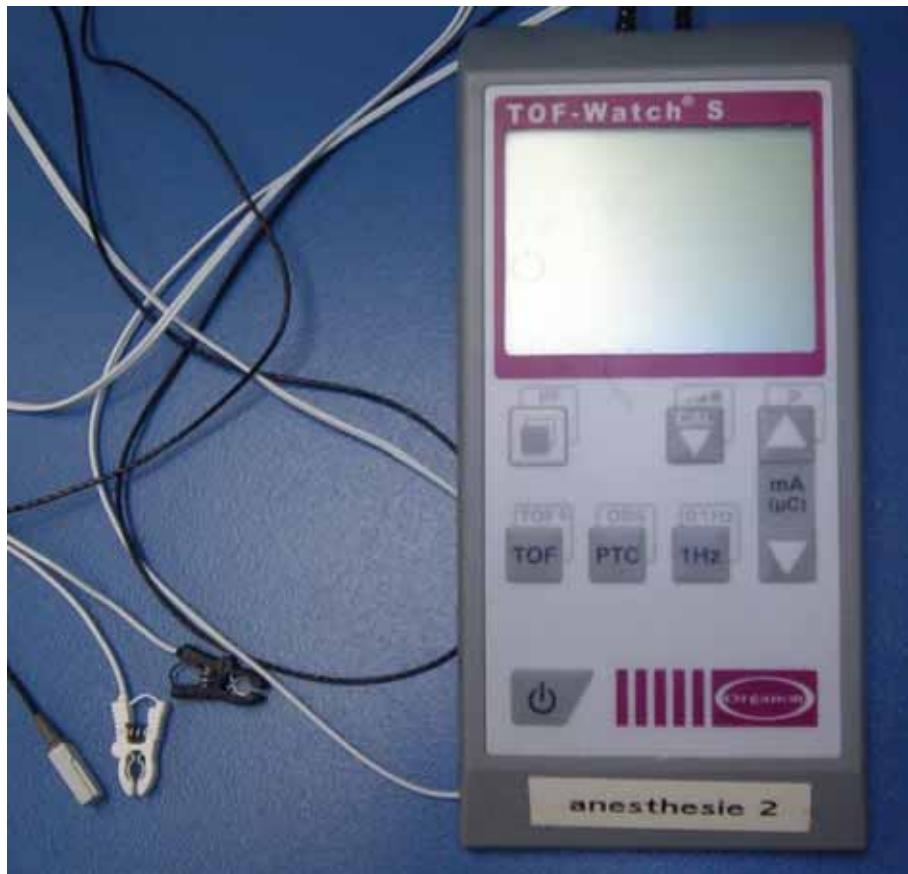
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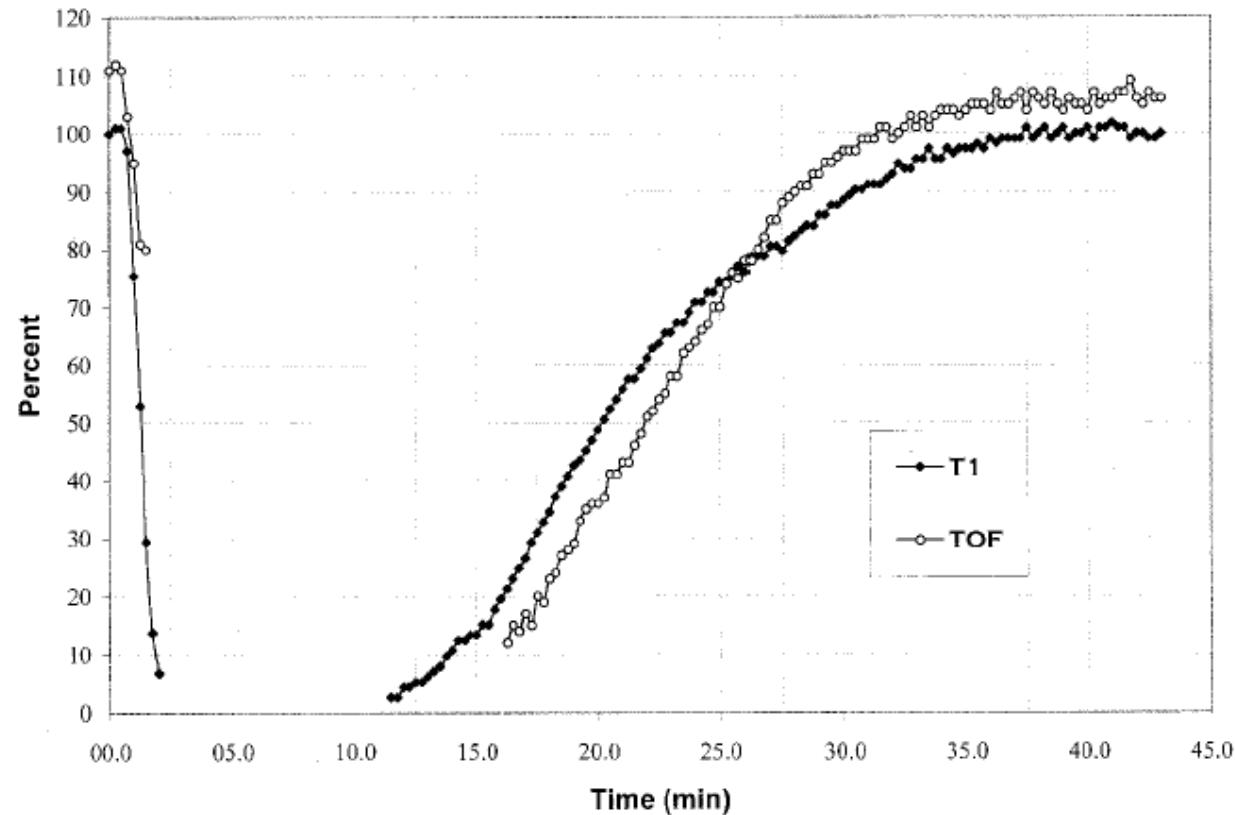
Accéléromyographie

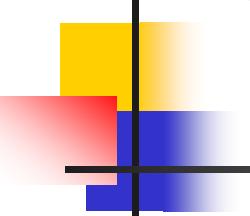
- Principe $F = ma$
- Commercialisé
- Plus compact
- Peu coûteux
- Adaptable à plusieurs muscles
- Liberté de mouvement nécessaire

AMG



AMG – Évolution de la curarisation





Techniques de mesure

- Visuelle et tactile
- Force (MMG)
- Électromyographie (EMG)
- Accélérométrie (AMG)
- Déplacement
- Phonomyographie (PMG)

Déplacement



Dahaba et al. AA 2002; 94: 591

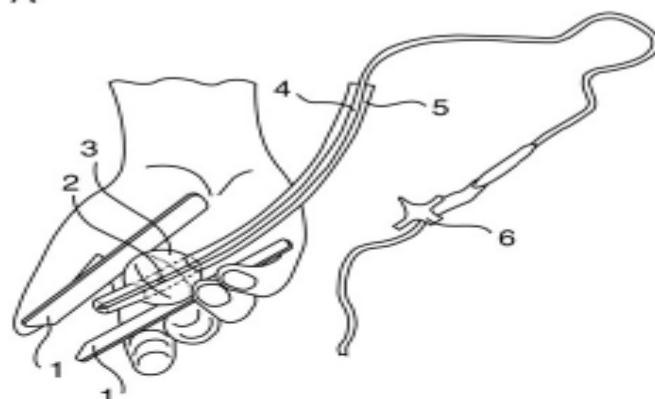


If the sensor only sees 2 twitches in response to a train of four, there will be no percentage given.

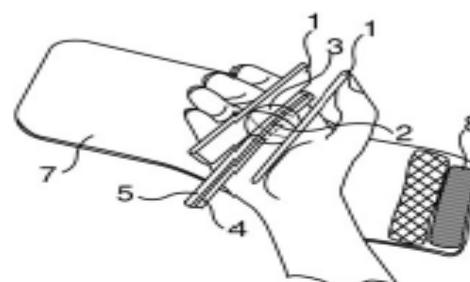


Compression

A



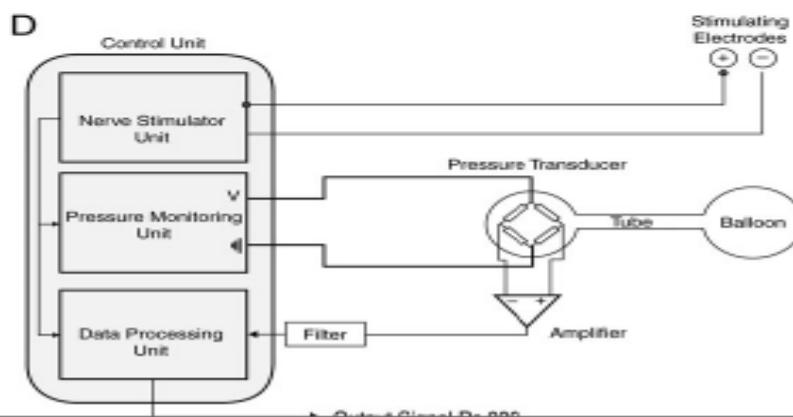
B



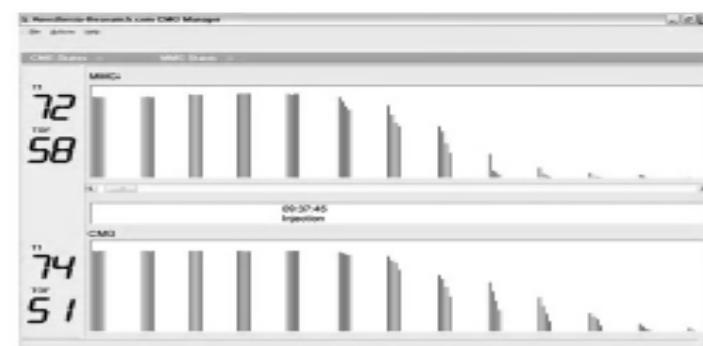
C

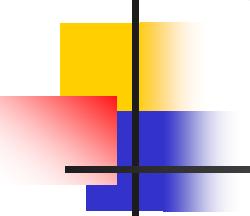


D



E

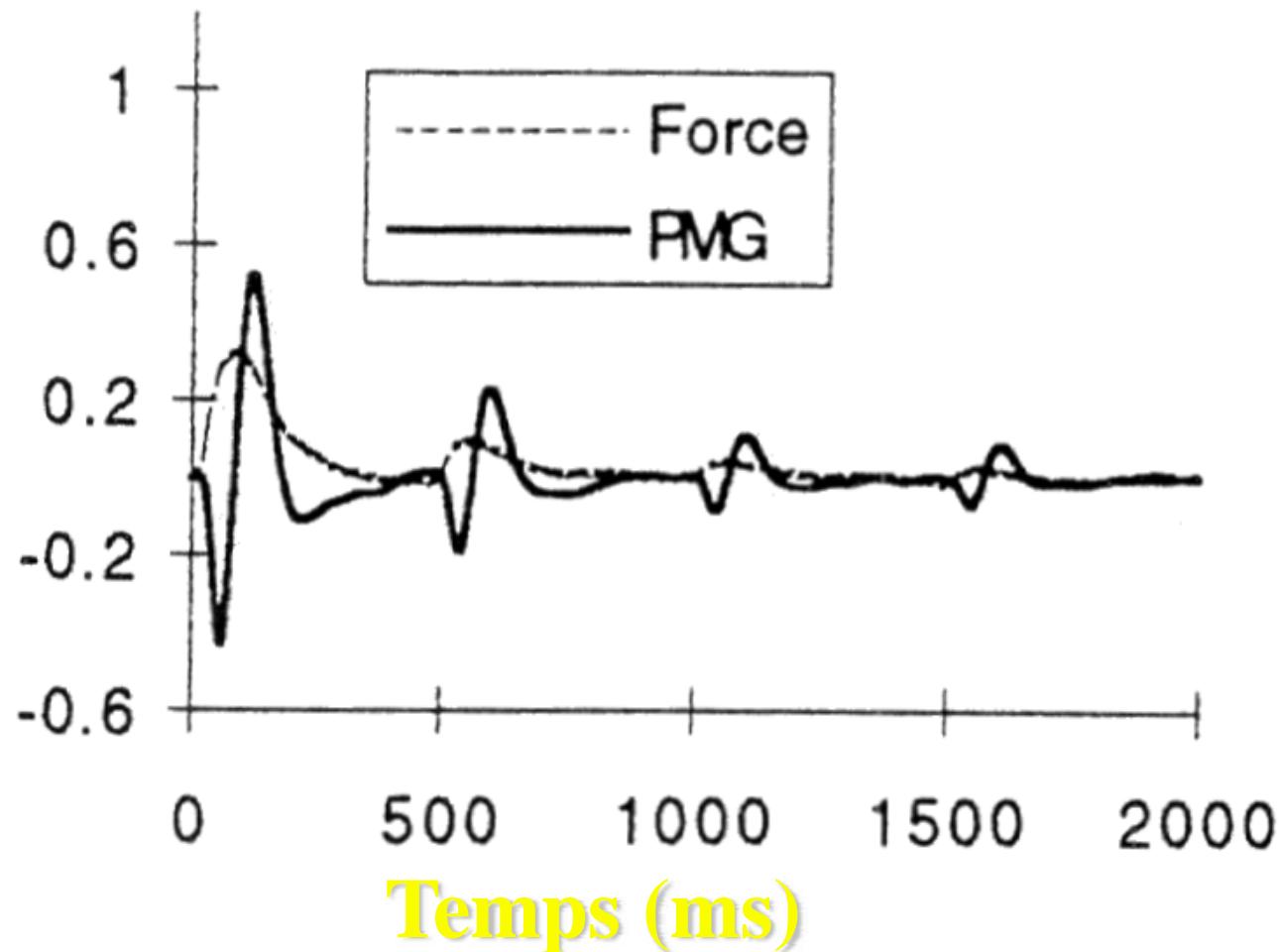




Techniques de mesure

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- Déplacement
- Phonomyographie (PMG)

Phonomyographie: exemple



Phonomyographie

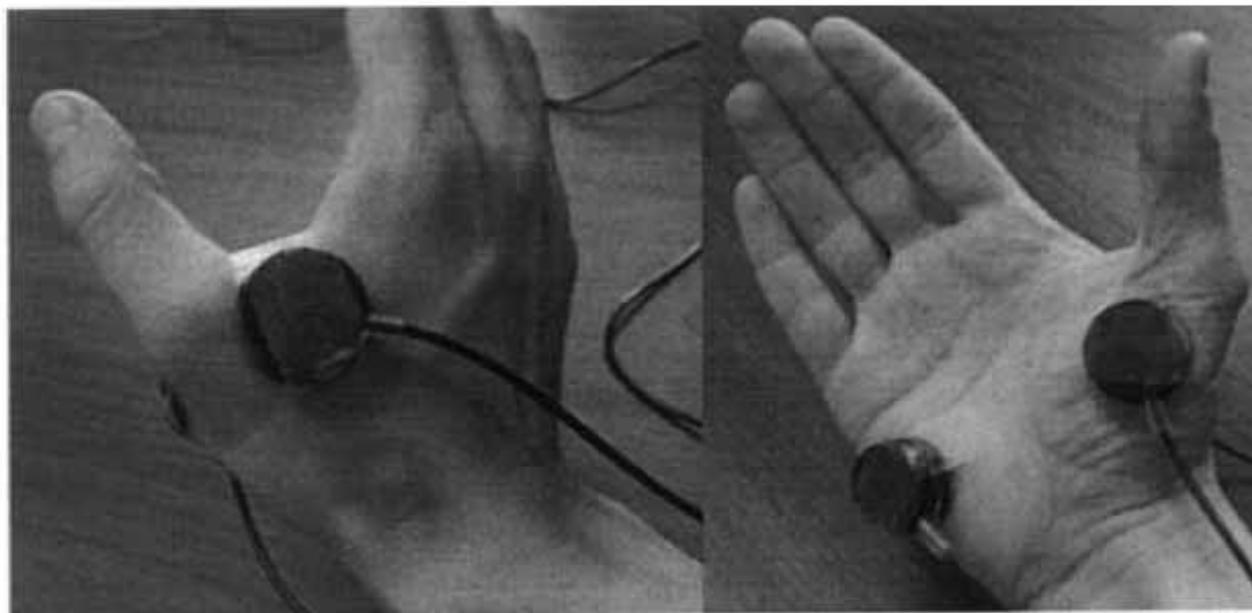


FIGURE 2 Positioning of the three microphones to monitor neuromuscular blockade of the first dorsal interosseus muscle (left), the adductor pollicis (right, thenar eminence), and the three hypothenar muscles (right, hypothenar eminence).

