Guided Self-rehabilitation Contracts in Spastic Paresis

Jean-Michel Gracies
Henri Mondor University Hospitals, Créteil, France

Disclosure

JMG received research grants and consultancy fees from Allergan, Ipsen and Merz.

L'approche éducative du thérapeute dans l'application des Contrats d'Autoréédication Guidée (CAG)

Kinésithér Scient 2018,0602:31-43

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Maud PRADINES*
Mouna GHÉDIRA*
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AP-HP

Hôpitaux universitaires
Henri Mondor
Créteil (94)

RÉSUMÉ | *SUMMARY*

Le thérapeute tient une place centrale dans le Contrats d'Autorééducation Guidée (CAG), jouant les rôles de prescripteur, éducateur et entraîneur. Grâce à ces trois fonctions assumées au sein des CAG, celui-ci amène le patient à améliorer progressivement la compréhension de son problème, puis, en conséquence, son degré de responsabilité quant à sa propre rééducation, lui permettant à terme d'augmenter l'intensité nécessaire de son travail rééducatif.

Cet article propose quatre fiches éducatives. Les deux premières présentent la survenue des différents phénomènes physiopathologiques de la parésie spastique. La troisième explique leurs intrications progressives et l'approche technique du CAG qui en découle, ciblant spécifiquement les muscles antagonistes. La dernière fiche illustre l'approche psychologique du CAG avec la place centrale occupée par le registre, outil fondamental de responsabilisation et de motivation.

The therapist plays a central part in the Guided Self-rehabilitation Contract (GSC), with the threefold mission of prescriber, teacher and coach. Successful fulfillment of this triple role will enable to increase the patients levels of knowledge and understanding of their problem, therefore their level of responsibility regarding their own rehabilitation, ultimately allowing to enhance the intensity level of the physical work that they will perform.

This article proposes four educational sheets for use by the therapist. The first two present the pathophysiological mechanisms at work in spastic paresis. The third sheet explains the progressive entanglements between them, and the technical approach of the GSC as a result, targeting specifically antagonist muscles. The final sheet illustrates the psychological approach of the GSC, the central component being the diary, fundamental tool of empowerment and motivation.

MOTS CLÉS | *KEYWORDS*

▶ Kinésithérapeute prescripteur ▶ Motivation
▶ Myopathie spastique ▶ Parésie spastique ▶ Registre

▶ *Therapist prescriber* ▶ *Motivation*
▶ *Spastic myopathy* ▶ *Spastic paresis* ▶ *Diary*

DU Neurorééducation du Mouvement
Université Paris-Est Créteil - mai-juillet 2022

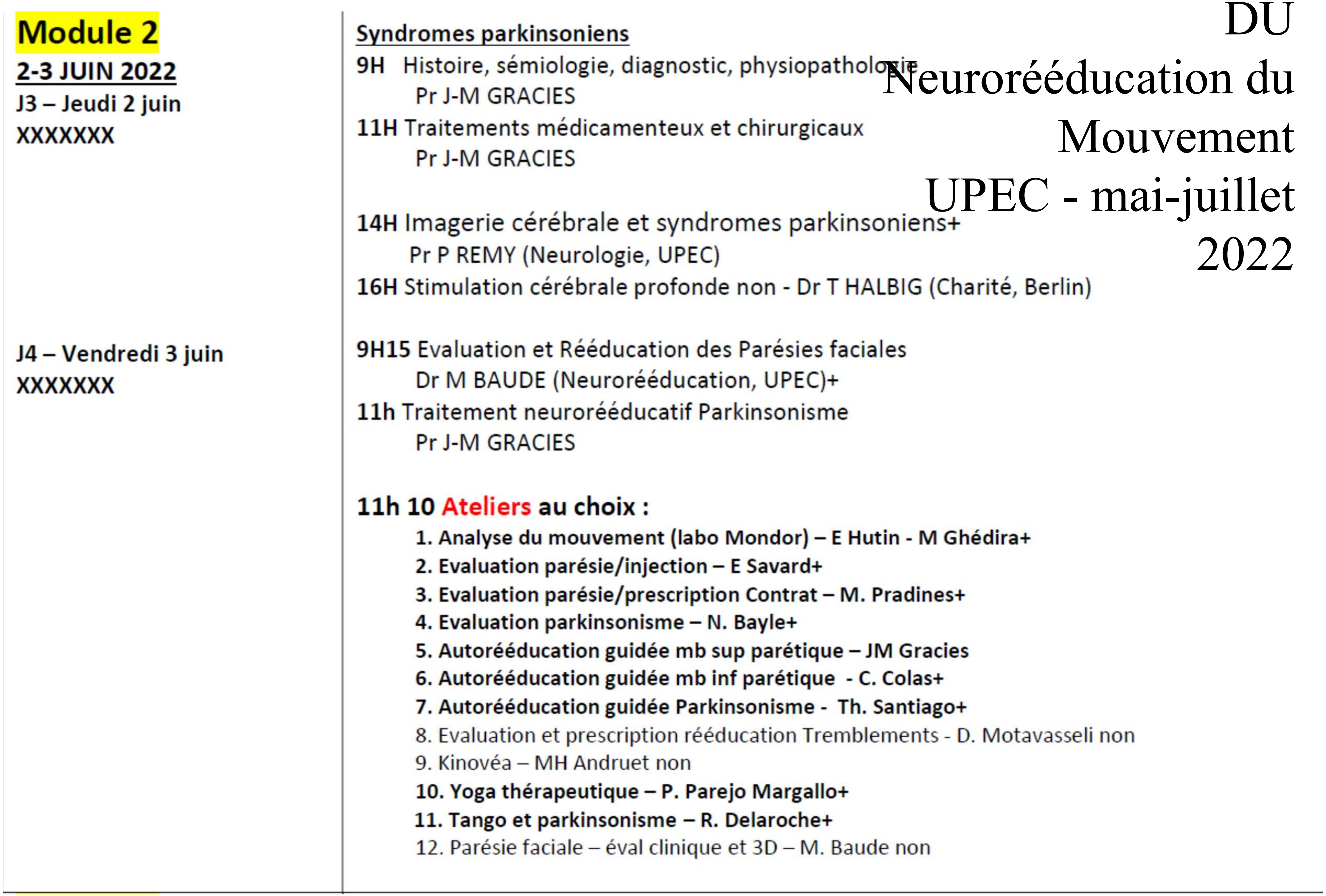
Neurorééducation du Mouvement - 10 journées d'enseignement

Jean-Michel Gracies, Professeur

Lieu des cours : Faculté de Médecine de Créteil, 8 rue du Général Sarrail, 94000 Créteil
Métro Créteil l'Echat - Hôpital Henri Mondor

Module 1 **19-20 mai 2022** **J1 – Jeudi 19 mai** **xxxxx**	**Parésie Spastique Déformante : définition d'un syndrome** **9H** Physiopathologie Pr J-M GRACIES *(Rééducation Neurolocomotrice, UPEC)* **14H** Taxonomie Pr J-M GRACIES **16H** Evaluations cliniques Pr J-M GRACIES
J2 – Vendredi 20 mai **xxxxx**	**9H** Plasticité cérébrale et musculaire Pr J-M GRACIES **15H** Techniques neuro-rééducatives validées dans la parésie Pr J-M GRACIES + Maud PRADINES (MCF, UPEC)

DU Neurorééducation du Mouvement UPEC - mai-juillet 2022



Module 2

2-3 JUIN 2022

J3 – Jeudi 2 juin
XXXXXXX

Syndromes parkinsoniens

9H Histoire, sémiologie, diagnostic, physiopathologie
Pr J-M GRACIES

11H Traitements médicamenteux et chirurgicaux
Pr J-M GRACIES

14H Imagerie cérébrale et syndromes parkinsoniens+
Pr P REMY (Neurologie, UPEC)

16H Stimulation cérébrale profonde non - Dr T HALBIG (Charité, Berlin)

J4 – Vendredi 3 juin
XXXXXXX

9H15 Evaluation et Rééducation des Parésies faciales
Dr M BAUDE (Neurorééducation, UPEC)+

11h Traitement neurorééducatif Parkinsonisme
Pr J-M GRACIES

11h 10 Ateliers au choix :

1. **Analyse du mouvement (labo Mondor) – E Hutin - M Ghédira+**
2. **Evaluation parésie/injection – E Savard+**
3. **Evaluation parésie/prescription Contrat – M. Pradines+**
4. **Evaluation parkinsonisme – N. Bayle+**
5. **Autorééducation guidée mb sup parétique – JM Gracies**
6. **Autorééducation guidée mb inf parétique - C. Colas+**
7. **Autorééducation guidée Parkinsonisme - Th. Santiago+**
8. Evaluation et prescription rééducation Tremblements - D. Motavasseli non
9. Kinovéa – MH Andruet non
10. **Yoga thérapeutique – P. Parejo Margallo+**
11. **Tango et parkinsonisme – R. Delaroche+**
12. Parésie faciale – éval clinique et 3D – M. Baude non

Module 3 **9-10 JUIN 2022** **J5 – Jeudi 9 juin** **xxxxxx**	**Tremblements – Cervelet - Ataxies – Apraxies – Chorées - Horizontalité** **9H** Tremblements : sémiologie, physiopathologie, typologie, évaluations Pr J-M GRACIES **11H** Tremblements : Neurorééducation et autres traitements Pr J-M GRACIES **14H** Ataxies, apraxies, chorées. Sémiolo Pr J-M GRACIES **16H** Complications de l'horizontalité Pr J-M GRACIES
J6 – Vendredi 10 juin Hôpital A. Chenevier	**9h30-11h Ateliers au choix :** 1. Analyse du mouvement (labo Mondor) – E Hutin- M Ghédira non **2. Evaluation parésie/injection – E Savard+**
Pavillon Wurtz	**3. Evaluation parésie/prescription Contrat – M. Pradines+** **4. Evaluation parkinsonisme – N. Bayle+** **5. Autorééducation guidée mb sup parétique – JM Gracies** **6. Autorééducation guidée mb inf parétique - C. Colas+** **7. Autorééducation guidée Parkinsonisme - Th. Santiago+** **8. Evaluation et prescription rééducation Tremblements - D. Motavasseli+** 9. Kinovéa – MH Andruet non **10. Yoga thérapeutique – P. Parejo Margallo+** **11. Tango et parkinsonisme – R. Delaroche+** **12. Parésie faciale – éval clinique et 3D – M. Baude 9h30+** **14H30** Traitements physiques du parkinsonisme (suite) Pr J-M GRACIES

DU Neurorééducation du Mouvement
UPEC - mai-juillet 2022

Module 4

16-17 JUIN 2022

J7 – Jeudi 16 juin

xxxxxxx

Analyse du Mouvement - Parésies faciales - Neurorestauration chez l'enfant

9H Parésies infantiles – aspects théoriques
Pr J-M GRACIES

14H Equilibre et Chutes chez le sujet âgé
Pr J-M GRACIES

J8 – Vendredi 17 juin
Hôpital A. Chenevier
Pavillon Wurtz

Visio plasticité musculaire influence muscle sur cerveau

14H Biothérapies dans la maladie de Parkinson+
Pr S PALFI (Neurochirurgie, UPEC)

16H Pratique neurorééducative en parkinsonisme (suite)
Th SANTIAGO et Pr J-M GRACIES

14H30 Droit et handicap - Réparation du dommage neurologique
Inclusion sociale et modifications des droits de l'homme
Maître ME AFONSO (Avocat à la Cour, Paris)

DU Neurorééducation du Mouvement
UPEC - mai-juillet 2022

Module 5 **23-24 JUIN** **J9 – Jeudi 23 juin** **xxxxx**	***Cas concrets - Handicap – Aspects juridiques*** **9H15** Hétérorééducation parentale guidée 0-2 ans+ Dr C AMELON-PETIT (CRF Saint-Fargeau) **11H** Kinésithérapie neurologique en pratique libérale+ F LAURENT (Kinésithérapeute libéral, Bordeaux) **14H** Kinésithérapie neurologique en pratique libérale++ M PRADINES (MCF, Université Paris-Est Créteil, Paris) **16H** *Tai Chi Médical et affections neurologiques du mouvement non* *Dr L CONDAMINE (Professeur et Championne du Monde de Tai Chi, UPEC)*
J10 – Vendredi 24 juin **xxxxx**	***9-10h +++ EXAMEN ECRIT FACULTE DE MEDECINE CRETEIL +++*** **11H** Rôle du kinésithérapeute dans les Contrats d'Autorééducation Guidée Th SANTIAGO Cas concrets Pr J-M GRACIES

Informations complémentaires - Conditions d'admission

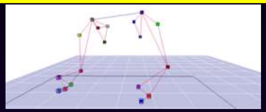
Auprès de la Faculté de Médecine de Créteil : DUFMC, 8 rue du Général Sarrail 94010 Créteil Cedex
Téléphone : 01 49 81 39 03 ou 37 32, mails : inscriptions.dufmc@u-pec.fr / dufmc.fi@u-pec.fr / dufmc.fc@u-pec.fr

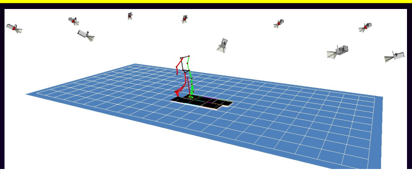
MASTER 2

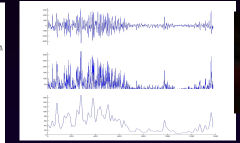
Biologie & Santé - Parcours

Neurosciences du Mouvement

PROGRAMME







Neurosciences du Mouvement

-De la conception à l'exécution

-Anatomie neurologique et musculaire

-Examen clinique quantifié

-Analyse biomécanique

-Neurophysiologie

-Modifications tissulaires

-Imagerie

-Techniques neurorestauratives

-Robotique d'assistance

-Biothérapies neurochirurgicales

-Podologie avancée

-Programmation en analyse du signal

-Parésies faciales

Objectifs : Initier à la recherche sur déterminants et thérapeutiques des affections centrales et périphériques du mouvement.