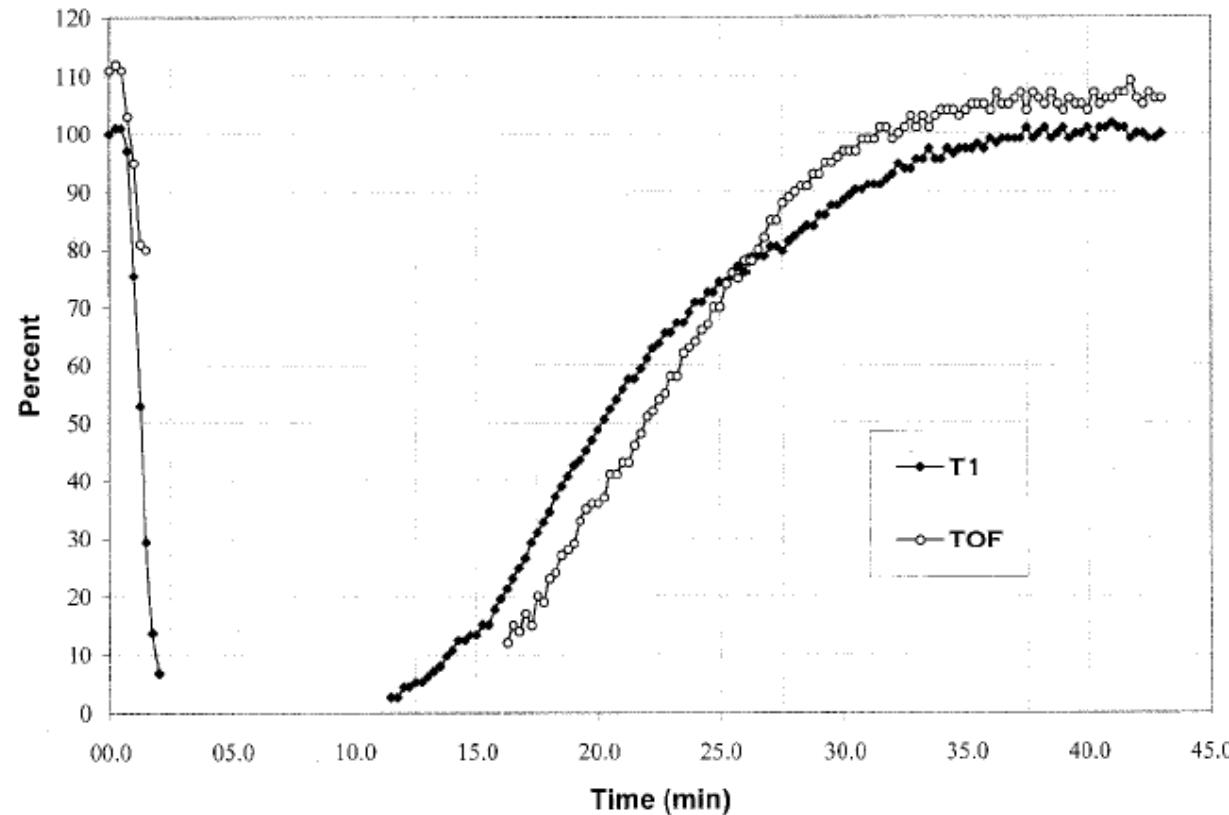
Plan

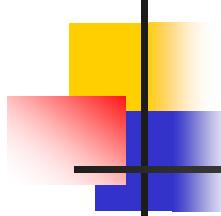
 Pourquoi?

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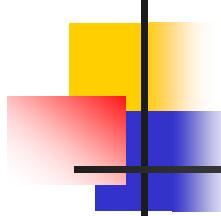
AMG – Évolution de la curarisation





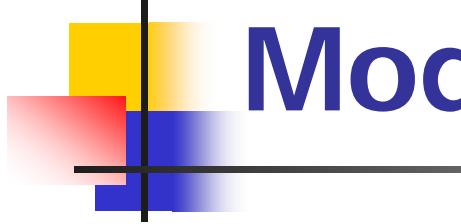
Modes de stimulation

- **Twitch unique**
- **Train-de-quatre**
- **Double-burst stimulation (DBS)**
- **Stimulation tétanique**
- **Post-tetanic count**



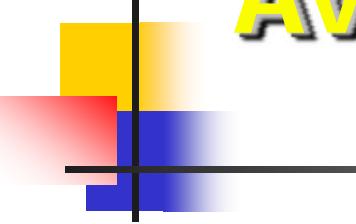
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- **Twitch unique**
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- **Stimulation tétanique**
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Modes de stimulation

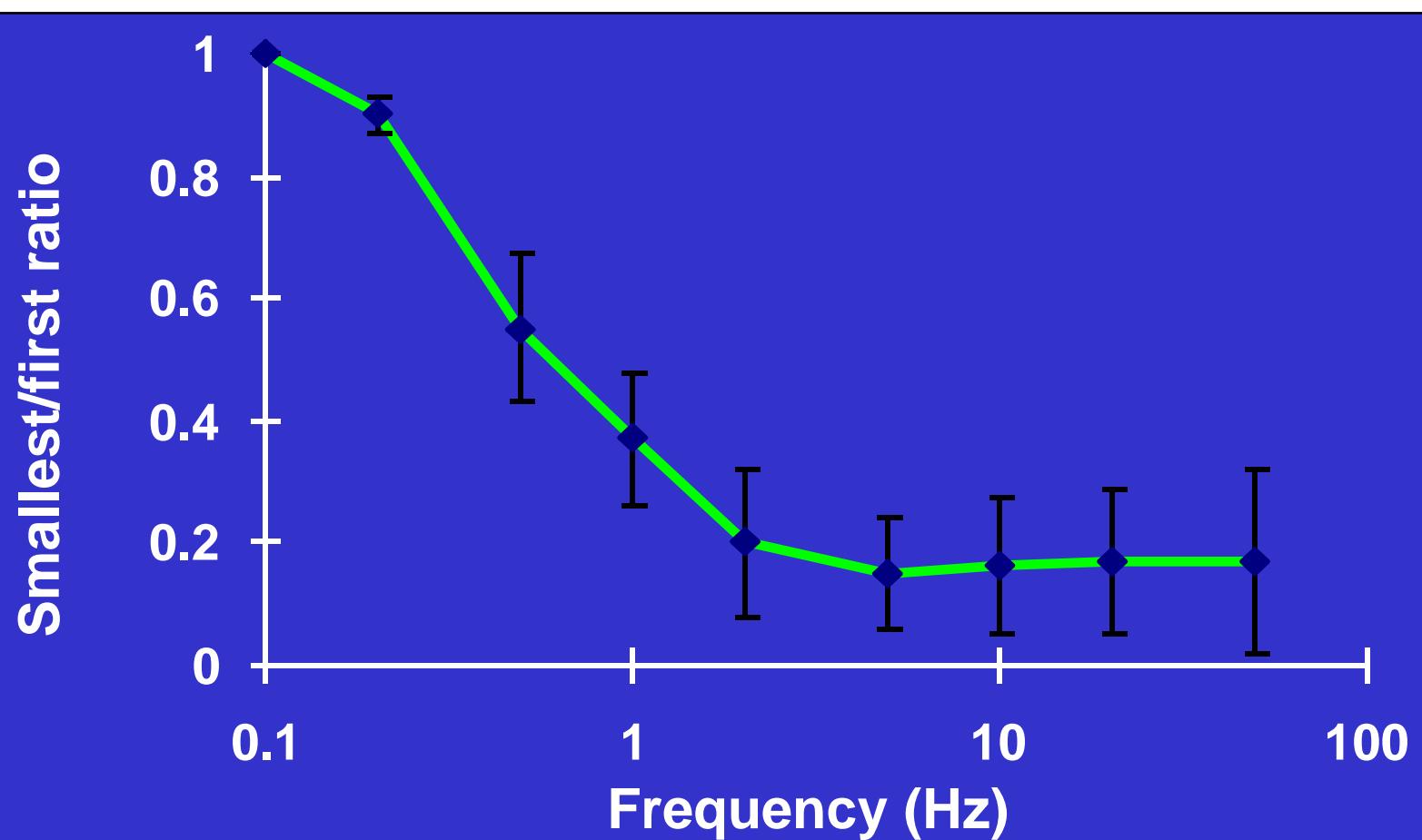
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- **Train-de-quatre**
- **Double-burst stimulation (DBS)**
- **Stimulation tétanique**
- **Post-tetanic count**



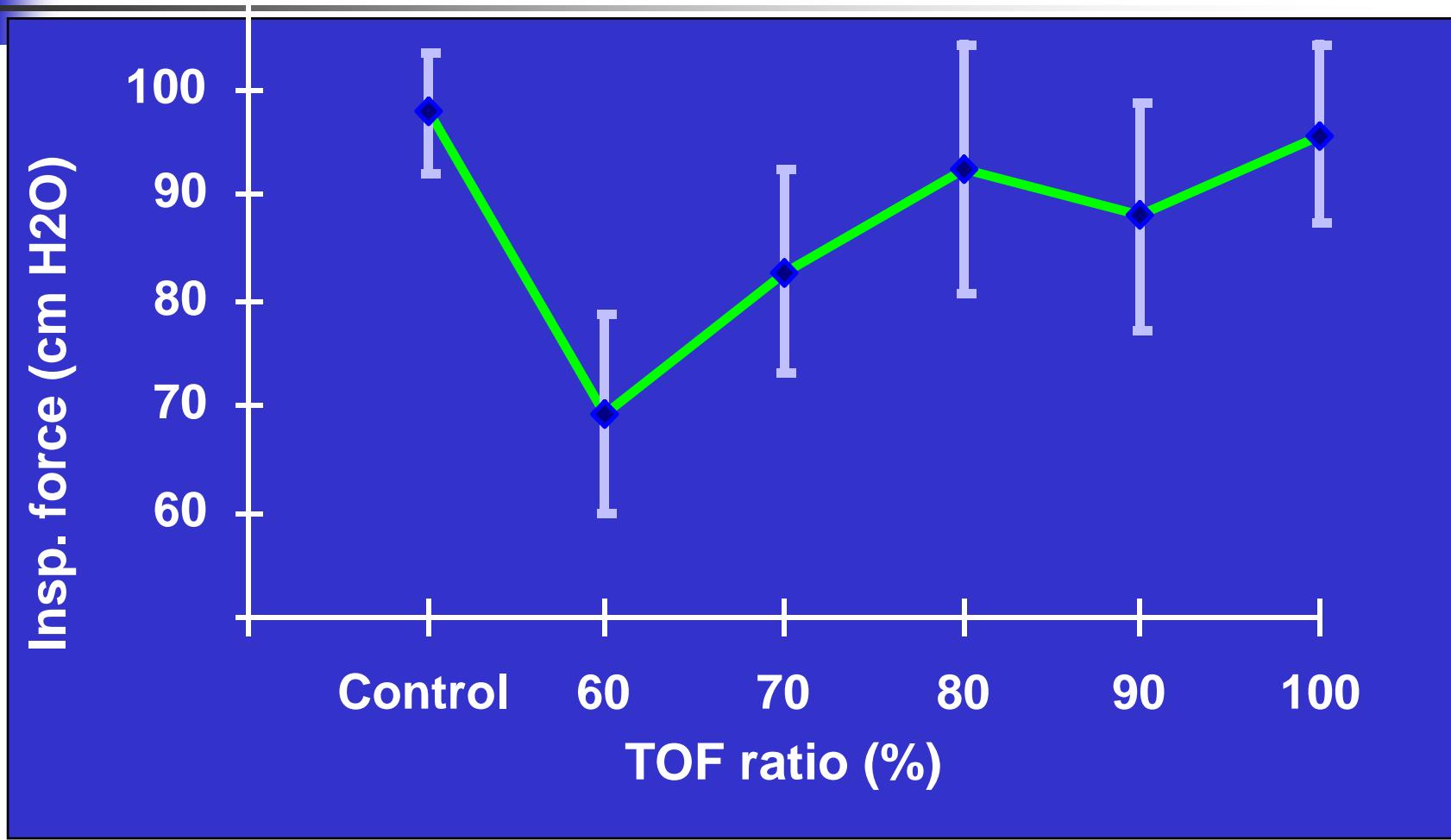
Avantages du train-de-quatre

- Chaque réponse peut être vue ou palpée
- Épuisement observable
- Absence de facilitation post-tétanique
- Peut être répété à toutes les 10-12 s
- Corrélation entre épuisement et bloc
- Plus de sensibilité que le twitch unique
- Valeur contrôle non-nécessaire

Pourquoi 2 Hz?