SEMESTRE 3 = 30 ECTS		
UE Enseignements obligatoires = 22 ECTS	**ECTS**	**Demi-journées**
ECUE 1 : Syndromes Moteurs Centraux (SMC - Gracies)	4	10
ECUE 2 : Analyse Biomécanique du Mouvement (ABM - Hutin)	3	8
ECUE 3 : Demandes Fonctionnelles et Adaptations Tissulaires (DFT - Zidi)	3	8
ECUE 4 : Pathologies Neurologiques Inflammatoires (PNI - Créange)	3	7
ECUE 5 : NeuroChirurgie du Mouvement (NCM - Palfi)	2	3
ECUE 6 : Recueil et Analyse des Signaux Neurophysiologiques (RSN - Lefaucheur)	2	5
ECUE 7 : Imagerie du Mouvement (IM - Rémy)	2	4
ECUE 8 : Maladies du Muscle (MM - Authier)	3	8
	22	53
UE Enseignements au choix = 8 ECTS à choisir		
ECUE 9 : Pathologies Orthopédiques chirurgicales et du Rachis (POR - Flouzat-Lachaniette)	2	5
ECUE 10 : Anatomie Neurologique et Musculaire du Mouvement Humain (ANM - Parratte, Tatu)	2	2
ECUE 11 : Recherche en Podologie Appliquée (RPA - Lavigne, Delacroix, Lescure)	2	6
ECUE 12 : Programmation en Analyse du Signal/Matlab (PAS - Guihard, Garric)	2	7
ECUE 13 : Parésies Faciales (PF - Baude)	2	4
ECUE 14 : Outils et Méthodologie pour la Recherche (OMR - Hutin)	2	7
ECUE 15 : Robotique d'Assistance (RA - Mohammed)	2	6
Statistiques - Rappels (Mathieu)	0	4
SEMESTRE 4 = 30 ECTS		
UE Enseignements obligatoires = 30 ECTS	**ECTS**	**Demi-journées**
ECUE 16 : Présentation du projet	6	120-240
ECUE 17 : Soutenance et Mémoire (stage de 3 à 6 mois à temps plein)	24	
UE Optionnelle = 0 ECTS		
ECUE 18 : Atelier Recherche (AR - Hutin)	0	6

ORGANISATION

- Semestre 3 d'octobre à décembre :
  8 ECUE obligatoires (22 ECTS)
  + 4 ECUE au choix (8 ECTS)
  Examen écrit début janvier.
- Semestre 4 de janvier à juin : Stage de recherche en laboratoire, validé par la rédaction d'un mémoire et une soutenance orale fin juin

Jean-Michel GRACIES Responsable pédagogique

Emilie HUTIN Directeur d'Etudes

Maud PRADINES

Alain CREANGE

Stéphane PALFI

Jean-Pascal LEFAUCHEUR

Philippe REMY

François Jérôme AUTHIER

Charles FLOUZAT-LACHANIETTE

Bernard PARRATTE

Alain LAVIGNE

Marina GUIHARD

Marjolaine BAUDE

Samer MOHAMMED

DIRECTEURS D'ECUE

http://www.u-pec.fr - courriel : master.biologie.sante@u-pec.fr - Tél : +33-1-4981-3553/3500/4399

EMPLOI du TEMPS 2021/2022 Master 2 Neurosciences du Mouvement

		SEPTEMBRE																									
LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM
30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Sauf indication différente. les cours sont de 9h à 13h et de 14h à 18h . à la Faculté de Médecine de Créteil.																											
																Réunion de rentrée 14h											

				OCTOBRE																							
LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM
27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
								MM1		**POR1**	**OMR1 9h30-13h**			**Statistiques (F. Mathieu) 9h30-12h30 et**	**MM2 8h30**	**PNI2**		**RSN3**				**MM3**	**OMR3 9h-12h IUT GEii Salle**	**Statistiques (F. Mathieu) 9h30-12h30 et**	**RSN4**		
							PNI1		**RSN1**	**RPA1**	**OMR2**					**RSN2**	**RPA2**				**PNI3**	**PNI4**	**ABM1**		**RPA3**		

OCTOBRE							NOVEMBRE																				
LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM
25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
OMR4 9h30-12h30	**OMR6 9h30-12h30**	**MM4**	**ABM2**	**NCM1 Senova**				**MM5**	**ABM3 10h30-12h30**	**RA2**	**POR2**			**RSN5**	**MM6**	**POR3**					**RA3**	**MM7**	**ABM4**	**SMC1**	**SMC2**		
OMR5 14h-17h	**OMR7 14h-17h**	**PNI5**	**RPA4**	**RA1**				**PNI7**	**OMR8 14h-17h**	**RPA5**				**DFT1 Maktouf**	**PF1**	**ANM 13h**		**DFT2 Martouf**			**PNI6**	**PF2**	**PAS1** IUT GEii Salle L3-	**RPA6**	**SMC3**		

NOVEMBRE									DECEMBRE																		
LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM
22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
RA4	**MM8**	**NCM1 Palfi**	**SMC5 Chenevier**	**NCM2 Senova**			**RA5**		**PAS4** IUT GEii Salle L3-	**DFT5 Portero**	**POR4**	**ANM1 Visioconf**		**RA6**				**POR5**				**NCM3**		**SMC7**	**SMC9 Chenevier**		
DFT3 Portero	**PF3**	**PAS2** IUT GEii Salle L3-	**SMC6**	**DFT4 Pradines**			**PAS3** IUT GEii Salle L3-	**PF4**	**IM1**		**PAS5** IUT GEii Salle L3-	**ANM2 Visioconf**		**DFT6 Pradines**	**OMR9 16h-18h**	**IM2**	**IM3**	**PAS6** IUT GEii Salle L3-				**PAS7** IUT GEii Salle L3-	**IM4**	**SMC8**	**SMC10 Blanchon**		

JANVIER															FEVRIER												
LUN	**MAR**	**MER**	**JEU**	**VEN**	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	**MER**	JEU	VEN	SAM	DIM
17	**18**	**19**	**20**	**21**	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	**9**	10	11	12	13
	Examens Session 1						**Stage**							**Stage**							**Rendu Synopsis**		**Présentation Projet (Session 1)**		**Stage**		

FEVRIER														MARS													
LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	**MAR**	**MER**	**JEU**	**VEN**	SAM	DIM
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	1	2	3	4	5	6	7	**8**	**9**	**10**	**11**	12	13
Stage							**Stage**							**Stage**								**Examens Session 2**					

MARS																	AVRIL										
LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	**MER**	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM
14	15	16	17	18	19	20	21	22	**23**	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10
Stage							**Rendu Synopsis (Session**		**Présentation Projet (Session 2) 14h**		**Stage**			**Stage**							**AR1 13h-17h**	**Stage**					

AVRIL																				MAI							
LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8
AR2 13h-17h	**Stage**							**Stage**						**Stage**							**Stage**						

MAI																							JUIN				
LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	**JEU**	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM
9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	**26**	27	28	29	30	31	1	2	3	4	5
Stage							**Stage**							**Stage**							**Stage**						

JUIN																								JUILLET			
LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	JEU	VEN	SAM	DIM	LUN	MAR	MER	**JEU**	VEN	SAM	DIM	LUN	MAR	**MER**	JEU	VEN	SAM	DIM
6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	**23**	24	25	26	27	28	**29**	30	1	2	3
Stage								**AR3 13h-17h**		**Stage**				**Stage**			**Dépôt Mémoire**				**AR4 13h-17h**		**Soutenance Mémoire**				

CAG-unlimited !

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INVITED REVIEW

ABSTRACT: Spastic paresis follows chronic disruption of the central execution of volitional command. Motor function in patients with spastic paresis is subjected over time to three fundamental insults, of which the last two are avoidable: (1) the neural insult itself, which causes paresis, i.e., reduced voluntary motor unit recruitment; (2) the relative immobilization of the paretic body part, commonly imposed by the current care environment, which causes adaptive shortening of the muscles left in a shortened position and joint contracture; and (3) the chronic disuse of the paretic body part, which is typically self-imposed in most patients. Chronic disuse causes plastic rearrangements in the higher centers that further reduce the ability to voluntarily recruit motor units, i.e., that aggravate baseline paresis. Part I of this review focuses on the pathophysiology of the first two factors causing motor impairment in spastic paresis: the vicious cycle of paresis–disuse–paresis and the contracture in soft tissues.

Muscle Nerve **31:** 535–551, 2005

PATHOPHYSIOLOGY OF SPASTIC PARESIS. I: PARESIS AND SOFT TISSUE CHANGES

JEAN-MICHEL GRACIES, MD, PhD

Department of Neurology, Mount Sinai Medical Center, One Gustave L Levy Place,
Annenberg 2/Box 1052, New York, New York 10029-6574, USA

Accepted 19 November 2004

INVITED REVIEW

ABSTRACT: In the subacute and chronic stages of spastic paresis, stretch-sensitive (spastic) muscle overactivity emerges as a third fundamental mechanism of motor impairment, along with paresis and soft tissue contracture. Part II of this review primarily addresses the pathophysiology of the various forms of spastic overactivity. It is argued that muscle contracture is one of the factors that cause excessive responsiveness to stretch, which in turn aggravates contracture. Excessive responsiveness to stretch also impedes voluntary motor neuron recruitment, a concept termed stretch-sensitive paresis. None of the three mechanisms of impairment (paresis, contracture, and spastic overactivity) is symmetrically distributed between agonists and antagonists, which generates torque imbalance around joints and limb deformities. Thus, each may be best treated focally on an individual muscle-by-muscle basis. Intensive motor training of the less overactive muscles should disrupt the cycle of paresis–disuse–paresis, and concomitant use of aggressive stretch and focal weakening agents in their more overactive and shortened antagonists should break the cycle of overactivity–contracture–overactivity.

Muscle Nerve **31:** 552–571, 2005

PATHOPHYSIOLOGY OF SPASTIC PARESIS. II: EMERGENCE OF MUSCLE OVERACTIVITY

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Annenberg 2/Box 1052, New York, New York 10029-6574, USA

Accepted 19 November 2004

Clinical Neurophysiology 124 (2013) 528–535

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Clinical Neurophysiology

journal homepage: www.elsevier.com/locate/clinph

Influence of effort intensity and gastrocnemius stretch on co-contraction and torque production in the healthy and paretic ankle

Maria Vinti [a,b,c,*], Annabelle Couillandre [d], Jérôme Hausselle [a], Nicolas Bayle [a,b,c], Aldo Primerano [b,c], Andrea Merlo [e], Emilie Hutin [a,b,c], Jean-Michel Gracies [a,b,c]

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[b] Université Paris Est Créteil (UPEC), Créteil, France
[c] AP-HP, Service de Médecine Physique et de Réadaptation, Unité de Neurorééducation, Groupe Hospitalier Henri Mondor, Créteil **94010**, France
[d] EA2931, Centre de Recherches sur le Sport et le Mouvement, UFR STAPS, Université Paris Ouest (UPO), Nanterre, France
[e] Movement Analysis Laboratory, Rehabilitation Department, Reggio Emilia Local Health Unit Correggio, Reggio Emilia, Italy

ARTICLE INFO

Article history:
Accepted 20 August 2012
Available online 10 October 2012

Keywords:
Hemiparesis
Spastic co-contraction
Torque

HIGHLIGHTS

- This study quantifies plantar flexor co-contraction in hemiparetic patients as compared with healthy subjects during graded dorsiflexor efforts in two ankle positions.
- In hemiparesis, gastrocnemius stretch (position knee extended) markedly increased co-contraction as compared to normal, reversing or canceling the torque intended in 26% cases.
- The major dynamometric impact of co-contraction with stretched position of the co-contracting muscle may justify muscle length modifications (aggressive stretch programs) to improve function in spastic paresis.

SPASTIC COCONTRACTION IN HEMIPARESIS: EFFECTS OF BOTULINUM TOXIN

MARIA VINTI, PT, MSc,[1,2,3] FILOMENA COSTANTINO, MSc,[1,2] NICOLAS BAYLE, MD,[1,2,3]
DAVID M. SIMPSON, MD,[4] DONALD J. WEISZ, PhD,[5] and JEAN-MICHEL GRACIES, MD, PhD[1,2,3]

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Accepted 23 April 2012

ABSTRACT: *Introduction:* In this study of spastic hemiparesis we evaluated cocontraction during sustained agonist/antagonist efforts, before and after botulinum toxin (BoNT) injection in 1 agonist. *Methods:* Nineteen hemiparetic subjects performed maximal isometric elbow flexion/extension efforts with the elbow at 100° (extensors stretched). Using flexor and extensor surface electromyography we calculated agonist recruitment/cocontraction indices from 500-ms peak voluntary agonist recruitment, before and 1 month after onabotulinumtoxinA injection (160 U) into biceps brachii. *Results:* Before injection, agonist recruitment and cocontraction indices were higher in extensors than flexors [0.74 ± 0.15 vs. 0.59 ± 0.10 ($P < 0.01$) and 0.43 ± 0.25 vs. 0.25 ± 0.13 ($P < 0.05$), respectively]. Biceps injection decreased extensor cocontraction index (−35%, $P < 0.05$) while increasing flexor agonist recruitment and cocontraction indices. *Conclusions:* In spastic hemiparesis, stretch may facilitate agonist recruitment and spastic cocontraction. In the non-injected antagonist, cocontraction may be reduced by enhanced reciprocal inhibition from a more relaxed, and therefore stretched, agonist, or through decreased recurrent inhibition from the injected muscle.

Muscle Nerve **46:** 926–931, 2012

offers opportunities to better stretch the injected muscle and strengthen its antagonist.[5,6]

Although several studies have qualitatively described cocontraction in spastic paresis, few have attempted to quantify the phenomenon.[7–9] Dynamometric measurements have been used, but the mathematical approaches involved[10,11] are difficult to apply in practice and would not have much validity in rheologically modified muscles, as is the case in spastic paresis. Electromyography (EMG) measurements are a preferred choice. The root mean square (RMS) of the EMG signal expresses average flows of electrical signals in a window of time and is considered a valid measure of motor unit behavior.[12] In this study, we used the RMS obtained during a 500-ms interval around the peak voltage as the reference for maximal voluntary muscle recruitment[13,14] to perform agonist recruit-

Annals of Physical and Rehabilitation Medicine 58 (2015) 173–178

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Annals of Physical & Rehabilitation Medicine
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Update article

Coefficients of impairment in deforming spastic paresis

J.-M. Gracies

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suppl. Informations

ARTICLE INFO

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Keywords:
Spastic paresis
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Spastic cocontraction
Spastic dystonia
Spasticity
Stepwise quantified assessment
Tardieu Scale
Fatigability
Weakness
Coefficients of impairment

ABSTRACT

This position paper introduces an assessment method using staged calculation of coefficients of impairment in spastic paresis, with its rationale and proposed use. The syndrome of deforming spastic paresis superimposes two disorders around each joint: a neural disorder comprising stretch-sensitive paresis in agonists and antagonist muscle overactivity, and a muscle disorder ("spastic myopathy") combining shortening and loss of extensibility in antagonists. Antagonist muscle overactivity includes spastic cocontraction (misdirected descending command), spastic dystonia (tonic involuntary muscle activation, at rest) and spasticity (increased velocity-dependent reflexes to phasic stretch, at rest). This understanding of various types of antagonist resistance as the key limiting factors in paretic movements prompts a stepwise, quantified, clinical assessment of antagonist resistances, elaborating on the previously developed Tardieu Scale. Step 1 quantifies limb function (e.g. ambulation speed in lower limb, Modified Frenchay Scale in upper limb). The following four steps evaluate various angles X of antagonist resistance, in degrees all measured from 0°, position of minimal stretch of the tested antagonist. Step 2 rates the functional muscle length, termed X_{V1} (V1, slowest stretch velocity possible), evaluated as the angle of arrest upon slow and strong passive muscle stretch. X_{V1} is appreciated with respect to the expected normal passive amplitude, X_N, and reflects combined muscle contracture and residual spastic dystonia. Step 3 determines the angle of catch upon fast stretch, termed X_{V3} (V3, fastest stretch velocity possible), reflecting spasticity. Step 4 measures the maximal active range of motion against the antagonist, termed X_A, reflecting agonist capacity to overcome passive (stiffness) and active (spastic cocontraction) antagonist resistances over a single movement. Finally, Step 5 rates the residual active amplitude after 15 seconds of maximal amplitude rapid alternating movements, X_{A15}. Amplitude decrement from X_A to X_{A15} reflects fatigability. Coefficients of shortening $(X_N - X_{V1})/X_N$, spasticity $(X_{V1} - X_{V3})/X_{V1}$, weakness $(X_{V1} - X_A)/X_{V1}$ and fatigability $(X_A - X_{A15})/X_A$ are derived. A high (e.g., $>10\%$) coefficient of shortening prompts aggressive treatment of the muscle disorder – e.g. by stretch programs, such as prolonged stretch postures –, while high coefficients of weakness or fatigability prompt addressing the neural motor command disorder, e.g. using training programs such as repeated alternating movements of maximal amplitude.

Clinical Neurophysiology 129 (2018) 89–94

Contents lists available at ScienceDirect

Clinical Neurophysiology

journal homepage: www.elsevier.com/locate/clinph

Review

On Denny-Brown's 'spastic dystonia' – What is it and what causes it?

Jakob Lorentzen [a,b,*], Maud Pradines [c], Jean-Michel Gracies [c], Jens Bo Nielsen [a,b]

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[b] *Elsass Institute, Holmegårdsvej 28, 2920 Charlottenlund, Denmark*
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ARTICLE INFO

Article history:
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Available online 4 November 2017

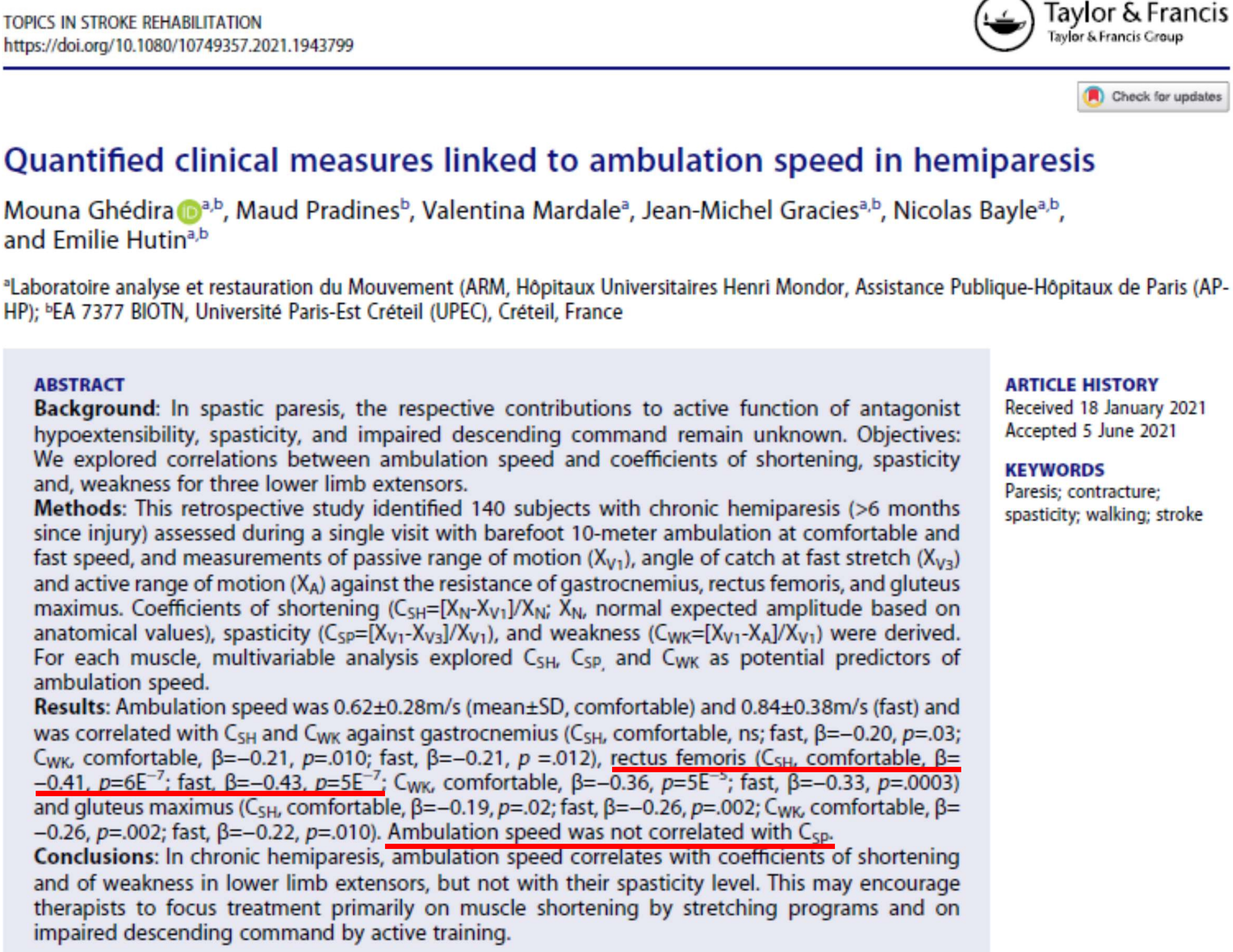
Keywords:
Spasticity
Spastic dystonia
Hypertonia

HIGHLIGHTS

- Stretch and effort-unrelated sustained involuntary muscle activity following central motor lesions may be caused by:
- Plastic changes at a spinal level involving upregulation and sprouting of surviving descending fibres and/or changes in intrinsic properties of motoneurones.
- Re-organization in the motor cortex.
- Lesions in basal ganglia.

Baude M, Nielsen JB, Gracies JM.
The neurophysiology of deforming spastic paresis: A revised taxonomy.
Ann Phys Rehabil Med. 2019;62(6):426-430

This paper revisits the taxonomy of the neurophysiological consequences of a persistent impairment of motor command execution in the classic environment of sensorimotor restriction and muscle hypo-mobilization in short position. Around each joint, the syndrome involves 2 disorders, muscular and neurologic. The muscular disorder is promoted by muscle hypo-mobilization in short position in the context of paresis, in the hours and days after paresis onset: this genetically mediated, evolving myopathy, is called spastic myopathy. The clinician may suspect it by feeling extensibility loss in a resting muscle, although long after the actual onset of the disease. The neurologic disorder, promoted by sensorimotor restriction in the context of paresis and by the muscle disorder itself, comprises 4 main components, mostly affecting antagonists to desired movements: the first is spastic dystonia, an unwanted, involuntary muscle activation at rest, in the absence of stretch or voluntary effort; spastic dystonia superimposes on spastic myopathy to cause visible, gradually increasing body deformities; the second is spastic cocontraction, an unwanted, involuntary antagonist muscle activation during voluntary effort directed to the agonist, aggravated by antagonist stretch; it is primarily due to misdirection of the supraspinal descending drive and contributes to reducing movement amplitude; and the third is spasticity, one form of hyperreflexia, defined by an enhancement of the velocity-dependent responses to phasic stretch, detected and measured at rest (another form of hyperreflexia is "nociceptive spasms", following flexor reflex afferent stimulation, particularly after spinal cord lesions). The 3 main forms of overactivity, spastic dystonia, spastic cocontraction and spasticity, share the same motor neuron hyperexcitability as a contributing factor, all being predominant in the muscles that are more affected by spastic myopathy. The fourth component of the neurologic disorder affects the agonist: it is stretch-sensitive paresis, which is a decreased access of the central command to the agonist, aggravated by antagonist stretch. Improved understanding of the pathophysiology of deforming spastic paresis should help clinicians select meaningful assessments and refined treatments, including the utmost need to preserve muscle tissue integrity as soon as paresis sets in.



TOPICS IN STROKE REHABILITATION
https://doi.org/10.1080/10749357.2021.1943799

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Quantified clinical measures linked to ambulation speed in hemiparesis

Mouna Ghédira[a,b], Maud Pradines[b], Valentina Mardale[a], Jean-Michel Gracies[a,b], Nicolas Bayle[a,b], and Emilie Hutin[a,b]

[a]Laboratoire analyse et restauration du Mouvement (ARM, Hôpitaux Universitaires Henri Mondor, Assistance Publique-Hôpitaux de Paris (AP-HP); [b]EA 7377 BIOTN, Université Paris-Est Créteil (UPEC), Créteil, France

ABSTRACT

Background: In spastic paresis, the respective contributions to active function of antagonist hypoextensibility, spasticity, and impaired descending command remain unknown. Objectives: We explored correlations between ambulation speed and coefficients of shortening, spasticity and, weakness for three lower limb extensors.

Methods: This retrospective study identified 140 subjects with chronic hemiparesis (>6 months since injury) assessed during a single visit with barefoot 10-meter ambulation at comfortable and fast speed, and measurements of passive range of motion (X_{V1}), angle of catch at fast stretch (X_{V3}) and active range of motion (X_A) against the resistance of gastrocnemius, rectus femoris, and gluteus maximus. Coefficients of shortening ($C_{SH}=[X_N-X_{V1}]/X_N$; X_N, normal expected amplitude based on anatomical values), spasticity ($C_{SP}=[X_{V1}-X_{V3}]/X_{V1}$), and weakness ($C_{WK}=[X_{V1}-X_A]/X_{V1}$) were derived. For each muscle, multivariable analysis explored C_{SH}, C_{SP}, and C_{WK} as potential predictors of ambulation speed.

Results: Ambulation speed was 0.62±0.28m/s (mean±SD, comfortable) and 0.84±0.38m/s (fast) and was correlated with C_{SH} and C_{WK} against gastrocnemius (C_{SH}, comfortable, ns; fast, β=−0.20, *p*=.03; C_{WK}, comfortable, β=−0.21, *p*=.010; fast, β=−0.21, *p* =.012), rectus femoris (C_{SH}, comfortable, β= −0.41, *p*=6E^{-7}; fast, β=−0.43, *p*=5E^{-7}; C_{WK}, comfortable, β=−0.36, *p*=5E^{-5}; fast, β=−0.33, *p*=.0003) and gluteus maximus (C_{SH}, comfortable, β=−0.19, *p*=.02; fast, β=−0.26, *p*=.002; C_{WK}, comfortable, β= −0.26, *p*=.002; fast, β=−0.22, *p*=.010). Ambulation speed was not correlated with C_{SP}.

Conclusions: In chronic hemiparesis, ambulation speed correlates with coefficients of shortening and of weakness in lower limb extensors, but not with their spasticity level. This may encourage therapists to focus treatment primarily on muscle shortening by stretching programs and on impaired descending command by active training.