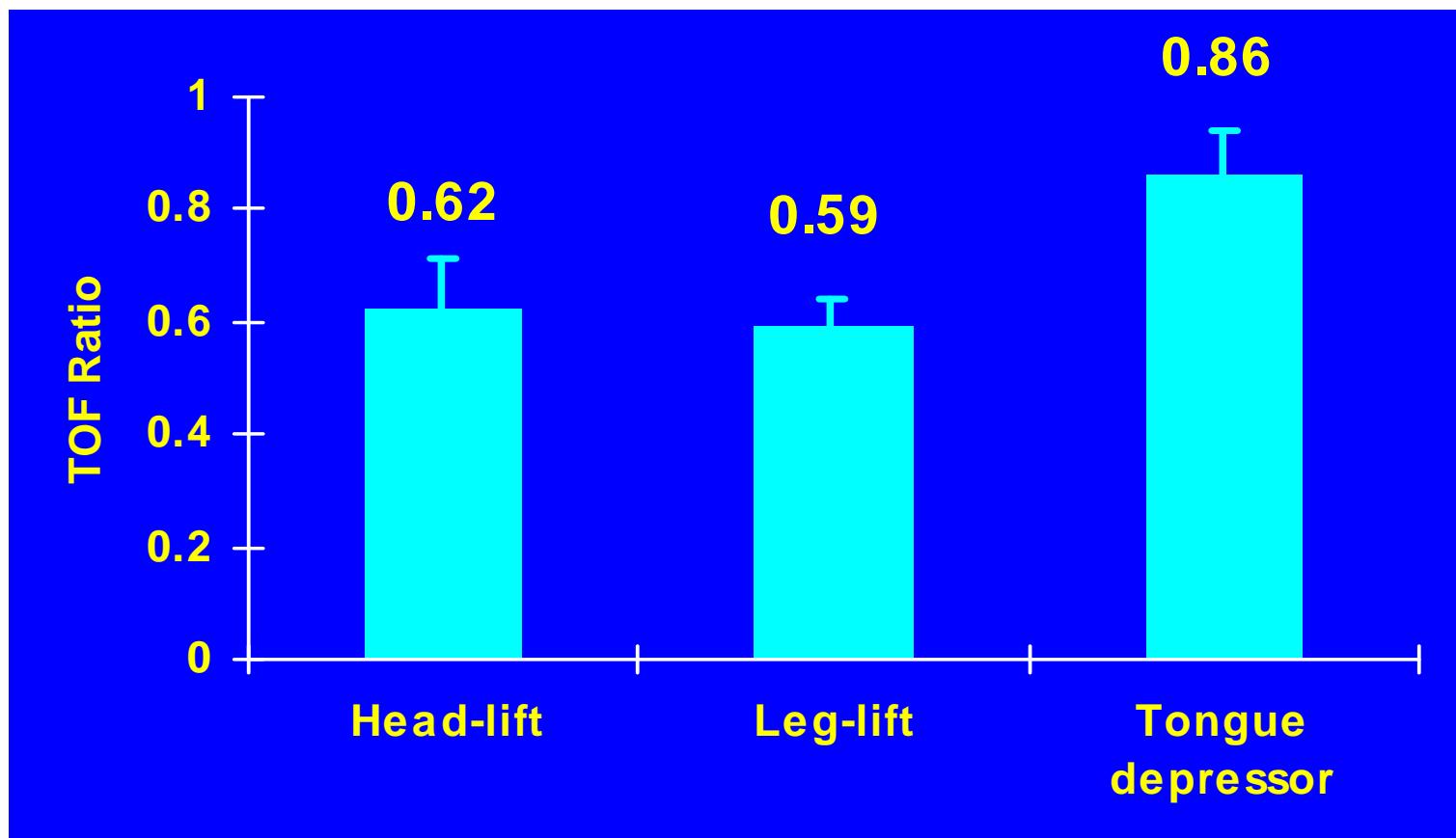


Le seuil traditionnel de 0.7



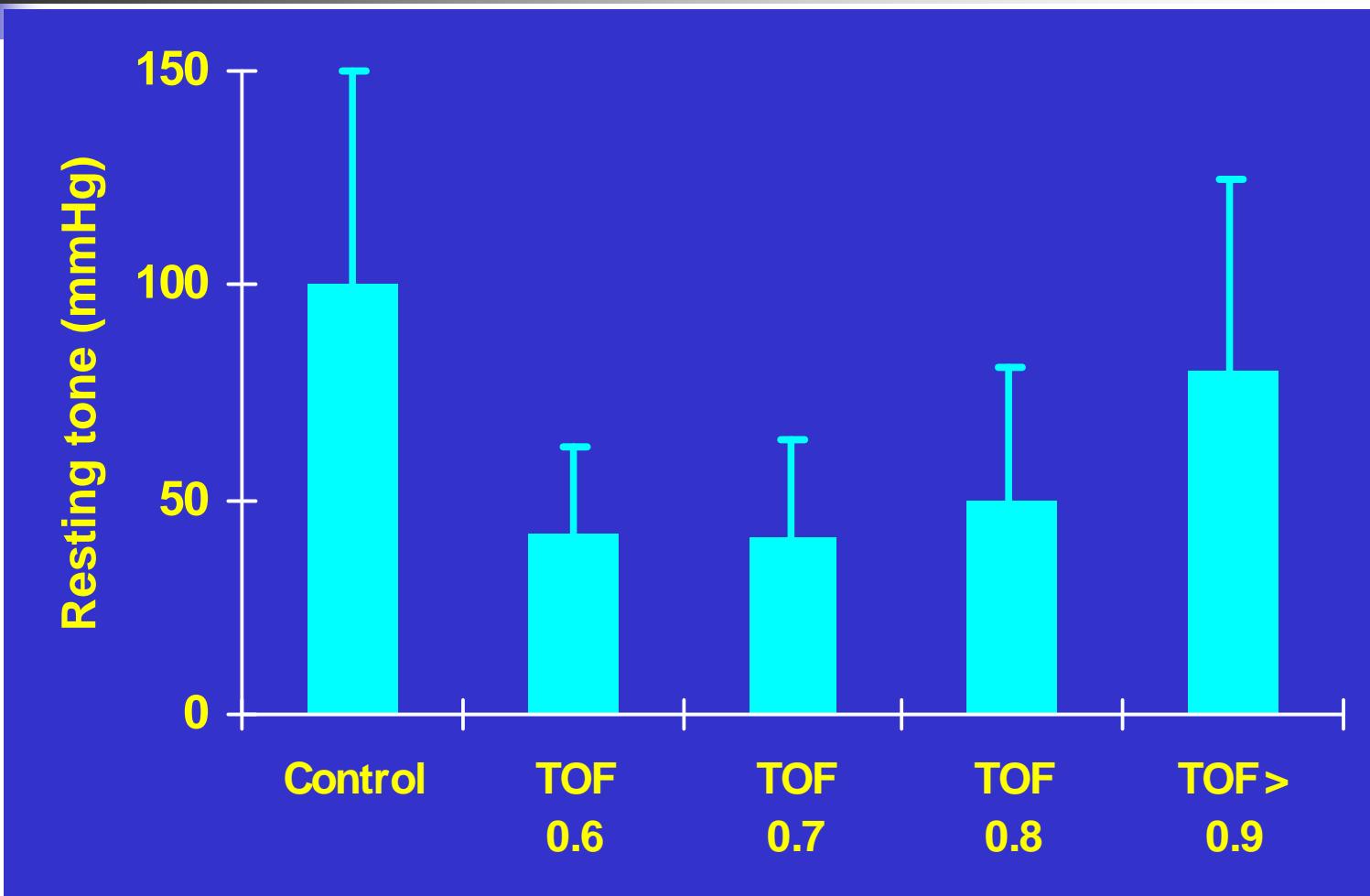
After Ali HH et al. Br J Anaesth 1975; 47: 570-4