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KEYWORDS
Paresis; contracture; spasticity; walking; stroke

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journal homepage: www.elsevier.com/locate/clinbiomech

Agonist and antagonist activation at the ankle monitored along the swing phase in hemiparetic gait

Mouna Ghédira [a,b,*], Inke Marie Albertsen [a,b], Valentina Mardale [a], Catherine-Marie Loche [a], Maria Vinti [a], Jean-Michel Gracies [a,b], Nicolas Bayle [a,b], Emilie Hutin [a,b]

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ARTICLE INFO

Keywords:
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Muscle spasticity
Paresis
Dorsiflexion
Stretching
Antagonist activation

ABSTRACT

Background: Descending command in hemiparesis is reduced to agonists and misdirected to antagonists. We monitored agonist and antagonist activation along the swing phase of gait, comparing paretic and non-paretic legs.
Methods: Forty-two adults with chronic hemiparesis underwent gait analysis with bilateral EMG from tibialis anterior, soleus and gastrocnemius medialis. We monitored ankle and knee positions, and coefficients of agonist activation in tibialis anterior and of antagonist activation in soleus and gastrocnemius medialis over the three thirds of swing phase. These coefficients were defined as the ratio of the root-mean-square EMG from one muscle over any period to the root-mean-square EMG from the same muscle over 100 ms of its maximal voluntary isometric contraction.
Findings: As against the non-paretic side, the paretic side showed lesser ankle dorsiflexion and knee flexion ($P < 1.E^{-5}$), with higher coefficients of agonist activation in tibialis anterior (+100 ± 28%, $P < 0.05$), and of antagonist activation in soleus (+224 ± 41%, $P < 0.05$) and gastrocnemius medialis (+276 ± 49%, $P < 0.05$). On the paretic side, coefficient of agonist activation in tibialis anterior decreased from mid-swing on; coefficients of antagonist activation in soleus and gastrocnemius medialis increased and ankle dorsiflexion decreased in late swing ($P < 0.05$).
Interpretation: During the swing phase in hemiparesis, normalized tibialis anterior recruitment is higher on the paretic than on the non-paretic leg, failing to compensate for a marked increase in plantar flexor activation (cocontraction). The situation deteriorates along swing with a decrease in tibialis anterior recruitment in parallel with an increase in plantar flexor activation, both likely related to gastrocnemius stretch during knee re-extension.
Clinical Trial Registration-URL: http://www.clinicaltrials.gov. Unique identifier: NCT03119948

Deforming Spastic Paresis?

Figure 66: William John Little (1810-1894)

Little WJ. “Deformities of the human frame”, 1843

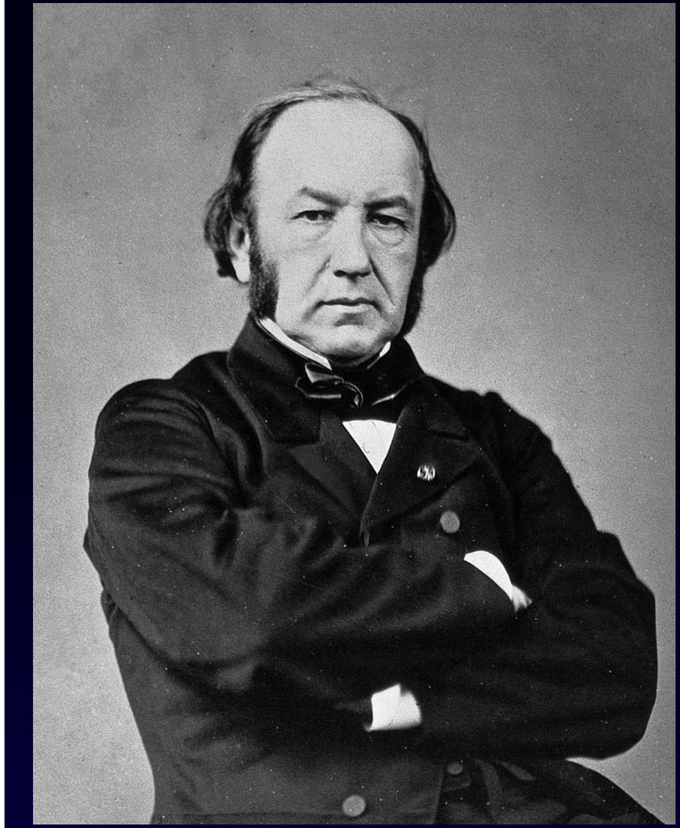
Which factors impede movements?

Gracies, 2021

Deforming spastic paresis is first a problem with the <u>antagonist</u>.

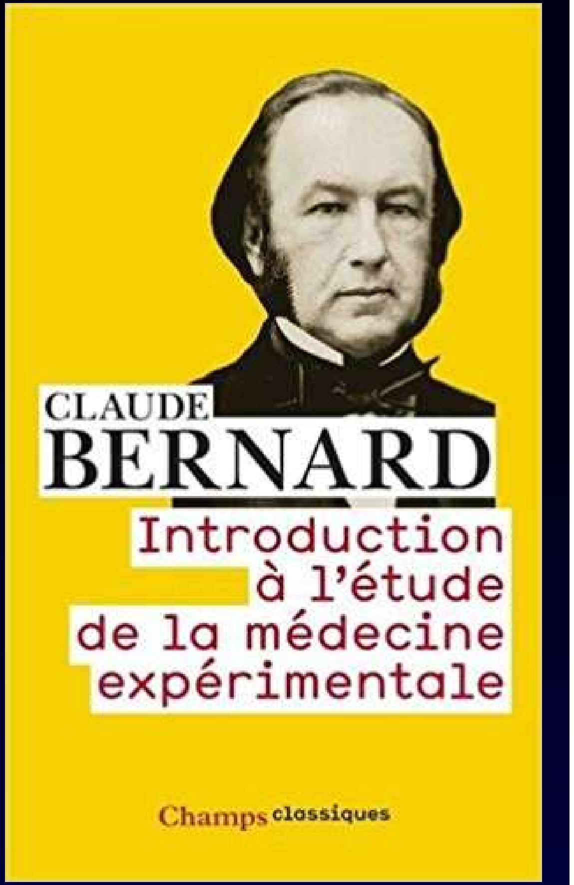
Tardieu, throughout his career

But which problem?



***Physiology** must be able to explain life's phenomena, provided it remains built upon the knowledge of **histology**.*

Claude Bernard, c 1845



CLAUDE
BERNARD
Introduction
à l'étude
de la médecine
expérimentale

Champs classiques

The Syndrome of
Deforming Spastic Paresis

=

<u>Spastic Myopathy</u>

+ …

Norvang *et al. BMC Neurology* (2018) 18:138
https://doi.org/10.1186/s12883-018-1134-0

BMC Neurology

RESE

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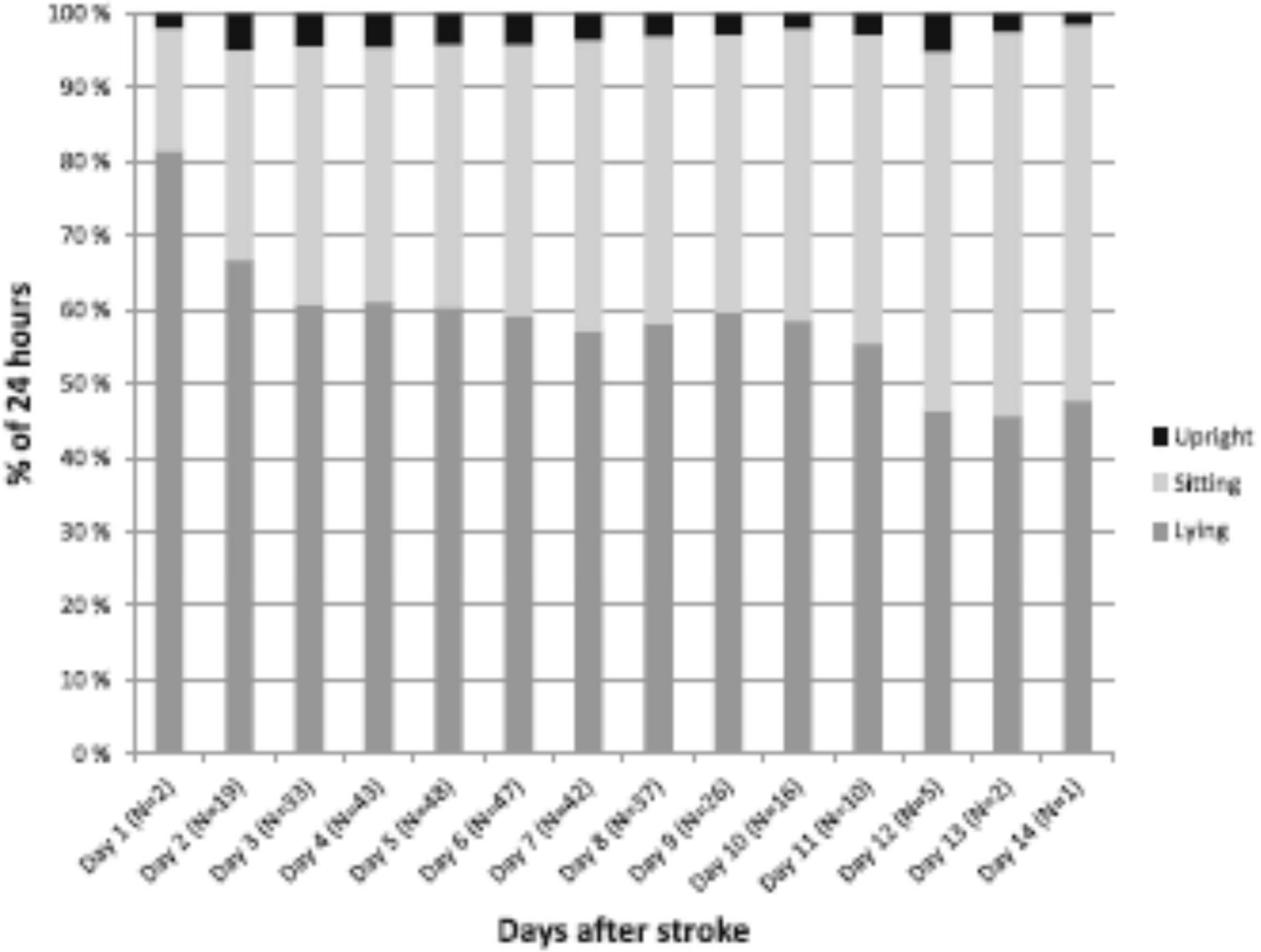


Fig. 2 Percentage of time spent in different positions within every 24 h

Time of arm positions in healthy subjects

- Arm movements observed for >5h/day in homes and local community of 21 older people age 73 (SD 7).
- Duration (min/hr) of arm positions > 90° elevation + purpose (manipulating, holding, reaching, pulling/pushing, or gesturing) recorded.
- Participants' arms spent 0.6 min/hr at > 90° elevation

~ 6-12 min / waking day !

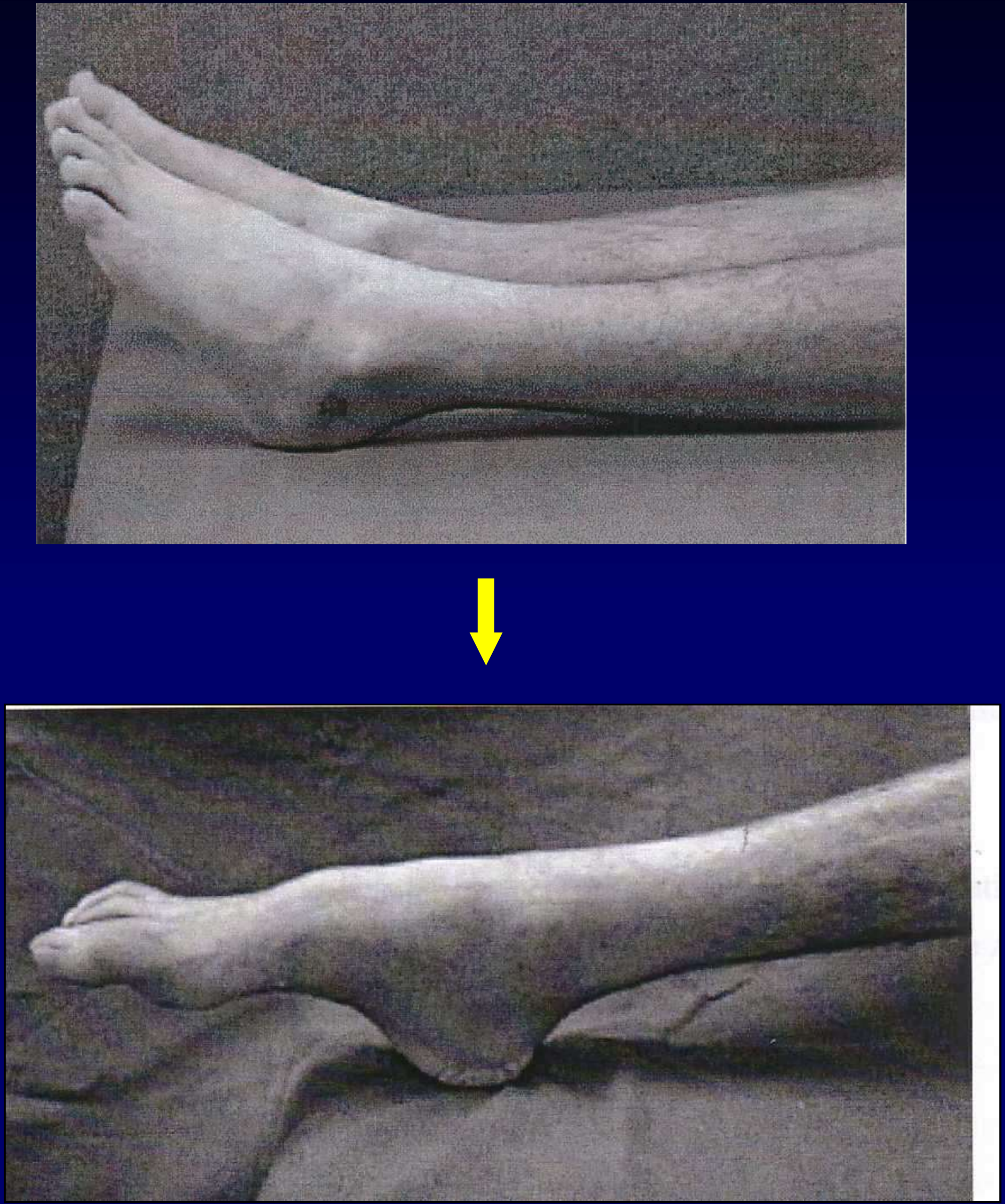
Schurr K, Ada L. Observation of arm behaviour in healthy elderly people: implications for contracture prevention after stroke. Aust J Physiother. 2006;52(2):129-33

Immobilization or <u>hypo-mobilization</u> in short position

=

<u>Muscle aggression</u> worse than stroke

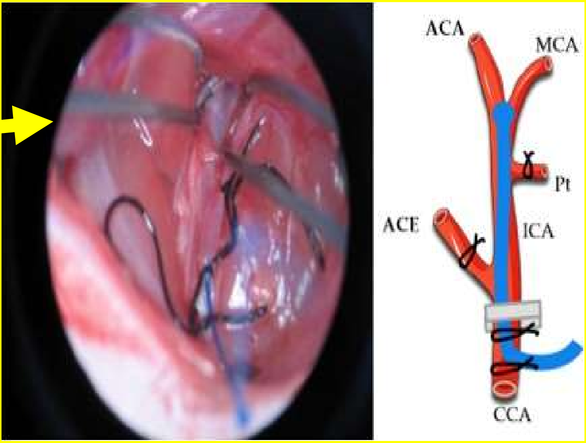
(Jalal et al, 2019)

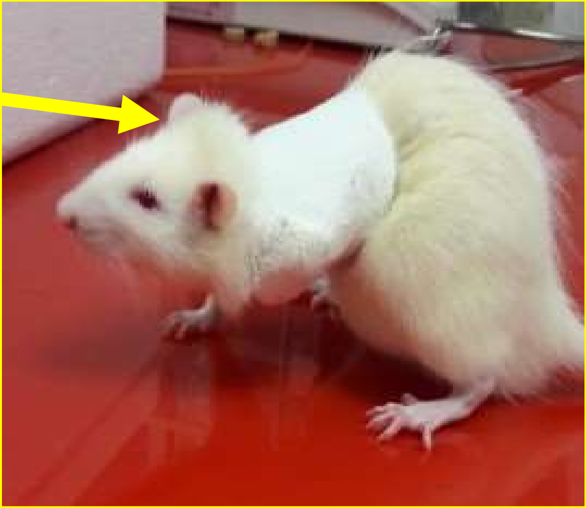


Singer et al, 2002

Gracies, 2003

Muscle structure: Role of Immobilization *vs* Stroke?





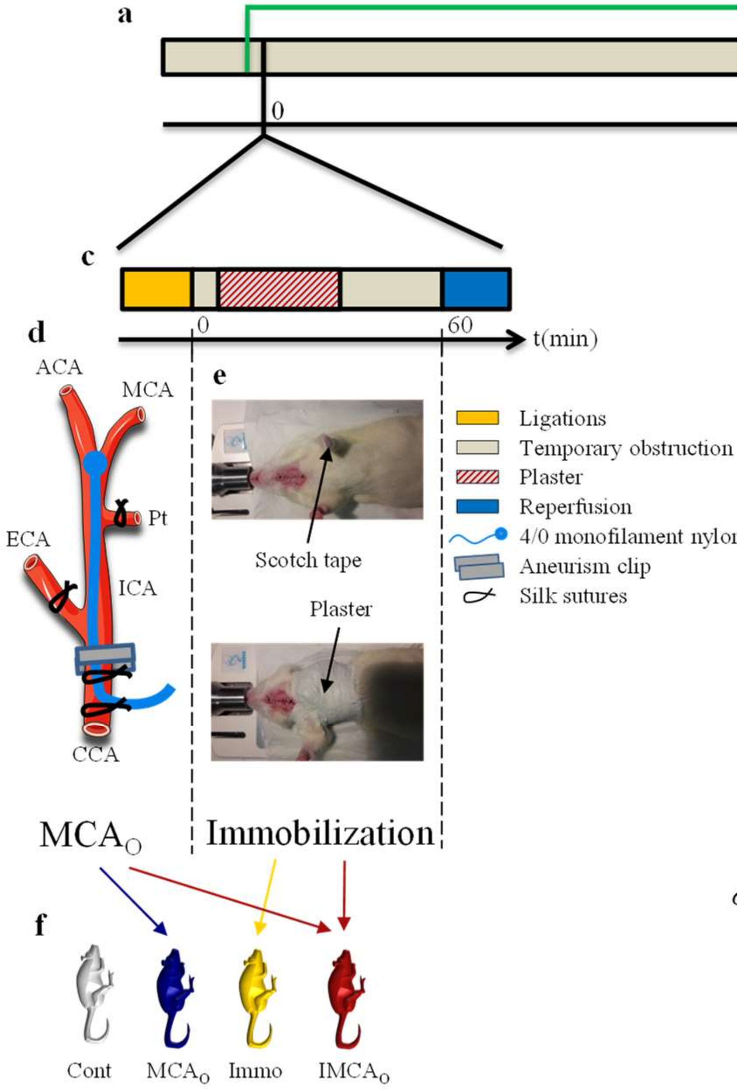
Four groups :

- S: “Stroke” without immobilization
- I: "Immobilization” without stroke
- S+I: “Stroke+Immobilization”
- C: “Sham” (failed strokes)

Duration : 14 days

Jalal N, Gracies JM, Zidi M. Mechanical and microstructural changes of skeletal muscle following immobilization and/or stroke. Biomech Model Mechanobiol. 2020;19(1):61-80

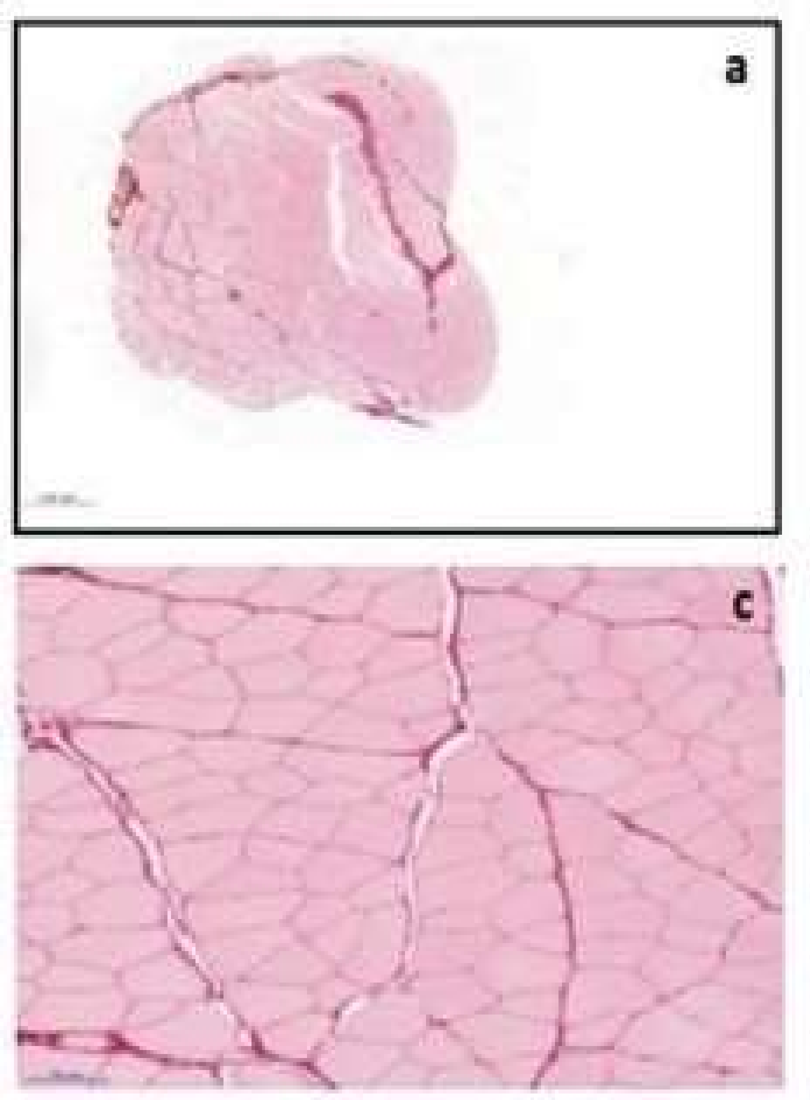
Methods



Jalal N, Gracies JM, Zidi M. *Mechanical and microstructural changes of skeletal muscle following immobilization and/or stroke.* ***Biomech Model Mechanobiol. 2020;19(1):61-80***

Histology of flexor carpi ulnaris

Red Sirius: quantification of collagen



Stroke w/o Immobilization

Immobilization w/o stroke

Jalal N, Gracies JM, Zidi M. Mechanical and microstructural changes of skeletal muscle following immobilization and/or stroke. ***Biomech Model Mechanobiol. 2020;19(1):61-80***

frontiers in Neurology

ORIGINAL RESEARCH
published: xx xx 2022
doi: 10.3389/fneur.2022.817229

Do Muscle Changes Contribute to the Neurological Disorder in Spastic Paresis?

Maud Pradines[1,2], Mouna Ghédira[1,2], Blaise Bignami[2], Jordan Vielotte[2], Nicolas Bayle[1,2], Christina Marciniak[3,4], David Burke[5], Emilie Hutin[1,2] and Jean-Michel Gracies[1,2]*

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Finger flexor angles

1. Angle

2. X_P

3. X_{V1}

4. X_{V3}

Five Step Assessment – Shoulder extensors

Five Step Assessment – Shoulder extensors

4. X_A

5. X_{A15}

Step 2 => "Coefficient of Shortening"
= Muscle disorder

Maximal passive range of motion X_{V1}

Expected physiological value: X_N

$$\text{Coefficient of Shortening} = (X_N - X_{V1})/X_N$$

Gracies. Coefficients if impairment in spastic paresis.

Ann Phys Med Rehabil 2015

Steps 4+2 => “Coefficient of Weakness” = Neurological disorder

Maximal active range of motion X_A

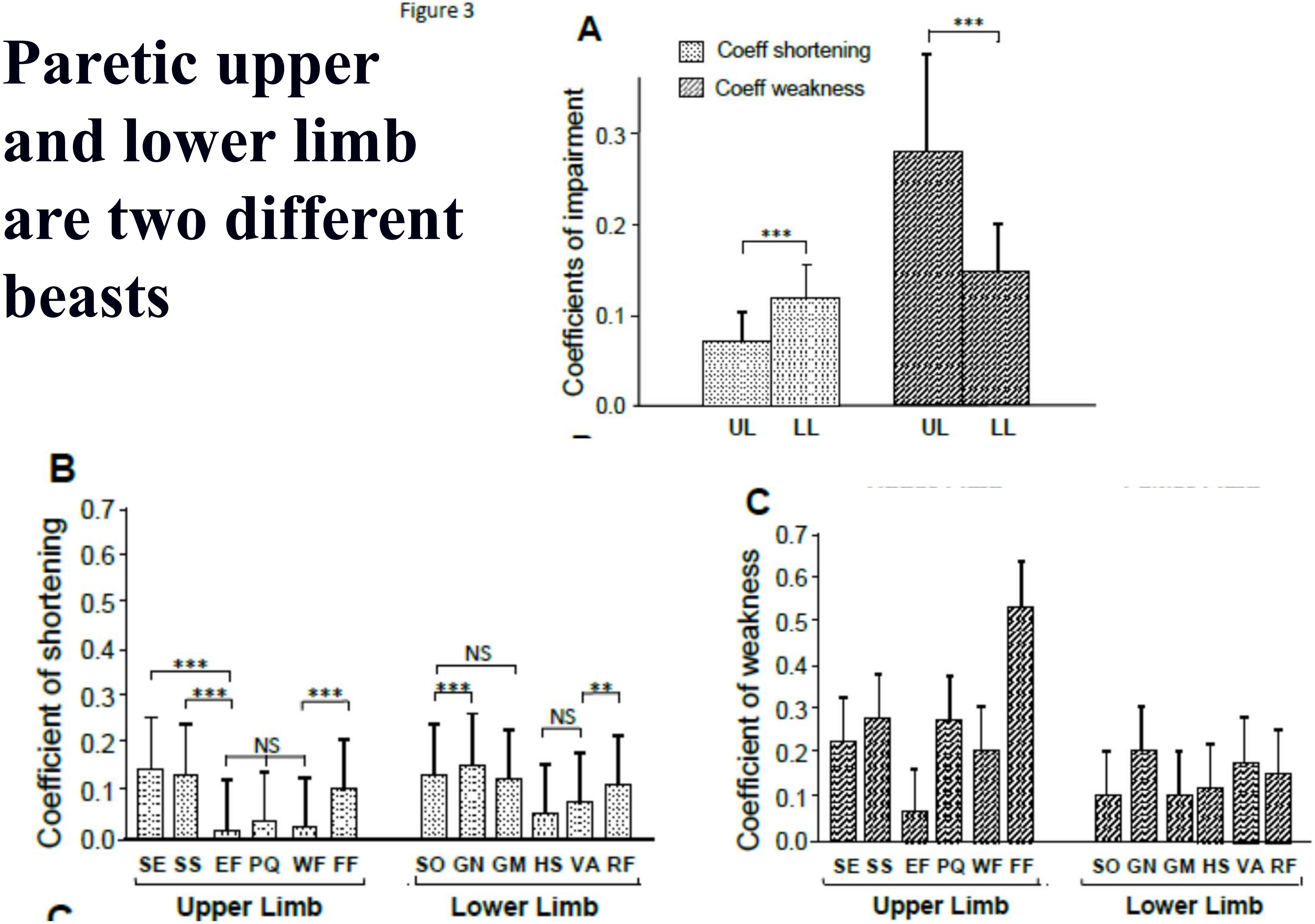
Maximal passive range of motion X_{V1}

$$\boxed{\text{Coefficient of Weakness} = (X_{V1}-X_A)/X_{V1}}$$

Gracies. Coefficients of Impairment in Spastic Paresis. Ann Phys Med Rehabil 2015