Tests de récupération

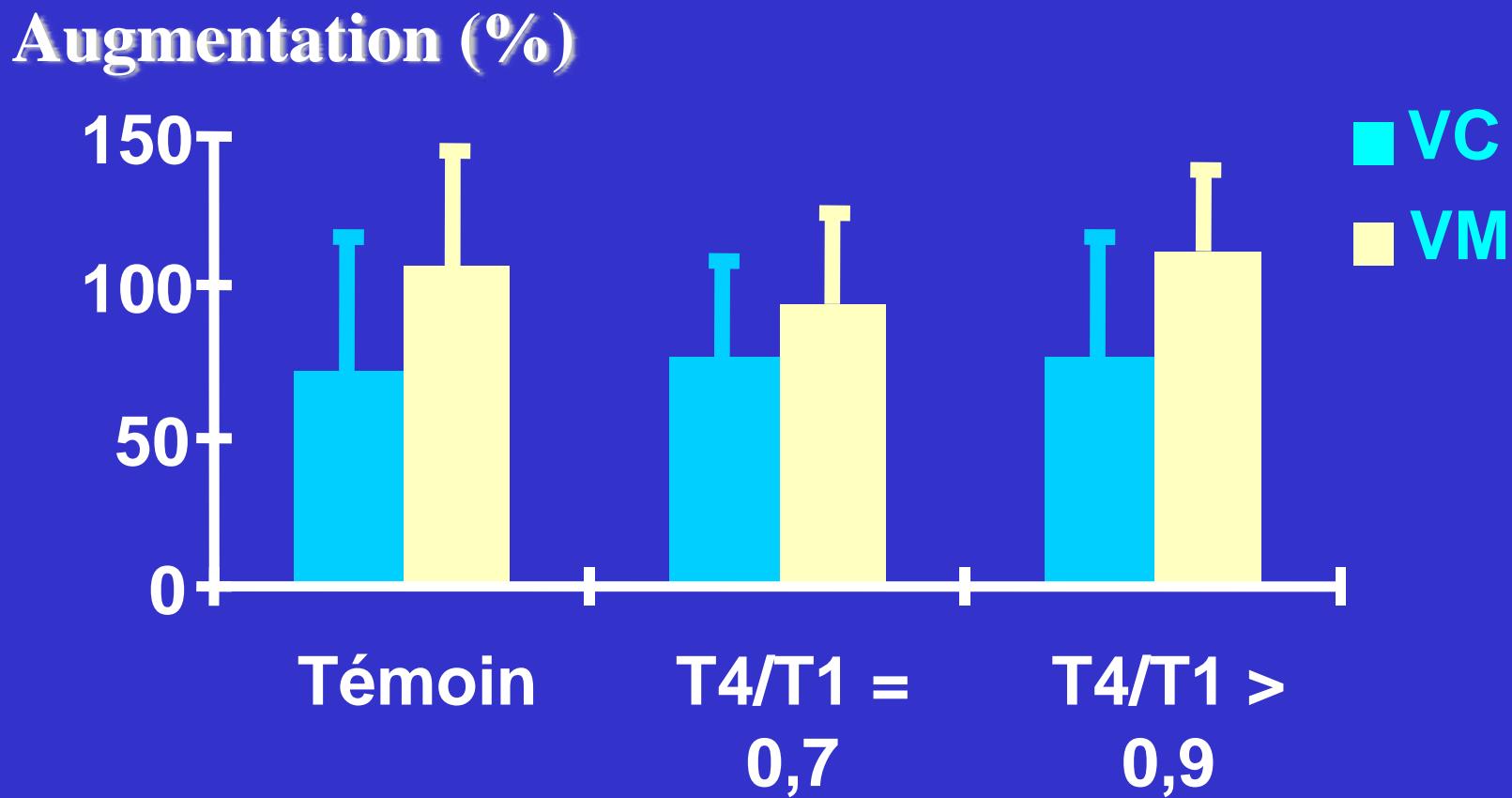


After Kopman et al. Anesthesiology 1997; 86: 765-71

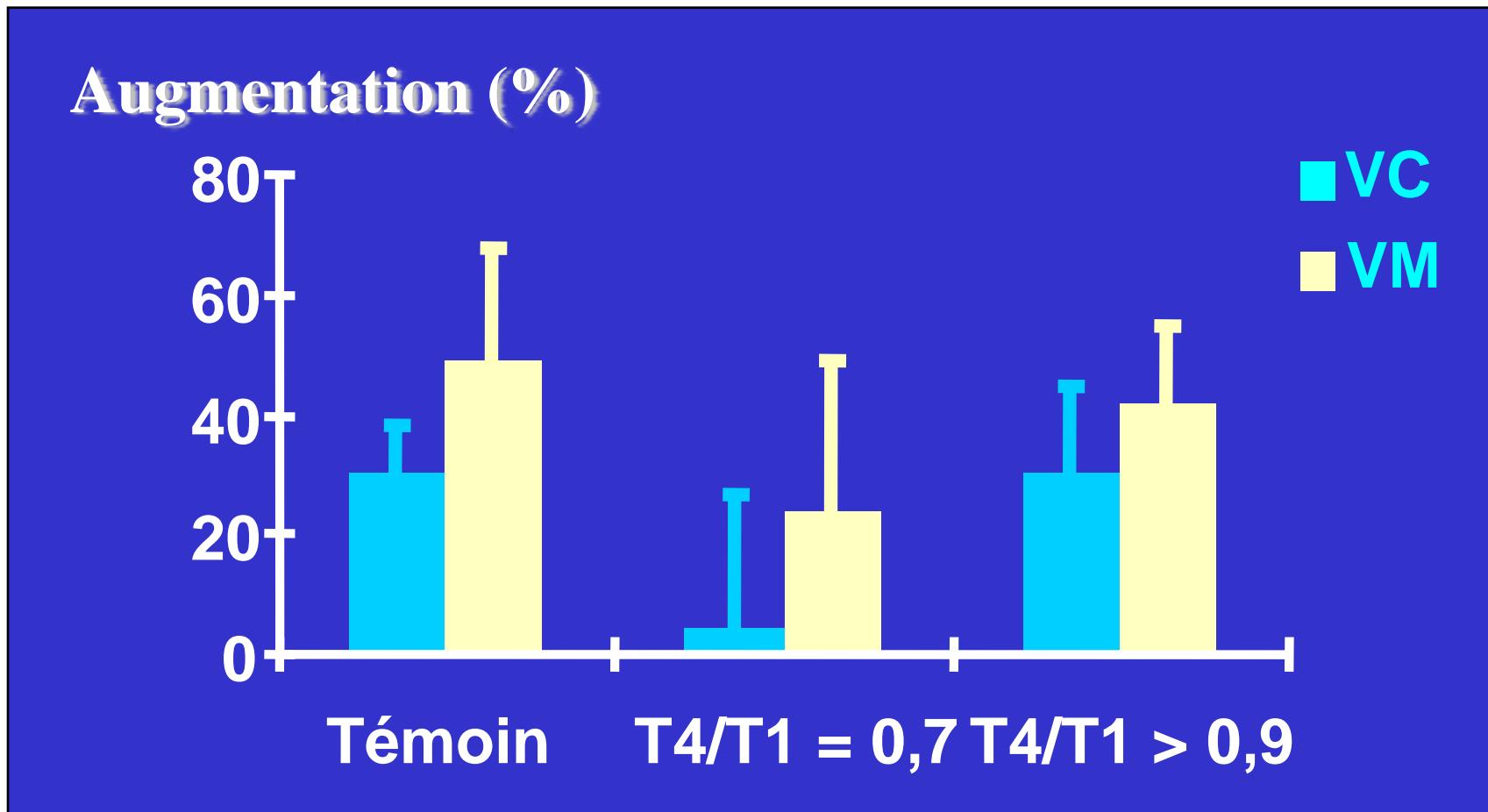
Tonus oesophagien



Réponse à l'hypercarbie

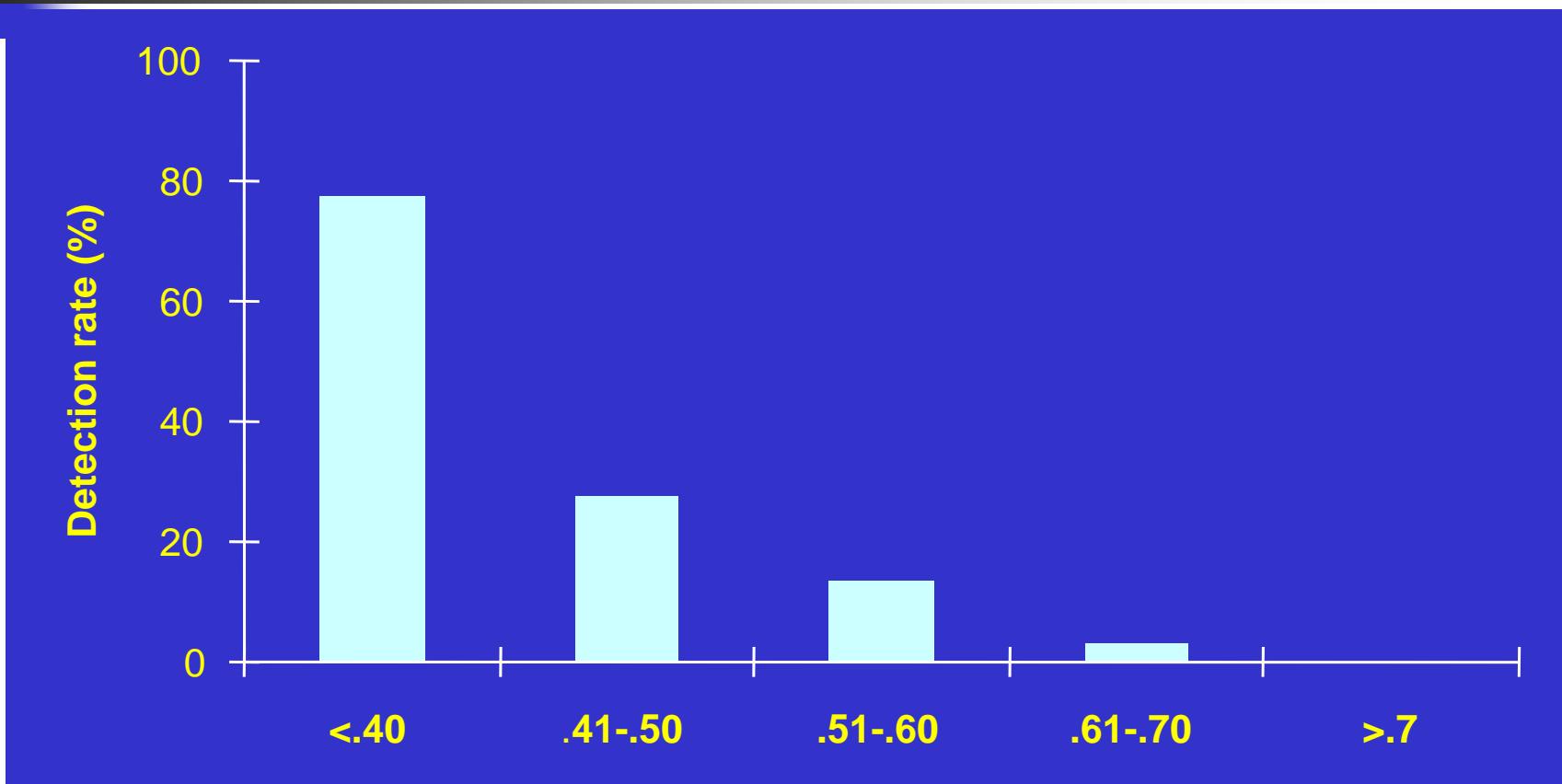


Réponse à l'hypoxie



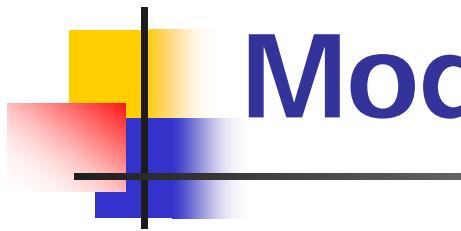
Il est difficile de détecter un T4/T1 >

0.4



Actual TOF Ratio

Drenk et al. Anesthesiology 1989; 70: 578-581

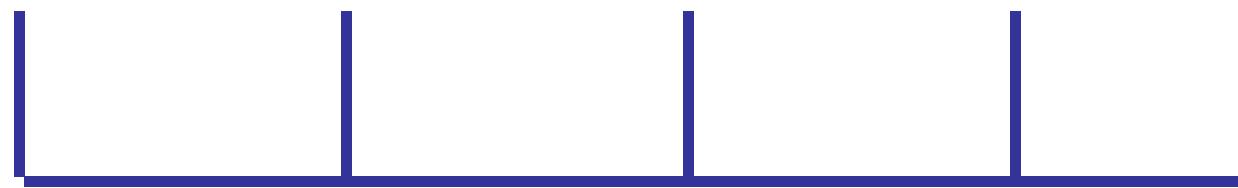


Modes de stimulation

- Twitch unique
- Train-de-quatre
- **Double-burst stimulation (DBS)**
- Stimulation tétanique
- Post-tetanic count

DBS vs TOF stimulation

TOF

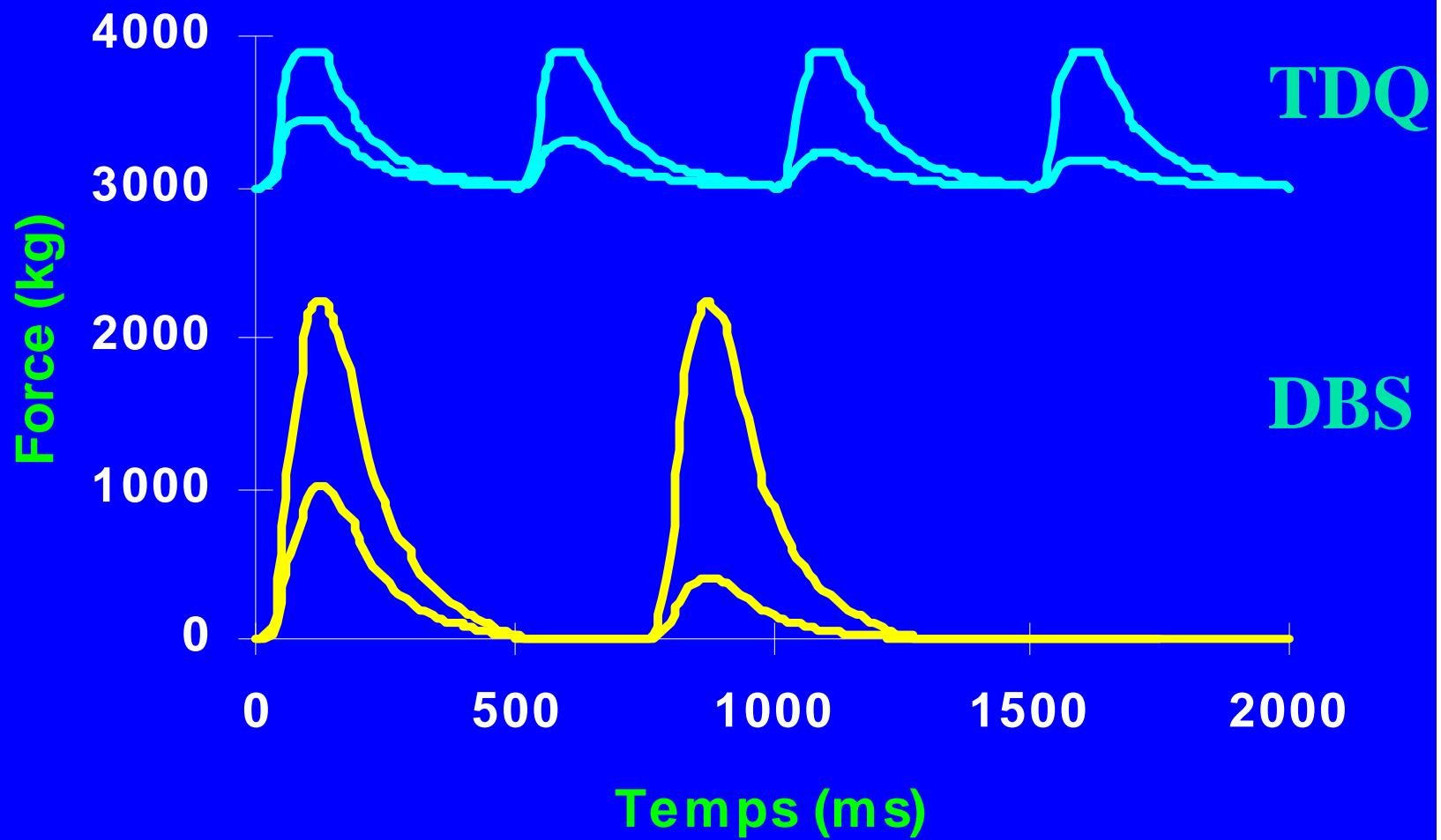


DBS_{3,3}

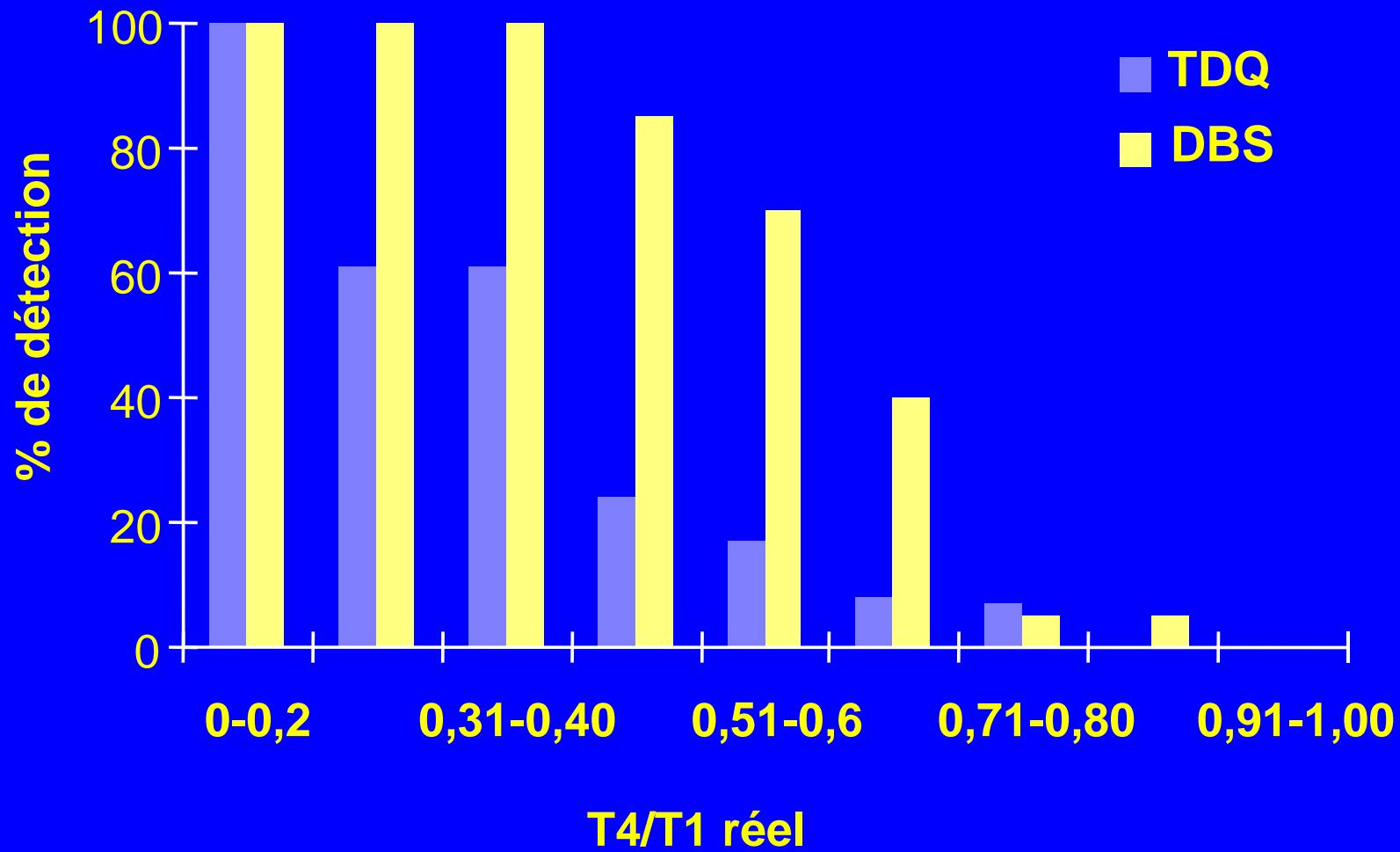


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seconde

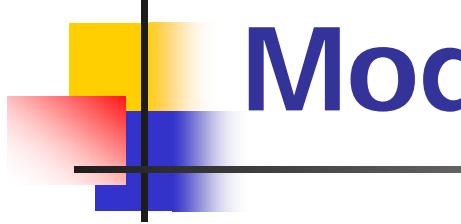
Double burst stimulation (DBS)



Détection avec DBS



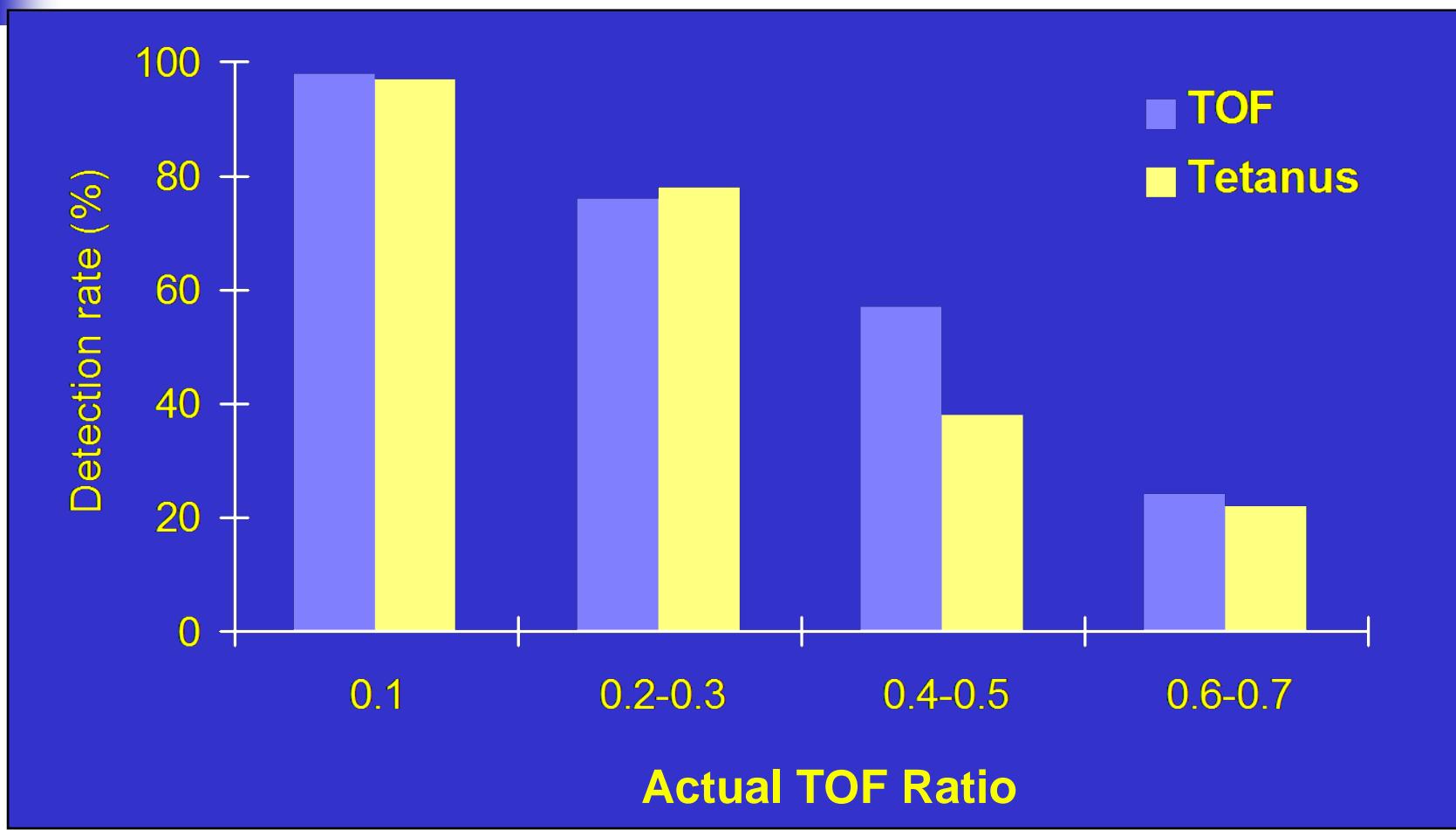
D'après Saitoh et al. Anesth Analg 1997; 84: 1354-8



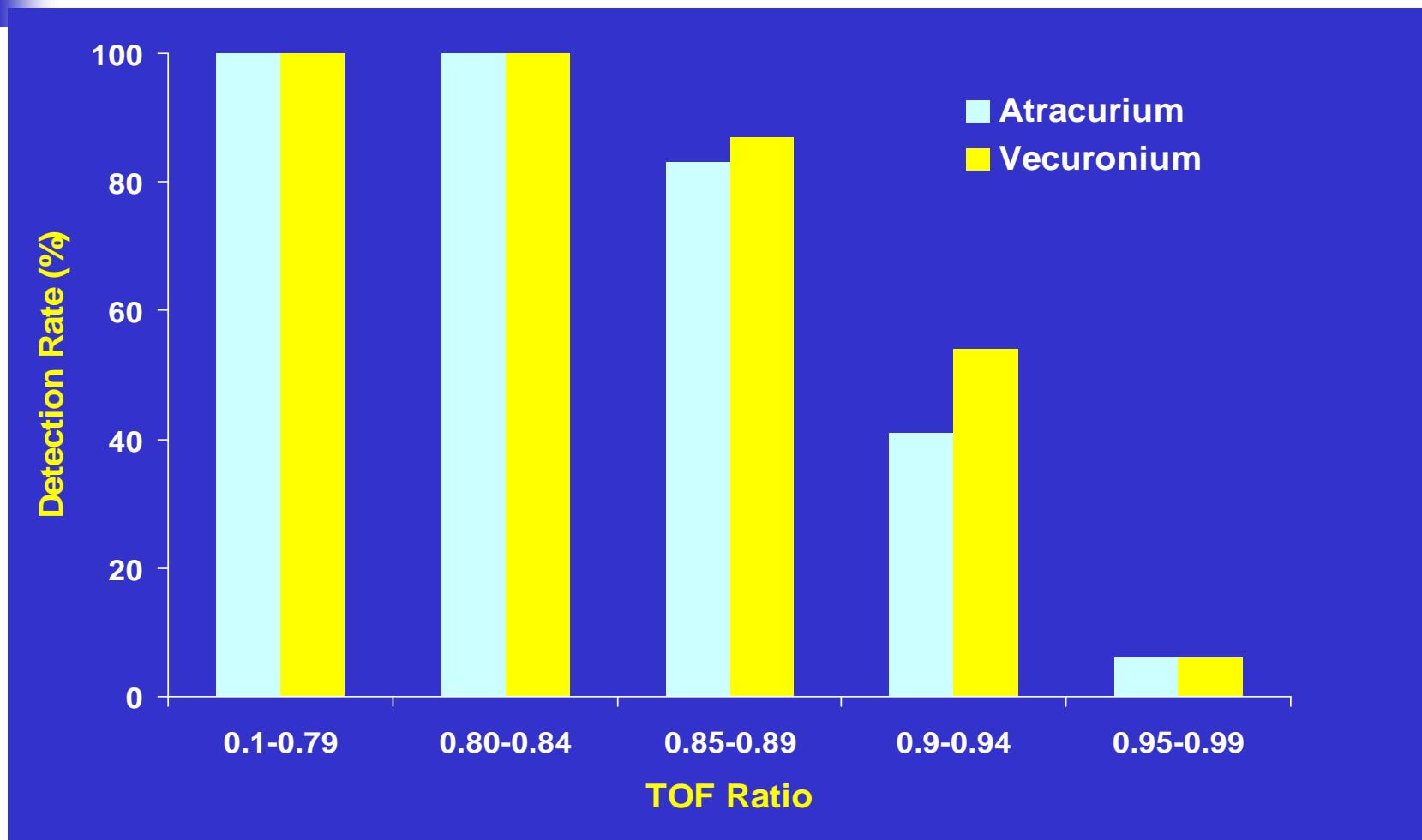
Modes de stimulation

- Twitch unique
- Train-de-quatre
- Double-burst stimulation (DBS)
- **Stimulation tétanique**
- Post-tetanic count

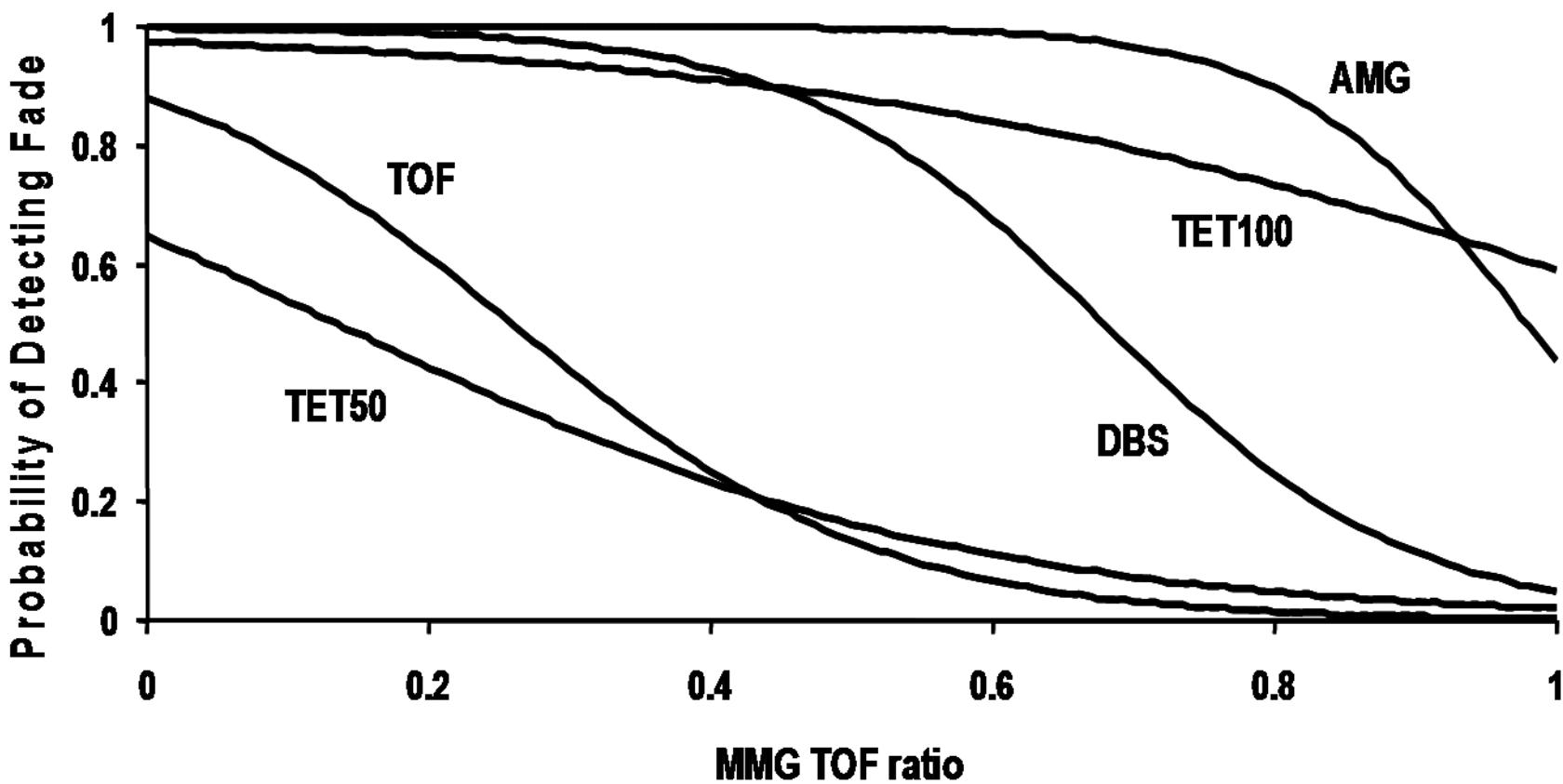
Stimulation tétanique 50 Hz

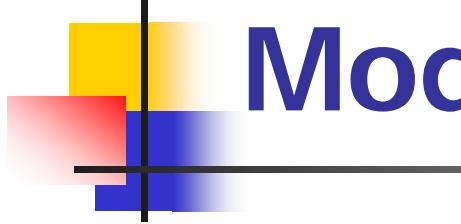


Stimulation tétanique 100 Hz



Tous les tests





Modes de stimulation

- **Twitch unique**
- **Train-de-quatre**
- **Double-burst stimulation (DBS)**
- **Stimulation tétanique**
- **Post-tetanic count**

Post-tetanic count (PTC)

- À faire quand il n'y a pas de twitch
- Tétanos: 50 Hz pendant 5 secondes
- Pause: 3 secondes
- Stimulation à 1 Hz
- Compter le nombre de twitches
- Moins il y a de twitches, plus la curarisation est profonde
- Ne pas répéter plus qu'à toutes les 2 min

PTC

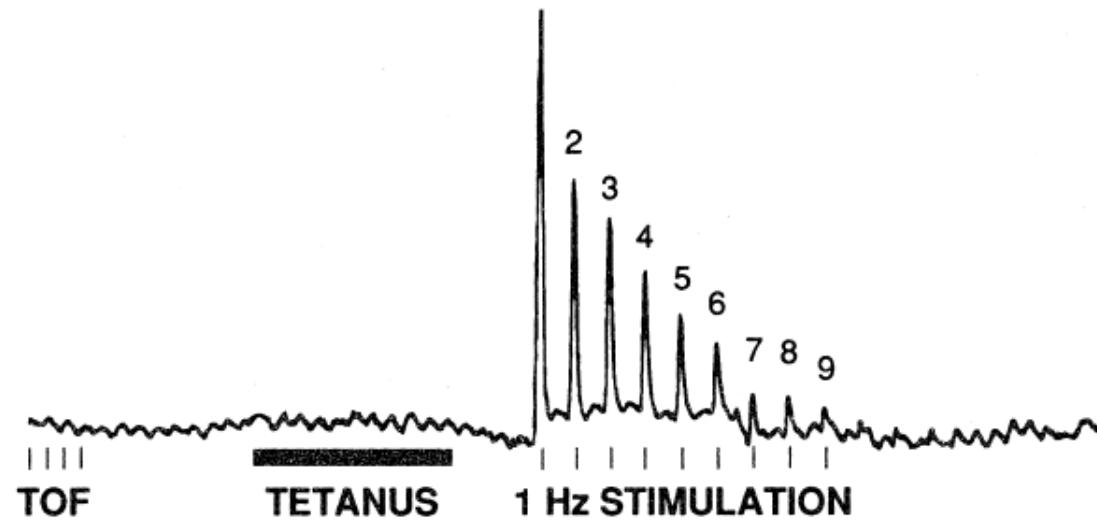


FIGURE 16-13. Posttetanic count (PTC). During profound blockade, no response is seen to train-of-four (TOF) or tetanus. However, because there is posttetanic facilitation, some twitches (in the case earlier, 9) can be seen after tetanic stimulation. In the example above, the PTC is 9.

PTC: interprétation

- Compte > 15: récupération imminente
- Compte = 0: curarisation très profonde
- Compte = 1-4: récupération dépend du curare intermédiaires 15-20 min

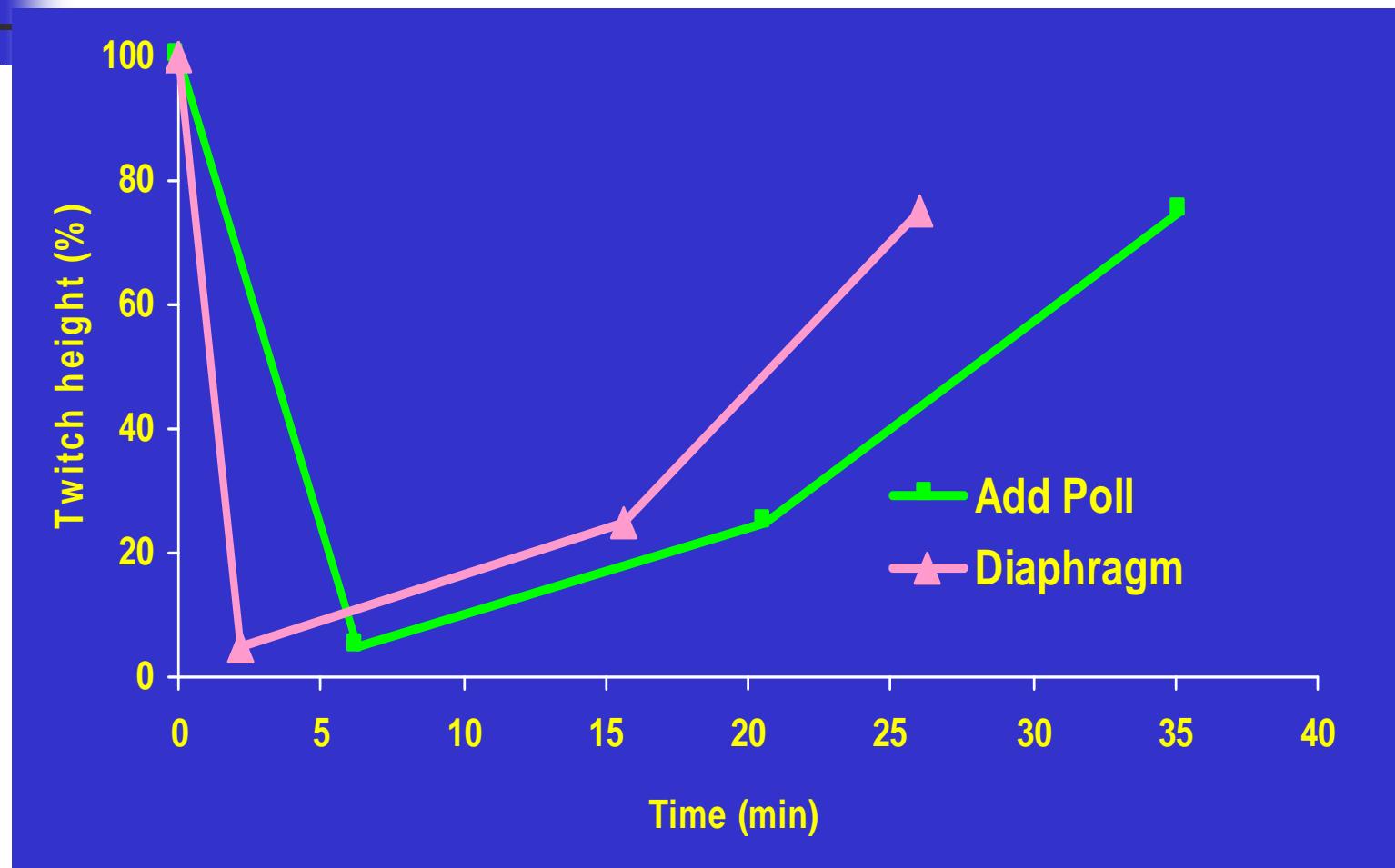
Plan

Pourquoi?