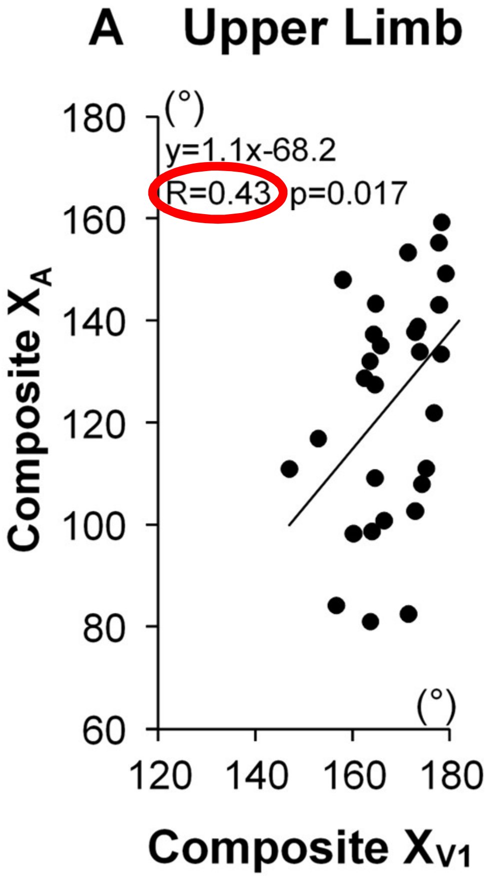
Paretic upper and lower limb are two different beasts

Figure 3



Pradines et al, Does the muscle disorder contribute to the neurological disorder in spastic paresis? Front Neurol 2022, in press

Role of histological muscle changes in active movements



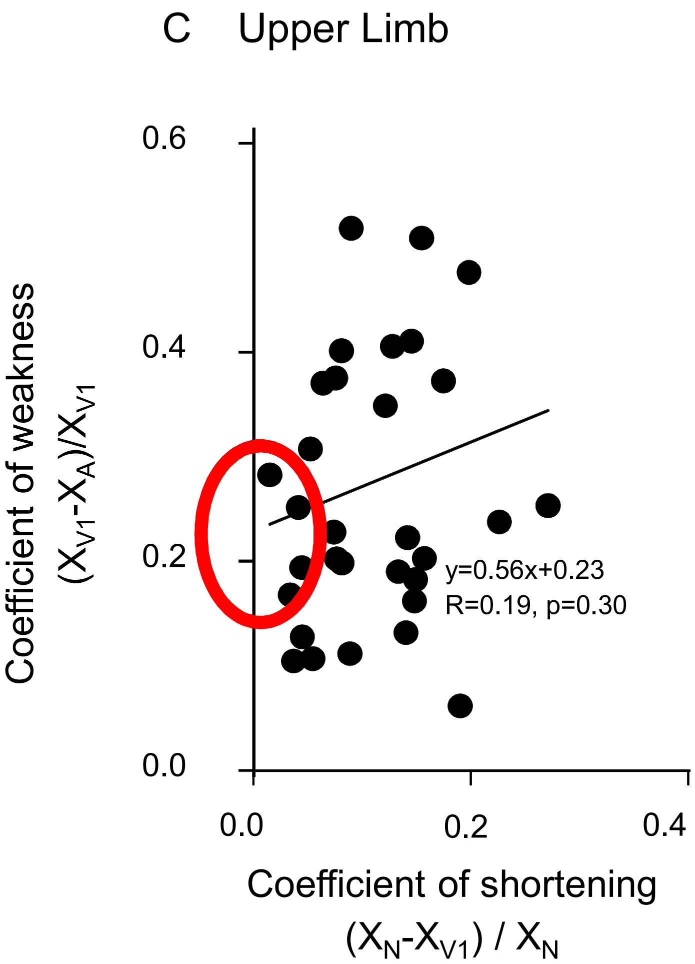
Pradines et al, Does the muscle disorder contribute to the neurological disorder in spastic paresis? Front Neurol 2022, in press

In words..

In the paretic lower limb (~50%) and to a lesser degree in the paretic upper limb (~16%?),

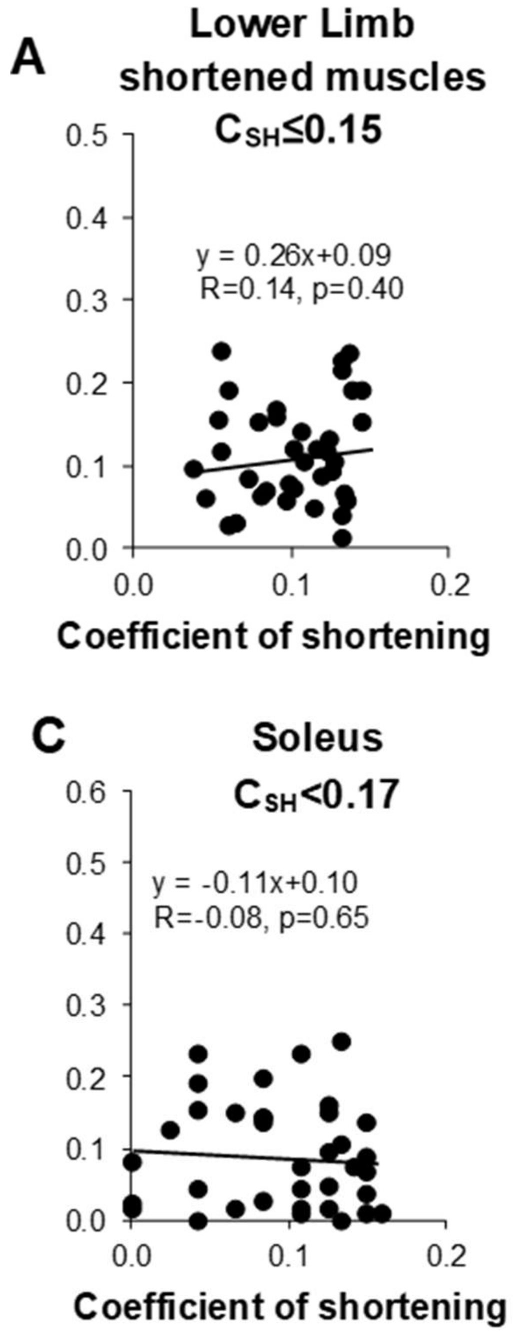
active movement capacities
are determined by
passive movement capacities.

Paretic upper and lower limb are two different beasts



Pradines et al, Does the muscle disorder contribute to the neurological disorder in spastic paresis? Front Neurol 2022, in press

Role of histological muscle changes in increasing cocontractions?



Pradines et al, Does the muscle disorder contribute to the neurological disorder in spastic paresis? Front Neurol 2022, in press

Double nature of 'coefficients of shortening' and 'of weakness'?

- **X_{V1}** = a mostly histological measure: X_{V1} measurements after lidocaine blocks still remain far from expected physiological values *(Winston et al, 2019)*

- **X_{A}** = a mostly neurological measure, of cocontractions: X_{A} markedly increased after lidocaine blocks *(Winston et al, 2019)*

Winston P, Mills PB, Reebye R, Vincent D. Cryoneurotomy as a Percutaneous Mini-invasive Therapy for the Treatment of the Spastic Limb: Case Presentation, Review of the Literature, and Proposed Approach for Use. Arch Rehabil Res Clin Transl. 2019 Oct 17;1(3-4):100030

The Syndrome of Deforming Spastic Paresis

=

Spastic Myopathy

\+ *Spastic Cocontraction*

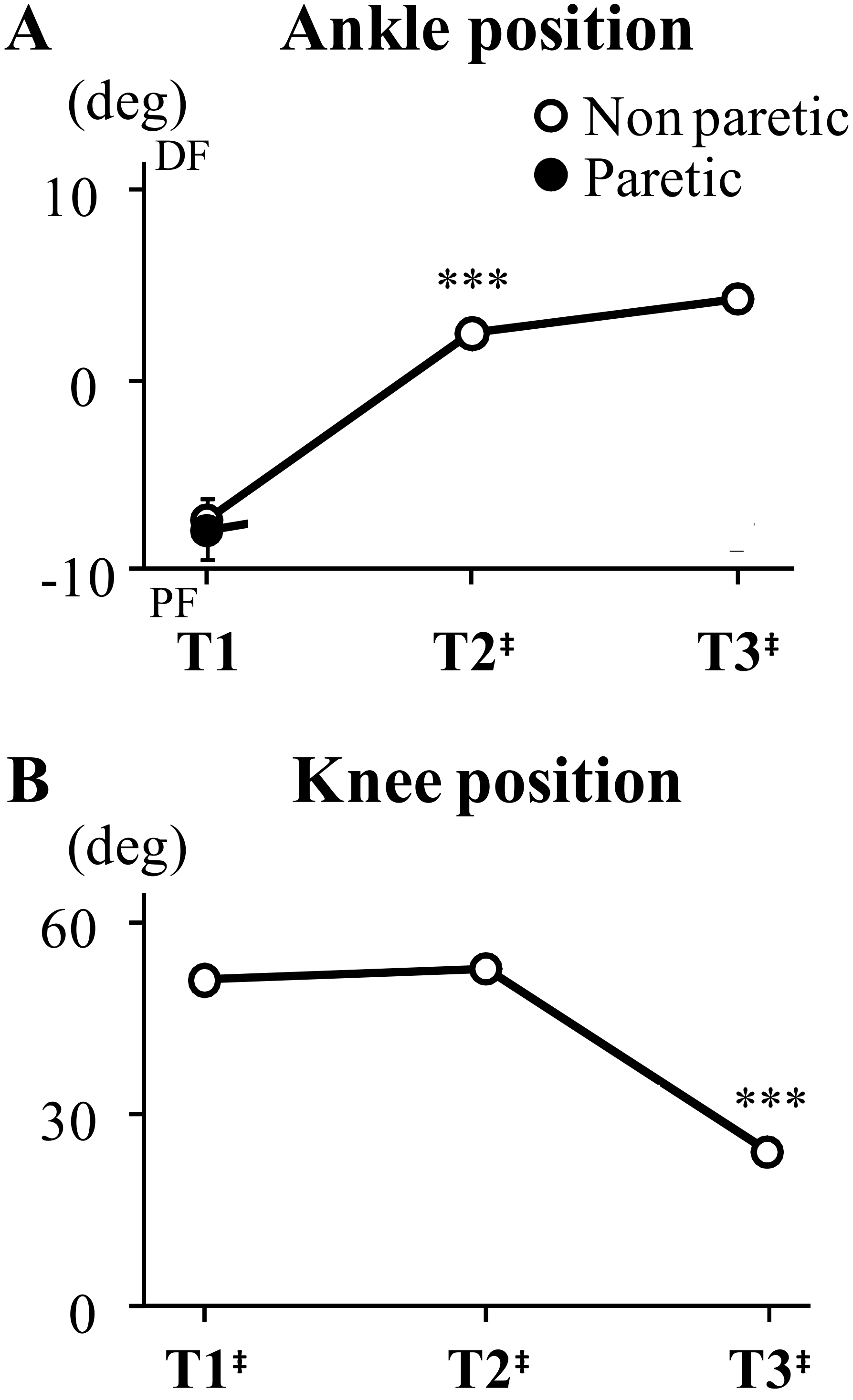
Spastic cocontraction recording during gait

Ghédira et al, Clin Biomech, 2021

Agonist and antagonist activation around the ankle during the swing phase of gait in hemiparesis

Subjects (n)	42
Age (y)	50 ± 15
Time since paresis onset (y)	7 ± 7
Gender	
Female (n)	14
Male (n)	28
Paretic side	
Left (n)	28
Right (n)	14
Cause	
Ischemic stroke (n)	21
Hemorrhagic stroke (n)	10
Non-evolutive tumor (n)	6
Traumatic brain injury (n)	5
Comfortable gait	
Speed (m/s)	0.66 ± 0.26
Paretic step length (m)	0.47 ± 0.12
Non paretic step length (m)	0.41 ± 0.16
Cadence (step/s)	1.47 ± 0.27

Ghédira M, Albertsen IM, Mardale V, Loche CM, Vinti M, Gracies JM, Bayle N, Hutin E. Agonist and antagonist activation at the ankle monitored along the swing phase in hemiparetic gait. Clin Biomech (Bristol, Avon). 2021 Oct;89:105459