Stimulateurs

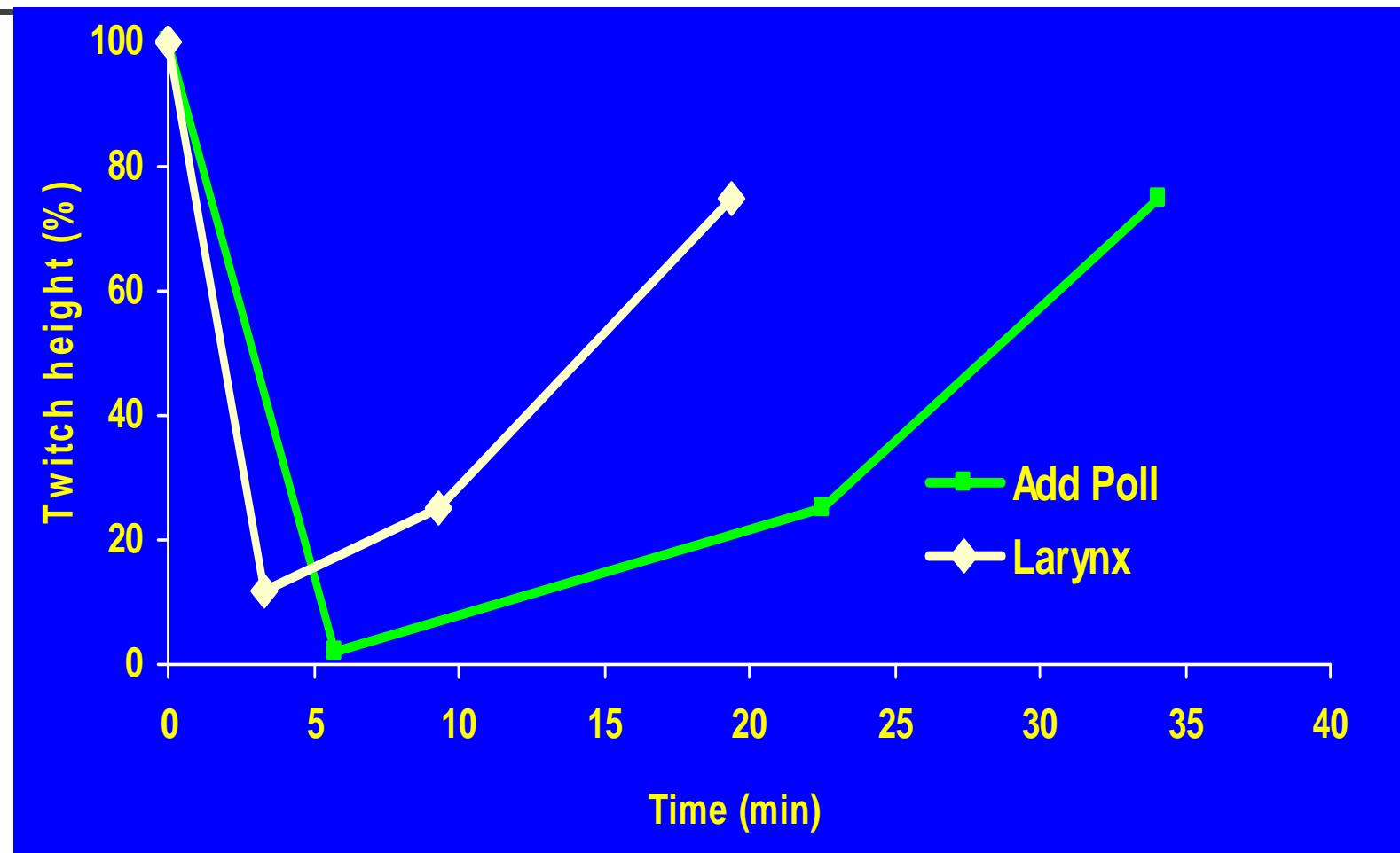
- Caractéristiques du bloc non-dépolarisant
- Caractéristiques du bloc dépolarisant
- Techniques de mesure
- Modes de stimulation
- Réponse des différents muscles
- Sites de stimulation
- Problèmes cliniques

Diaphragm vs Adductor pollicis vecuronium, 0.07 mg/kg



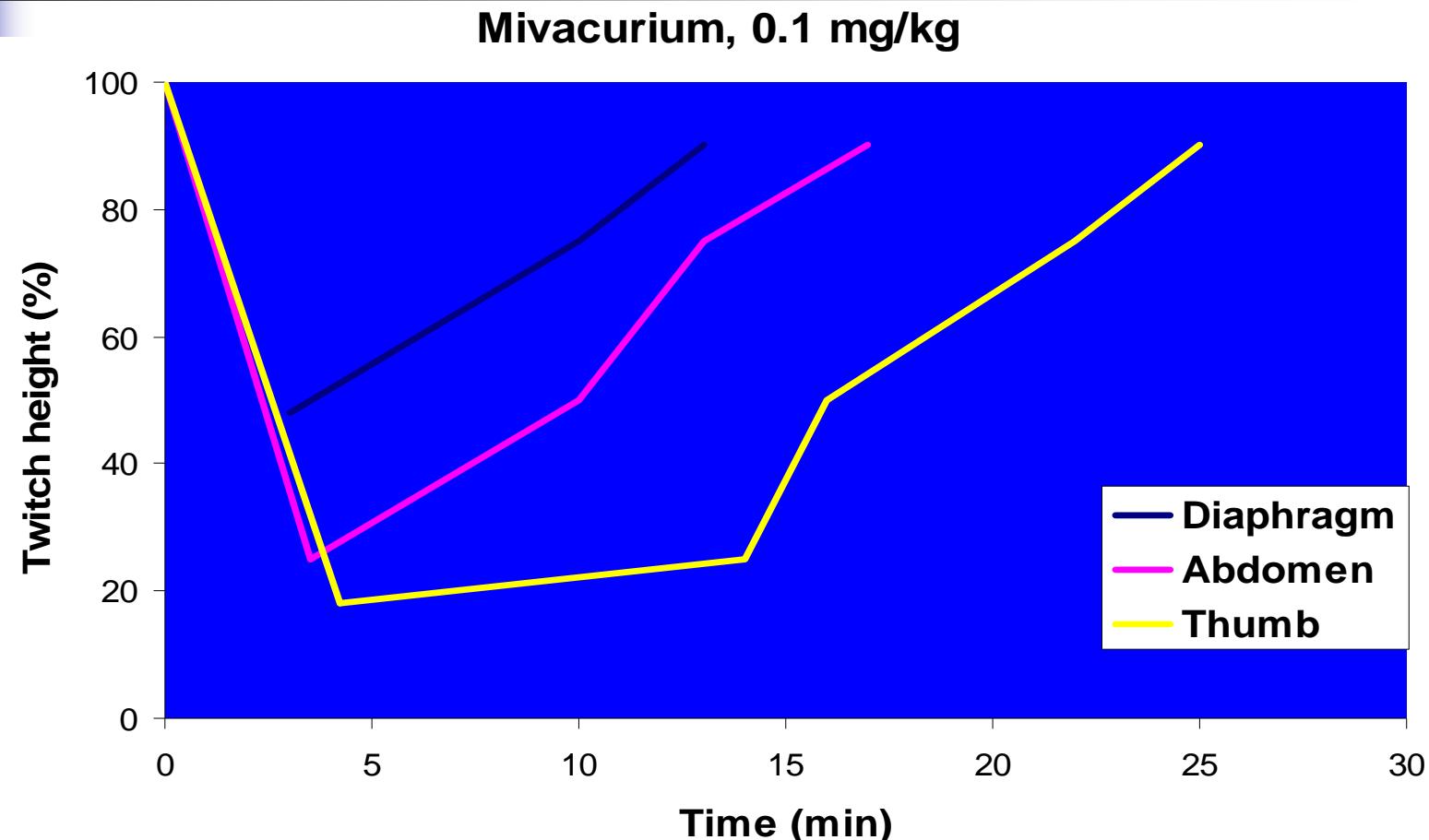
Donati et al. Anesthesiology 1990; 73: 870

Larynx vs Adductor pollicis vecuronium, 0.07 mg/kg



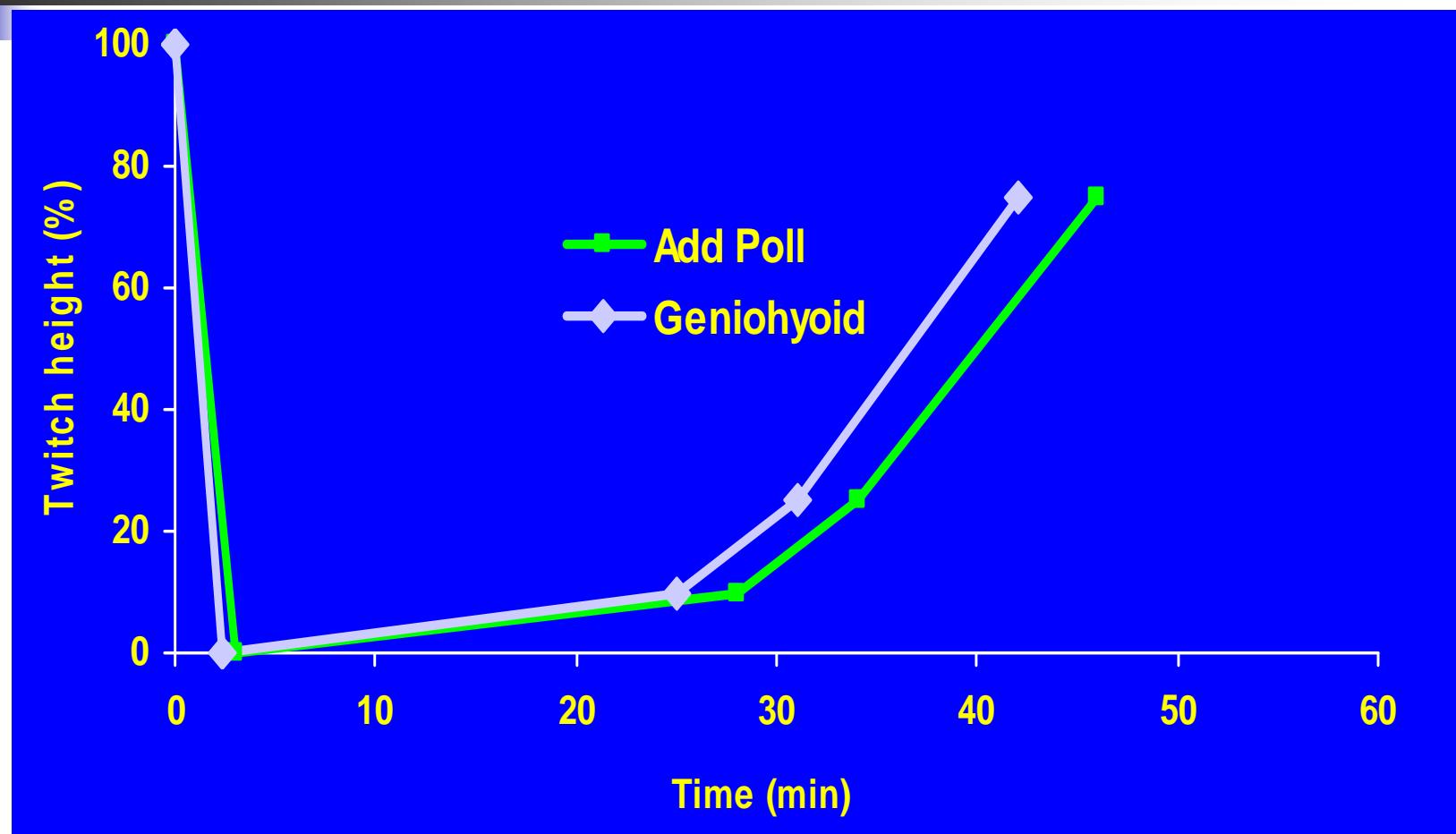
Abdominal Muscles

Kirov et al. Anesthesiology 2001; 95: 1323



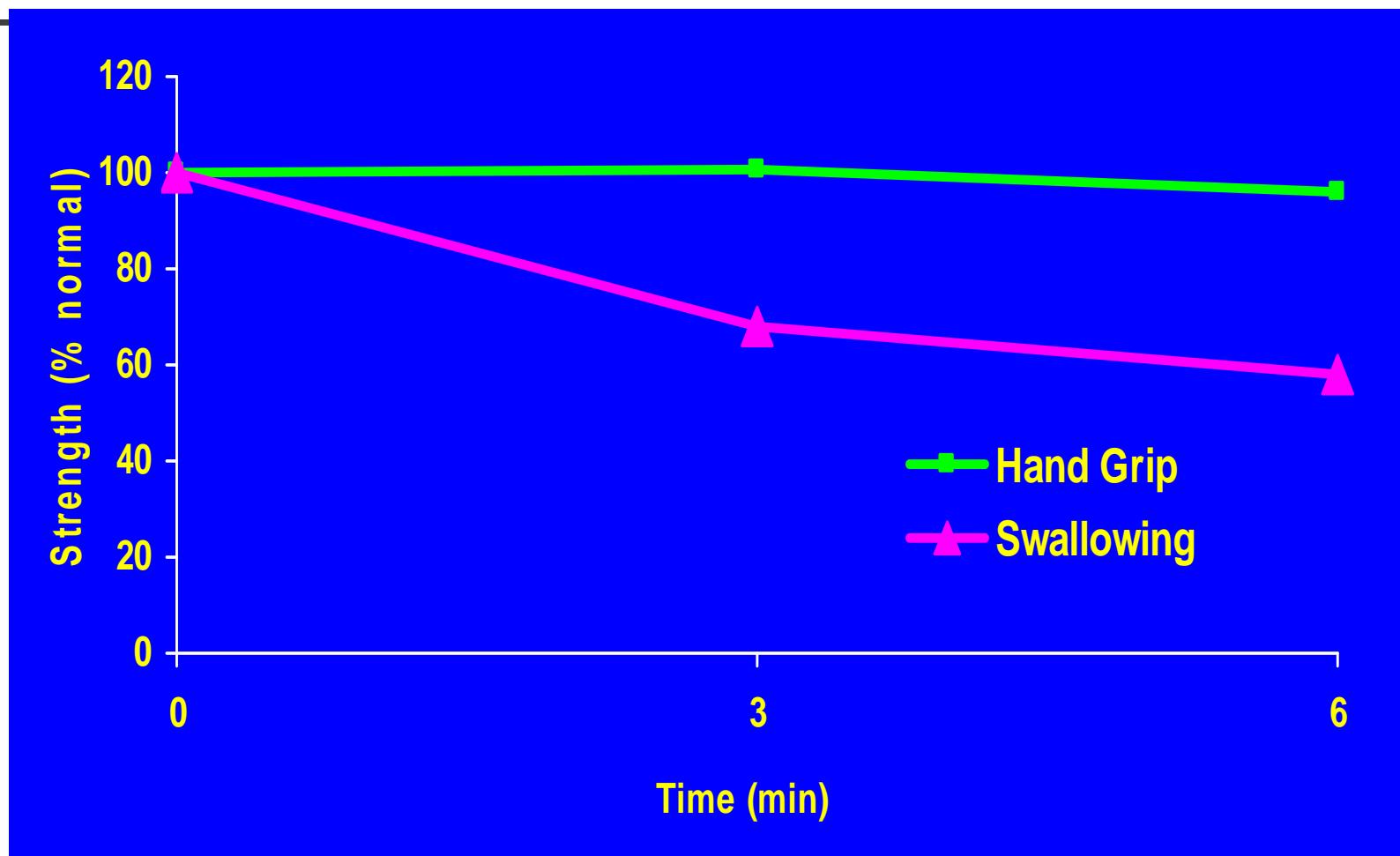
Kirov et al. Anesthesiology 2002; 96: 583