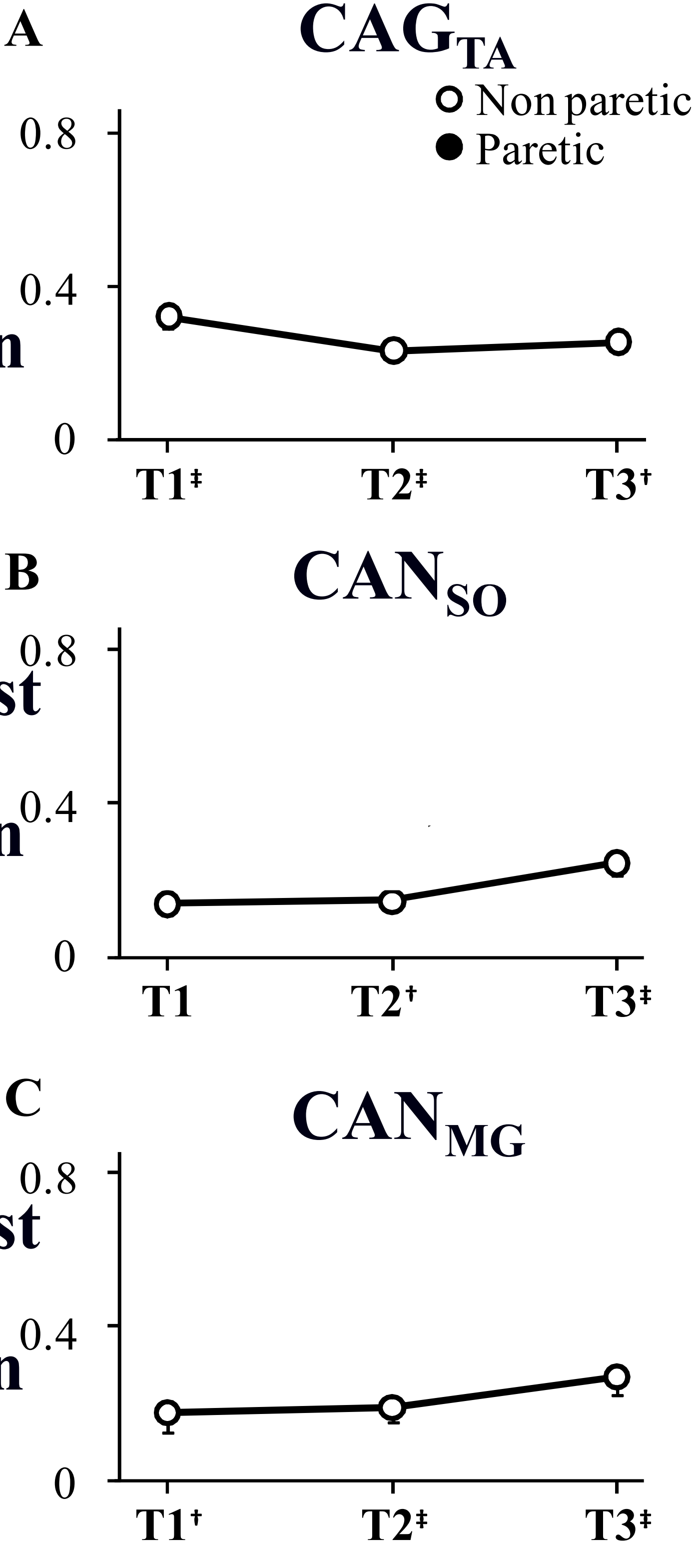


Ghédira et al, Clin Biomech, 2021

Coeff agonist tib ant activation

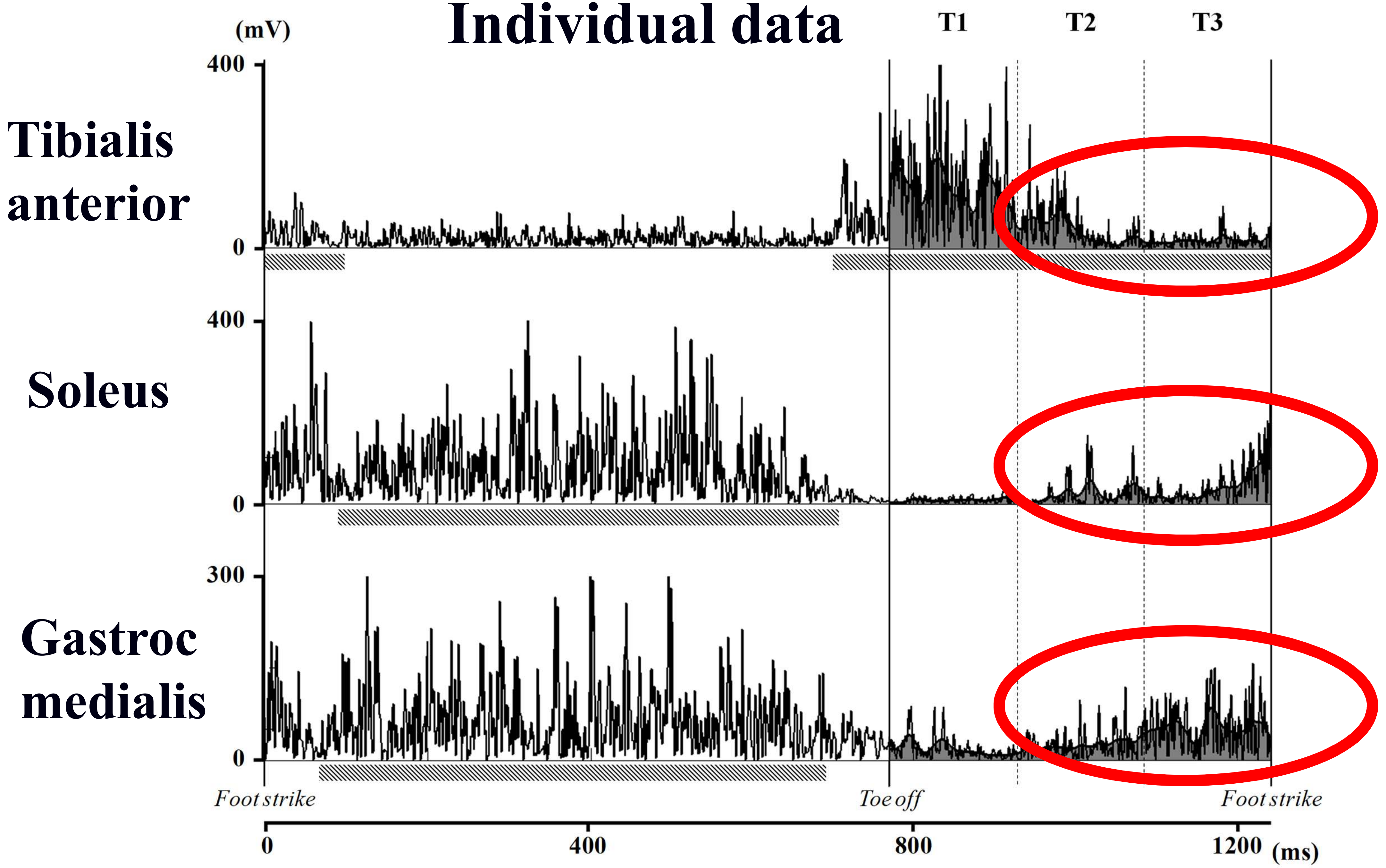
Coeff antagonist soleus activation

Coeff antagonist gastroc activation



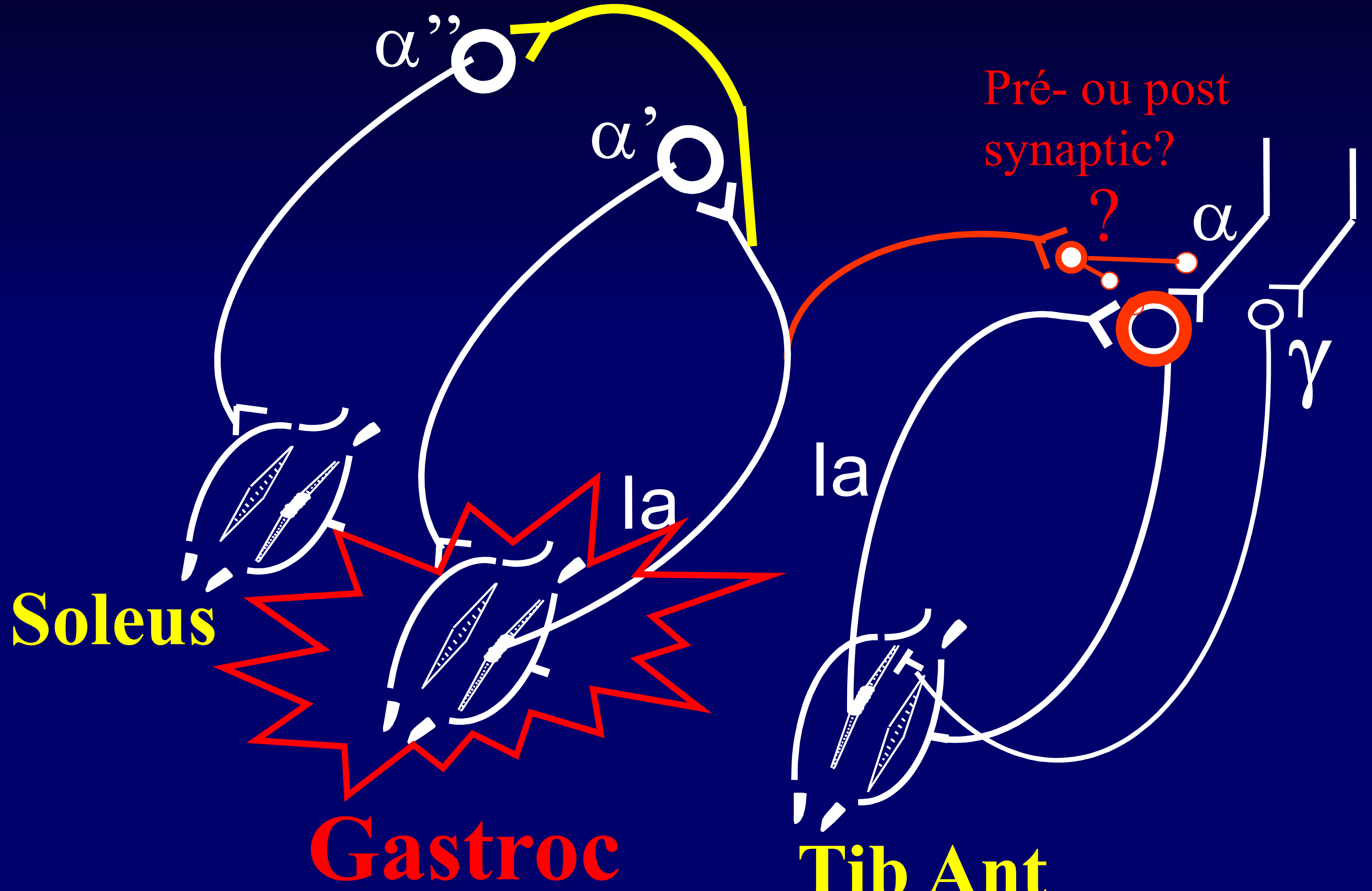
Wagner JM, Dromerick AW, Sahrmann SA, Lang CE. Upper extremity muscle activation during recovery of reaching in subjects with post-stroke hemiparesis. Clin Neurophysiol. 2007;118(1):164-76

Individual data



Ghédira M, Albertsen IM, Mardale V, Loche CM, Vinti M, Gracies JM, Bayle N, Hutin E. Agonist and antagonist activation at the ankle monitored along the swing phase in hemiparetic gait. Clin Biomech (Bristol, Avon). 2021 Oct;89:105459

Hypothesis for stretch-sensitive paresis and for spastic cocontraction



Gracies, 2021

The Syndrome of Deforming Spastic Paresis

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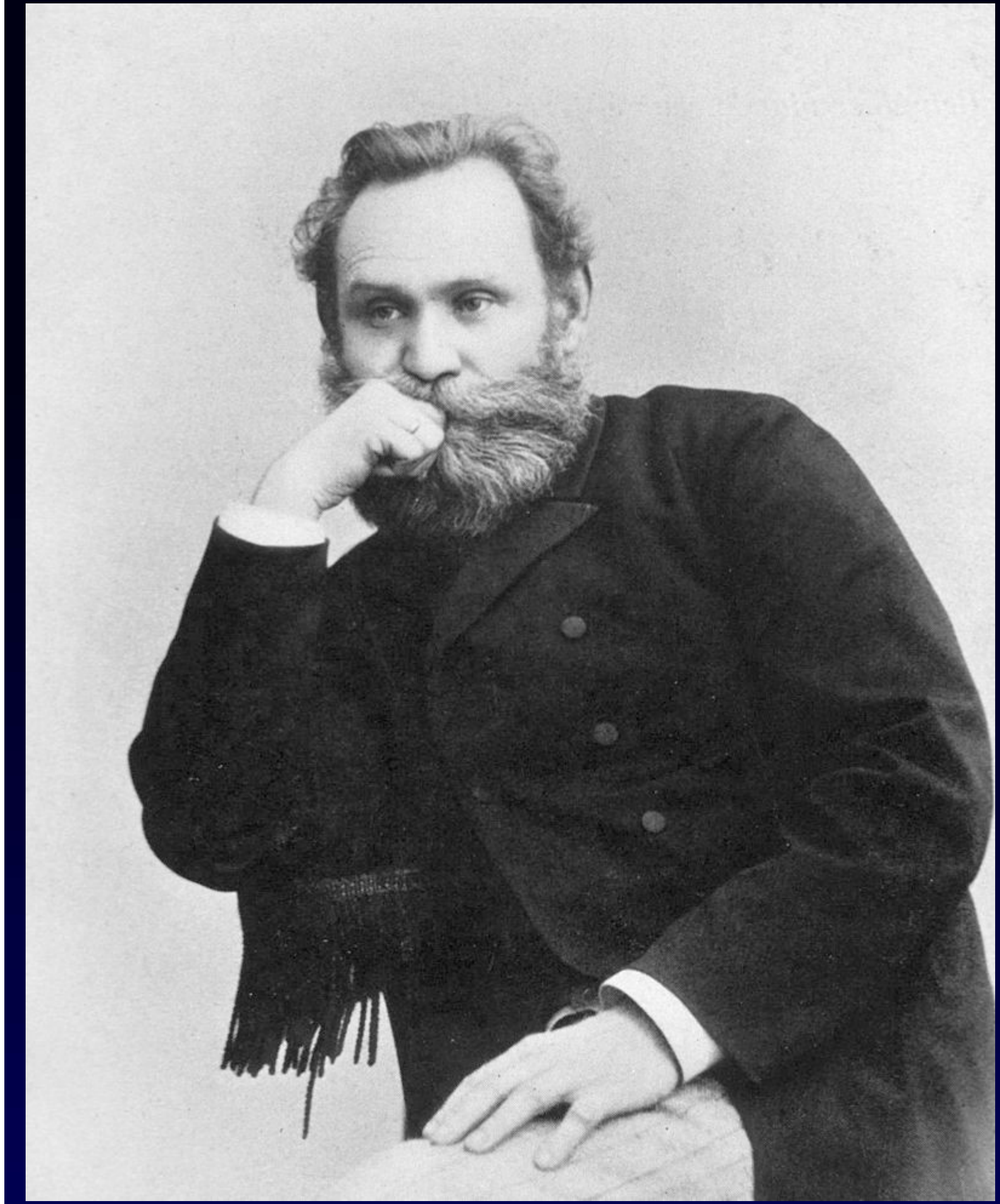
Spastic Myopathy

+ Spastic Cocontraction !

- Botulinum toxins ~ effective but crude way to take care of excessive muscle activations (only)
- Comprehensive approach? → Let us start by trying to take care of the *sick muscle*



"It is often said, and rightly so, that science advances in fits, according to successes in the methodological field. ... This is why our most urgent task was the development of a Method."

Ivan Petrovitch PAVLOV, 1897
Conferences on the activity of the main digestive glands.
I. Pavlov. Selected works, ed. Kh. Kochtoianz, Moscow, 1954. p.92

Five Step Assessment
→Muscle disease?

2nd step

=

Maximal extensibility?