Geniohyoid vs Adductor pollicis vecuronium, 0.1 mg/kg



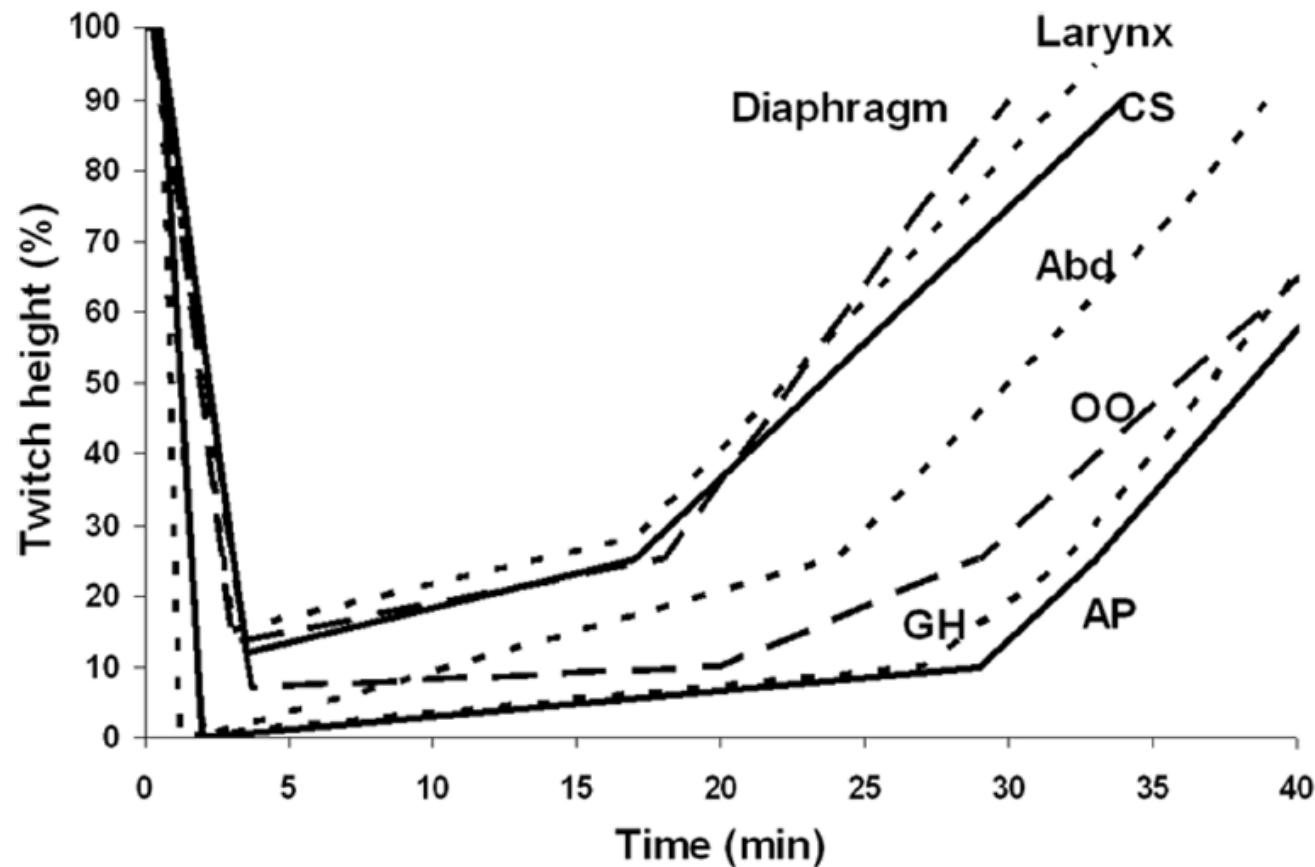
D'honneur et al. Anesthesiology 1995; 82: 649

Hand vs Upper airway vecuronium, 0.015 mg/kg



D'Honneur et al. Anesthesiology 1992; 77: 1070

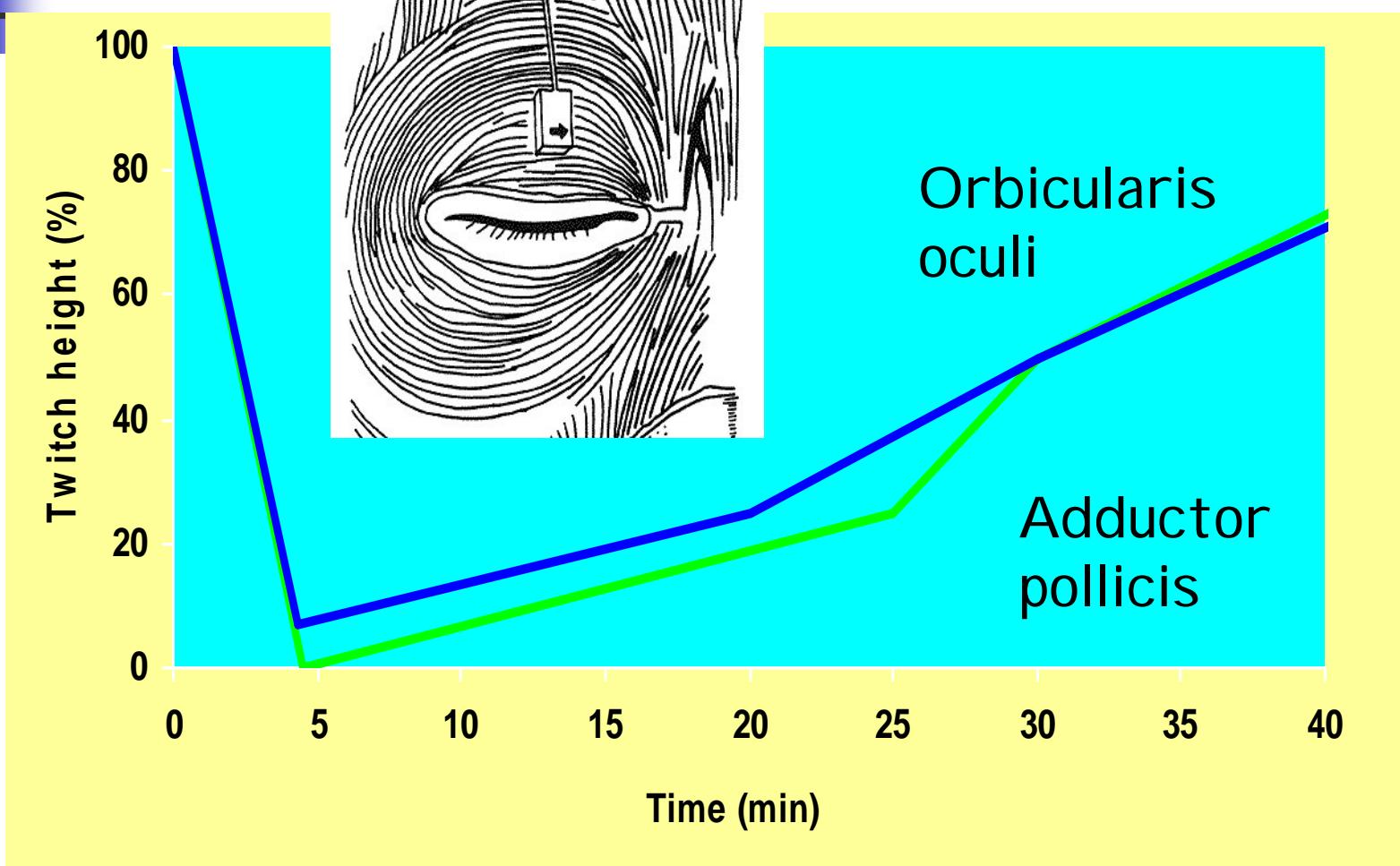
Muscles: résumé



Plan

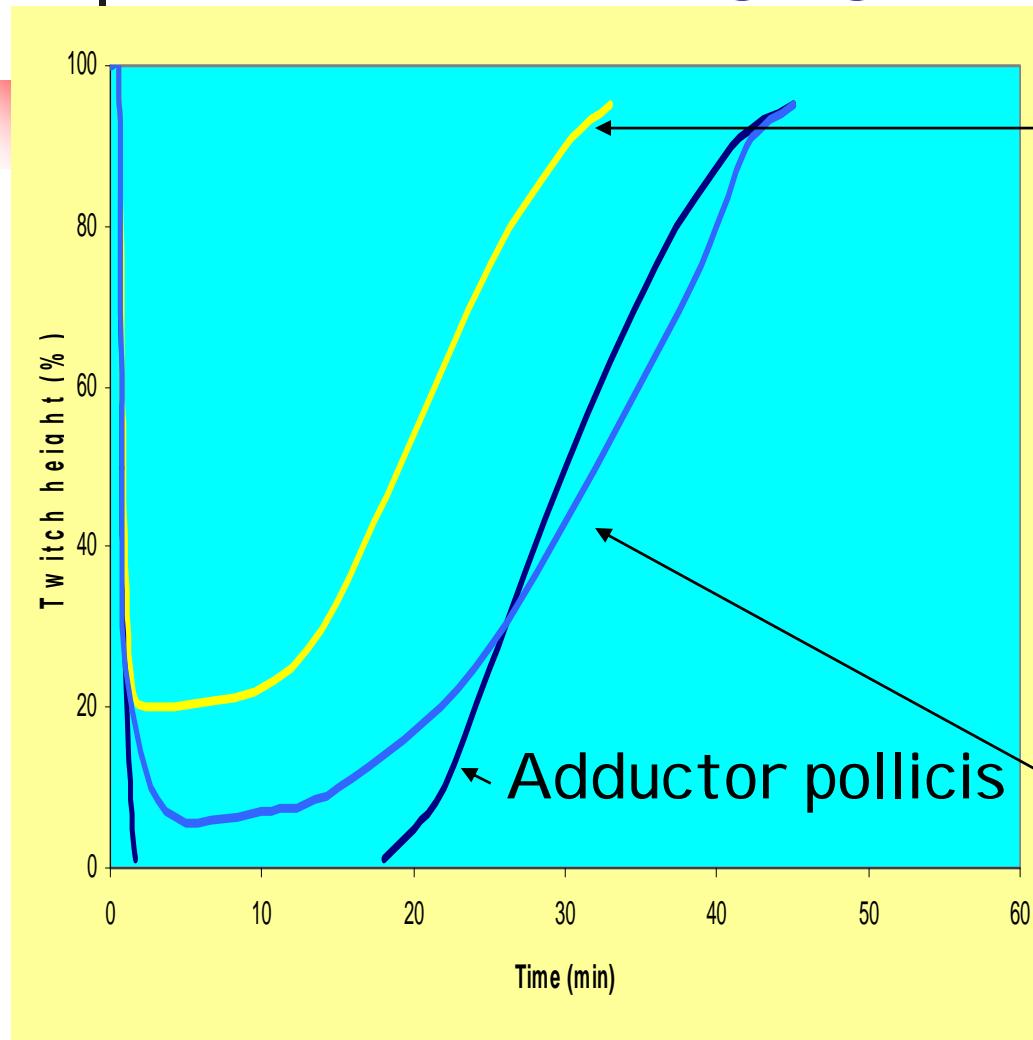
- Pourquoi?
- Stimulateurs
- Caractéristiques du bloc non-dépolarisant
- Caractéristiques du bloc dépolarisant
- Techniques de mesure
- Modes de stimulation
- Réponse des différents muscles
- **Sites de stimulation**
- Problèmes cliniques

Orbiculaire de l'oeil vs adducteur du pouce Vécuronium, 0,06 mg/kg

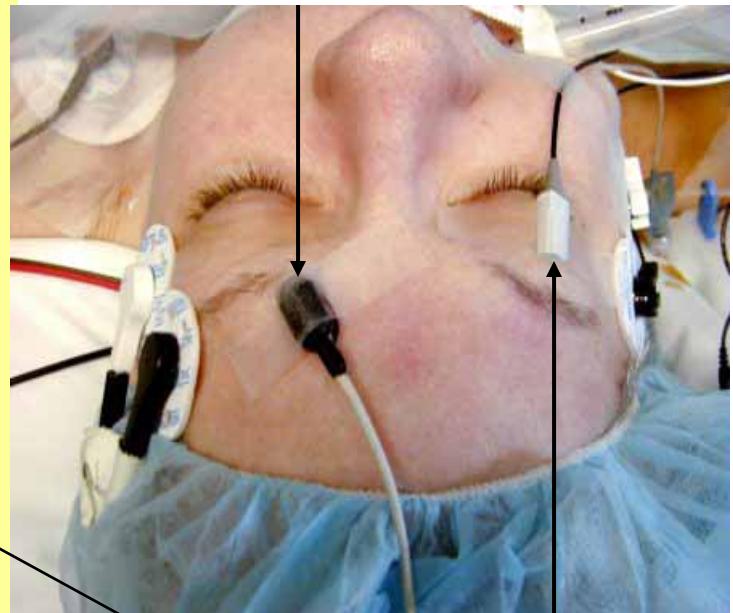


Rimaniol et al. Anesth Analg 1996; 83: 808

Orbiculaire de l'oeil vs sourciliier: rocuronium, 0.5 mg/kg

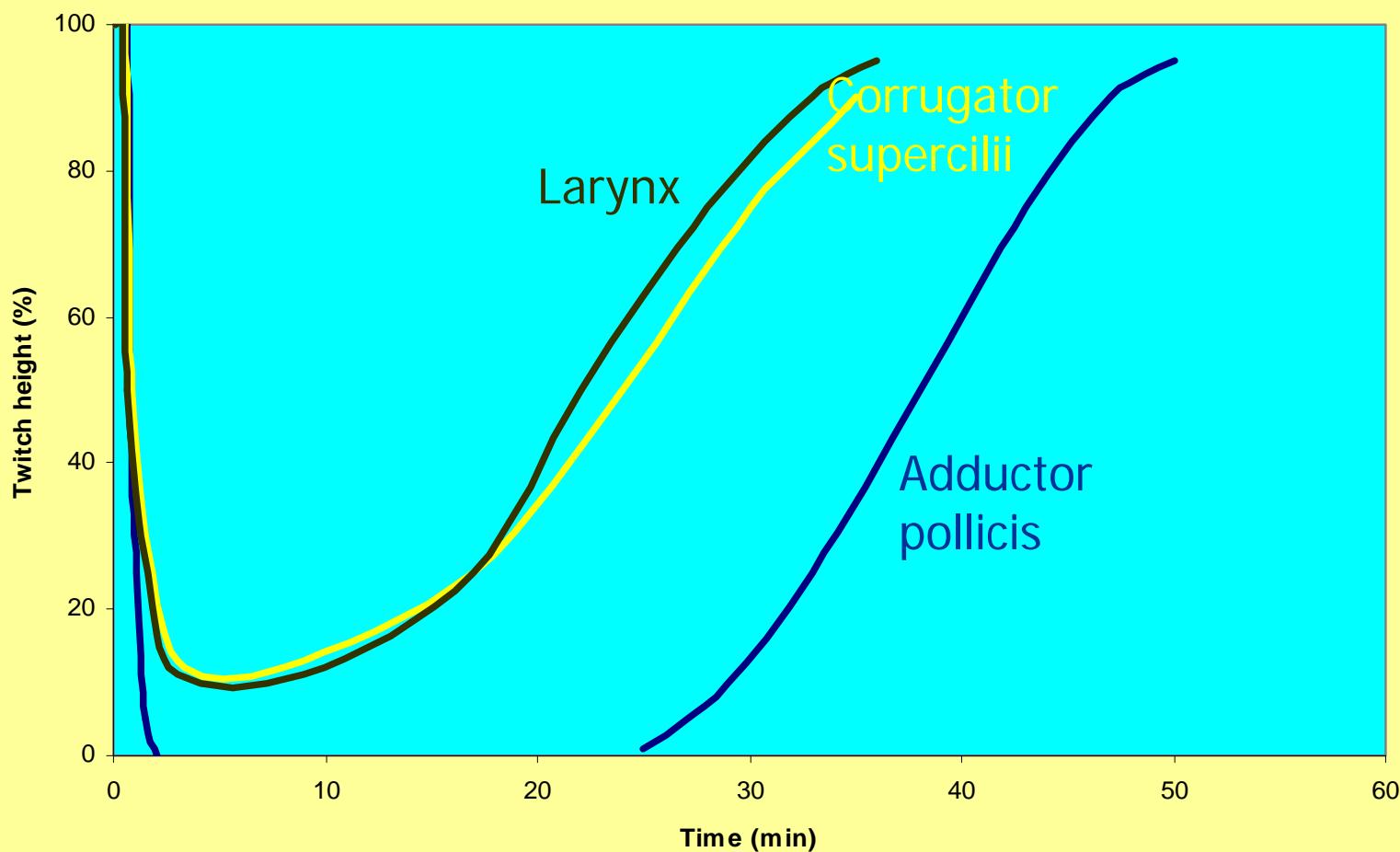


Corrugator
supercilii



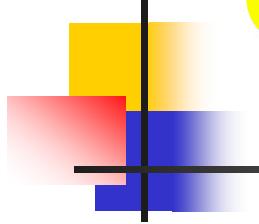
Orbicularis oculi

Sourciliers vs larynx



Résumé sur les muscles

Muscles	Délai	Intensité du bloc	Durée
Adducteur du pouce Petit doigt Pied	Lent	Profond	Longue
Adducteurs du larynx Diaphragme Sourciliers	Court à haute dose	Faible	Courte
Voies aériennes sup. Orbiculaire de l'oeil	Court	Très profond	Longue



Curarisation profonde

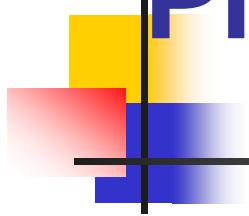
- Post-tetanic count
- Sourciliier (corrugator supercilii)

Plan

Pourquoi?

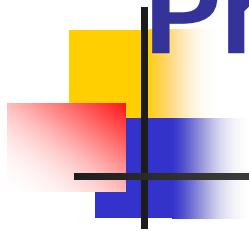
Stimulateurs

- Caractéristiques du bloc non-dépolarisant
- Caractéristiques du bloc dépolarisant
- Techniques de mesure
- Modes de stimulation
- Réponse des différents muscles
- Sites de stimulation
- Problèmes cliniques



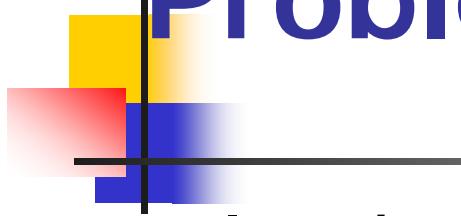
Problèmes cliniques - 1

- Intubation:
 - Rocuronium, 3 mg
 - Succinylcholine, 160 mg
- Monitorage?
 - Site
 - Mode



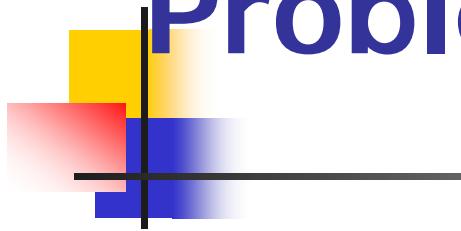
Problèmes cliniques - 2

- Intubation:
 - Rocuronium, 50 mg
- Monitorage?
 - Site
 - Mode
 - Attendre quoi?



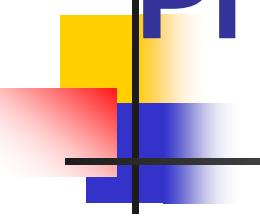
Problèmes cliniques - 3

- Intubation:
 - Rocuronium, 50 mg
- Après 45 minutes
 - Le chirurgien se plaint
 - Pas de twitch au pouce
- Traitement?
 - Engueuler le chirurgien?
 - Faire réparer le neurostimulateur?
 - Donner plus de curare?



Problèmes cliniques - 4

- Intubation:
 - Rocuronium, 50 mg
- Entretien
 - Rocuronium, 10 mg x 1
- Le patient respire, 10 min avant la fin
- Que faire?



Problèmes cliniques - 5

- Intubation:
 - Rocuronium, 50 mg
- Entretien:
 - Rocuronium, 20 mg
- Monitorage à l'adducteur du pouce
- 4 twitches égaux à la fin de l'intervention
 - Néostigmine?

Ce que vous voyez quand il y a 4 réponses égales

$T4/T1$

0.4

0.7

0.9

1.0

100

80

60

40

20

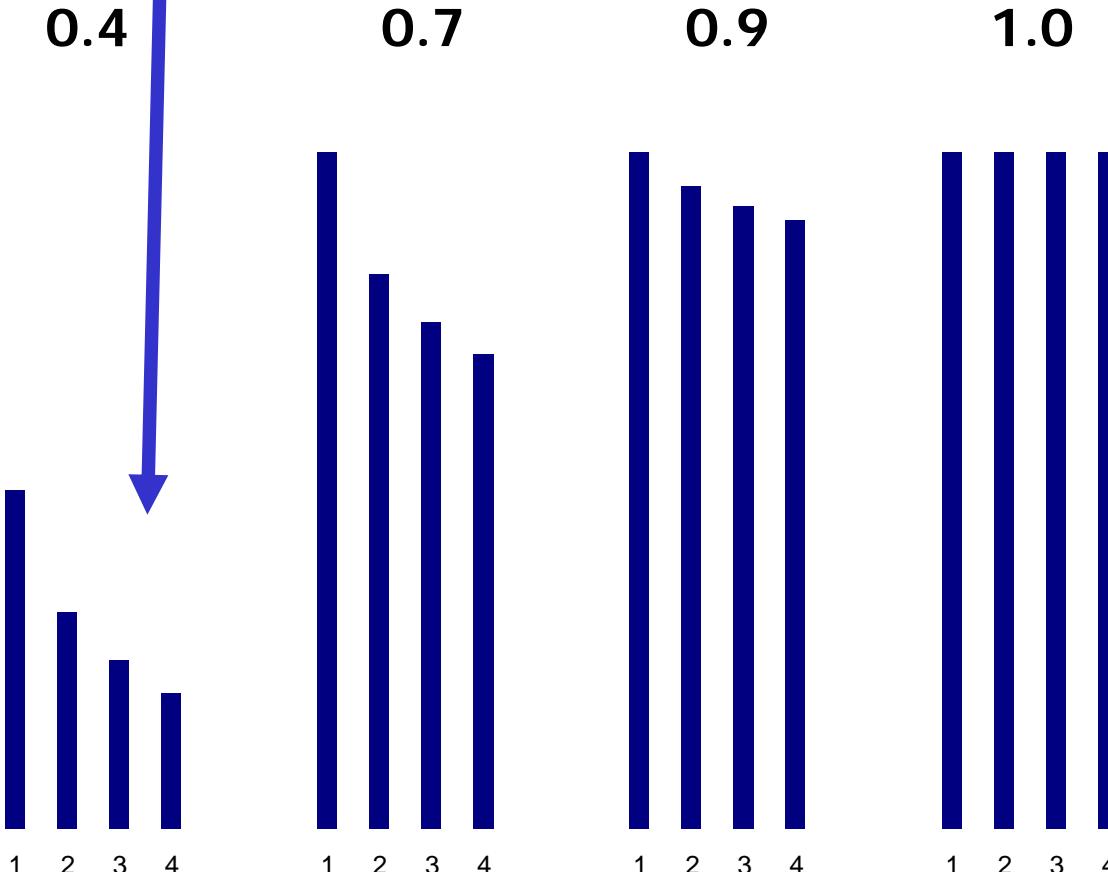
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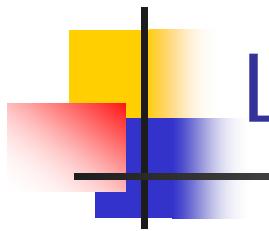
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Le seuil « traditionnel »

$T4/T1$

0.4

0.7

0.9

1.0

100

80

60

40

20

0

1 2 3 4

1 2 3 4

1 2 3 4

1 2 3 4

0.7

80

70

60

50

0.9

90

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1.0

100

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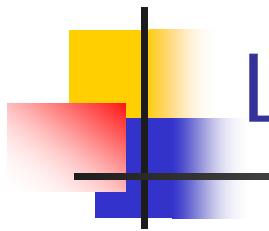
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Le seuil « adéquat »

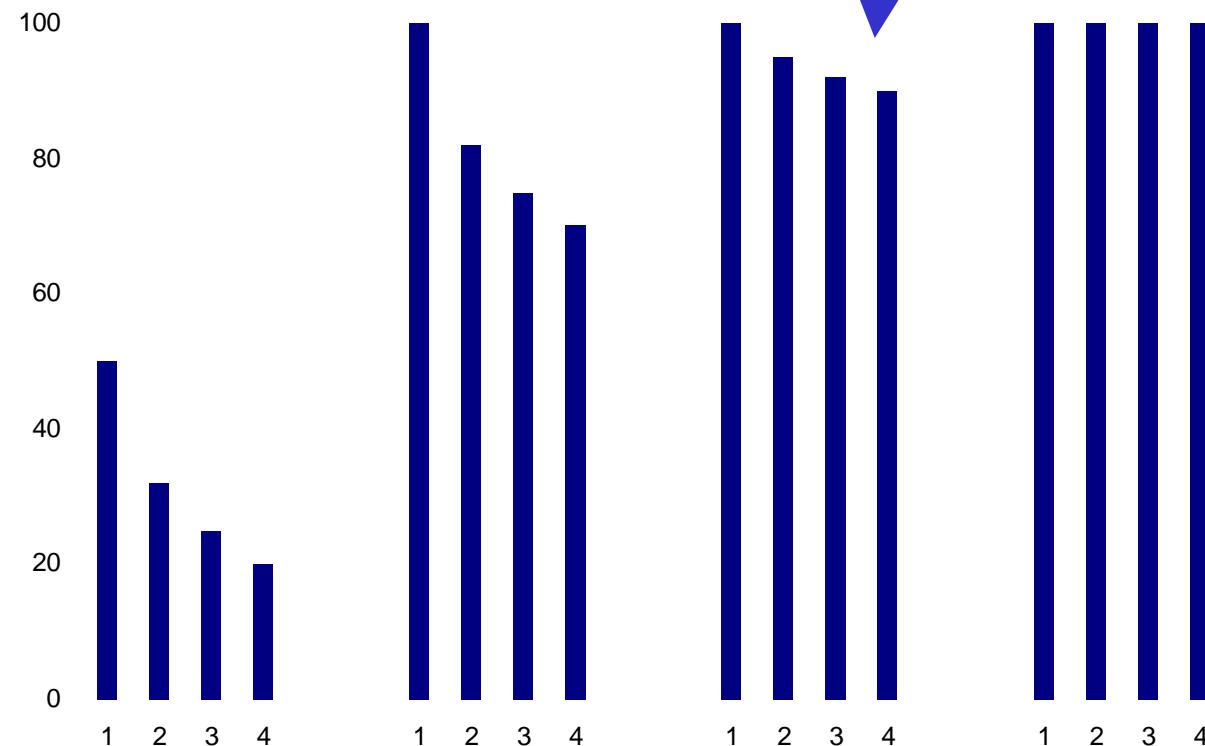
$T4/T1$

0.4

0.7

0.9

1.0



Fonction normale

$T4/T1$

0.4

0.7

0.9

1.0

100

80

60

40

20

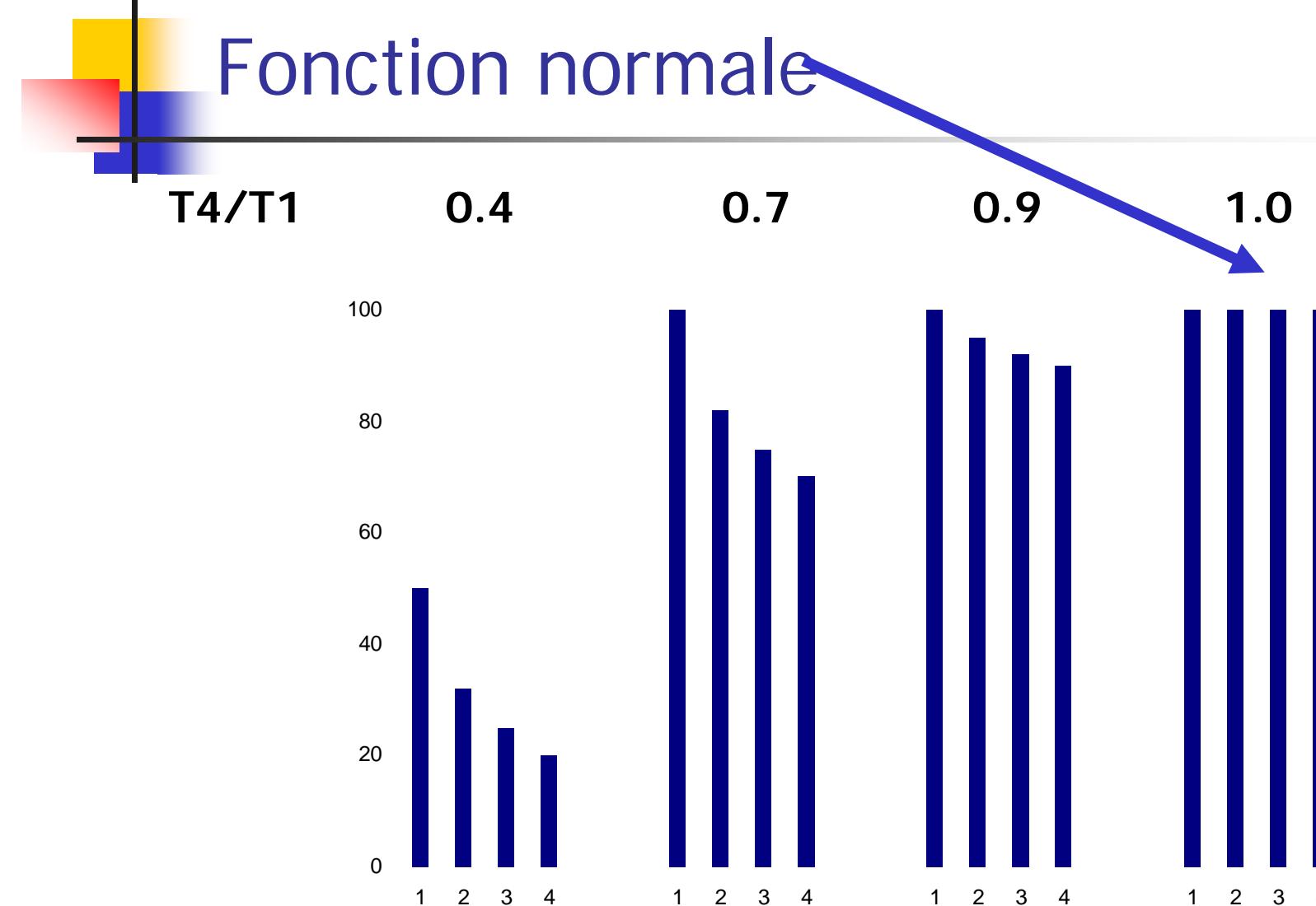
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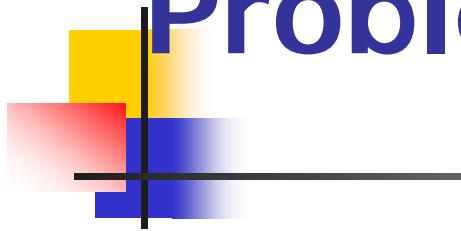
1 2 3 4

1 2 3 4

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1 2 3 4





Problèmes cliniques - 6

- Intubation:
 - Rocuronium, 50 mg
- Entretien:
 - Rocuronium, 20 mg
- Monitorage au sourciliier
- 4 twitches à la fin de l'intervention
- Néostigmine, extubation
- Désaturation en salle de réveil

Sourciliers vs larynx