=

$\underline{X_{V1}}$

=

Slow and strong passive movement by clinician

Rectus femoris

Passive range of motion: X_{V1}
Expected value: X_N

Coefficient of Shortening = $(X_N - X_{V1})/X_N$

Gracies. Coefficients if impairment in spastic paresis. Ann Phys Med Rehabil 2015

4th step

=

What can the agonist achieve against the tested antagonist?

=

$\underline{\mathbf{X}_{\mathbf{A}}}$

=

Active Movement by patient

Five Step Assessment →Neurological disease?

Rectus femoris

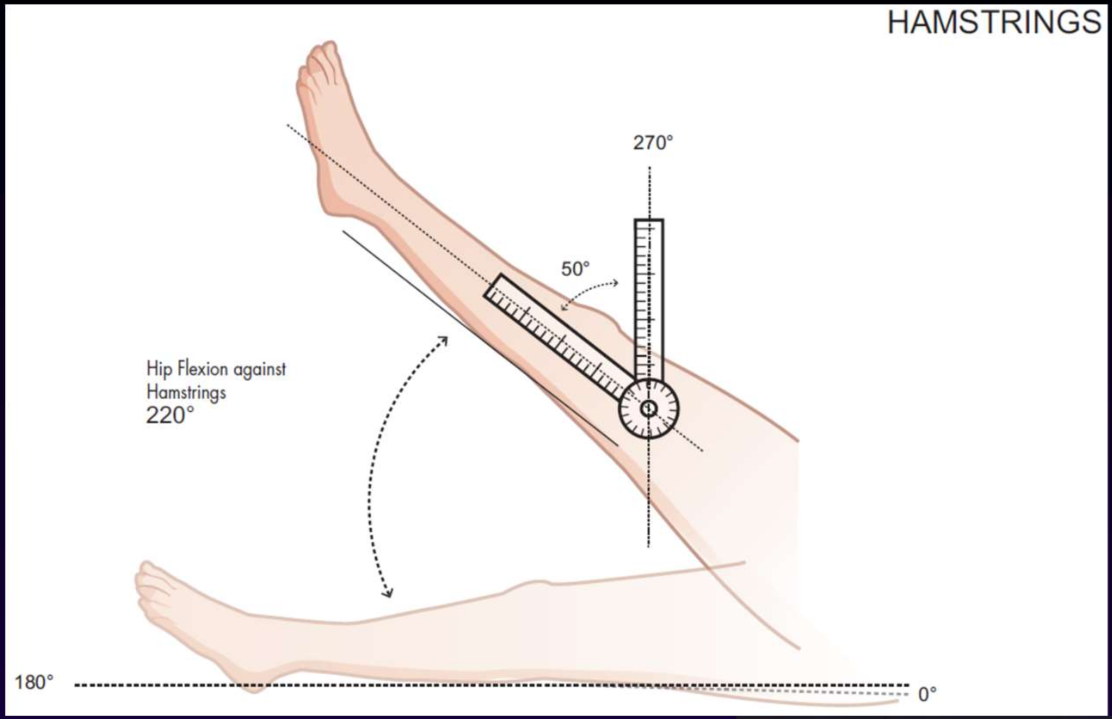
Maximal active ROM X_A
Maximal passive ROM X_{V1}

$$\boxed{\text{Coefficient of Weakness} = (X_{V1}-X_A)/X_{V1}}$$

Gracies. Coefficients of Impairment in Spastic Paresis. Ann Phys Med Rehabil 2015

Hamstrings X_A

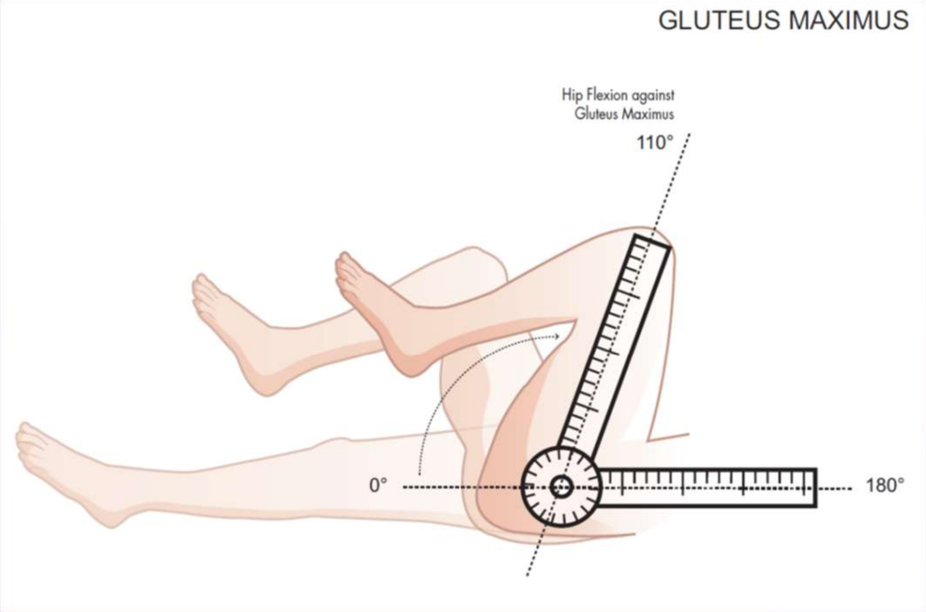
Hamstrings



Five Step Assessment
→**neurological disorder?**

Rectus femoris X_{V1}, X_A

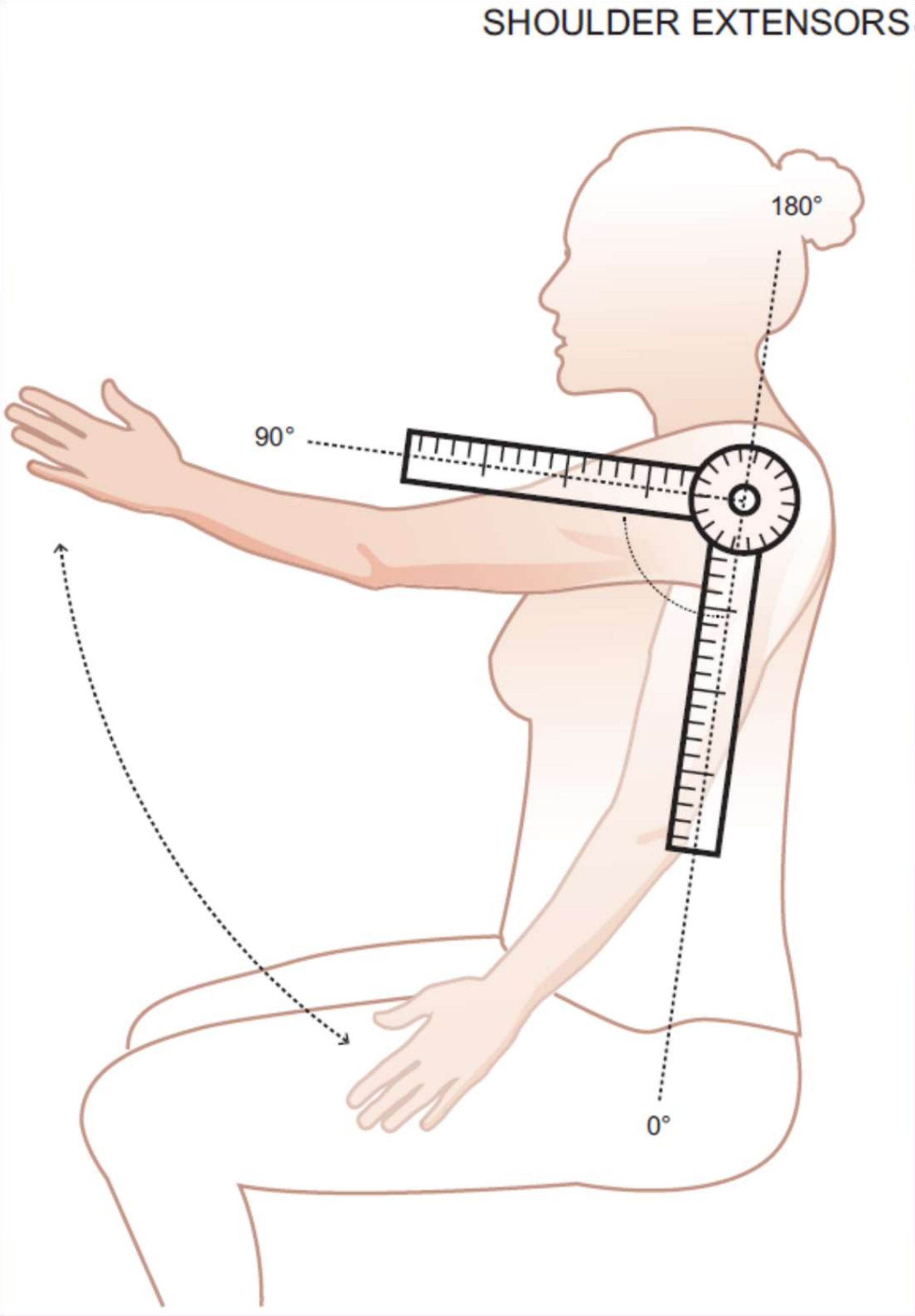
Gluteus maximus, X_{V1}, X_A



Five Step Assessment

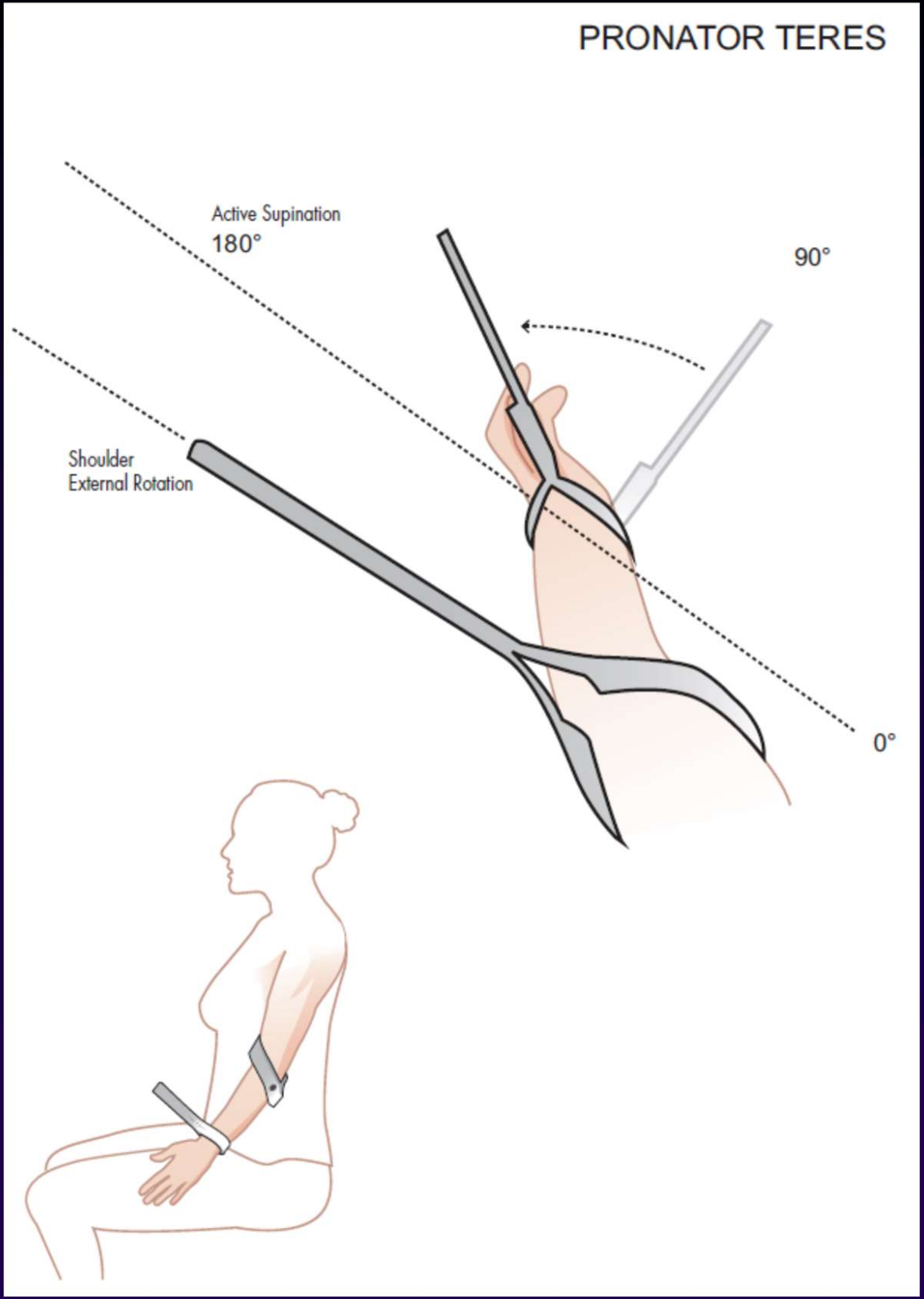
Coefficient of Weakness = $(X_{V1}-X_A)/X_{V1}$

Shoulder extensors



Coefficient of Fatigability = $(X_A\text{-}X_{A15})/X_A$

Pronator teres



Influence maladie du muscle *sur* commande?

Objectif :

Etudier relation extensibilité musculaire et association parésie/cocontraction

Hypothèses :

1. Au-delà d'un certain seuil de perte d'extensibilité, influence myopathie spastique *sur* commande descendante
2. Au-delà d'un certain seuil de perte d'extensibilité, influence myopathie spastique sur fonction active

Pradines et al, Ann Phys Rehabil Med 2018

Méthodes

Pradines et al
Ann Phys Rehabil Med 2018

Critères de sélection

- Unique AVC, ≥<u>1 an</u>
- Pas de <u>toxine</u> < 3 mois
- 6 muscles testés
- Marche autonome

Muscles évalués

6 Mb Sup - Inf

Critères d'évaluation

X_{V1} extensibilité

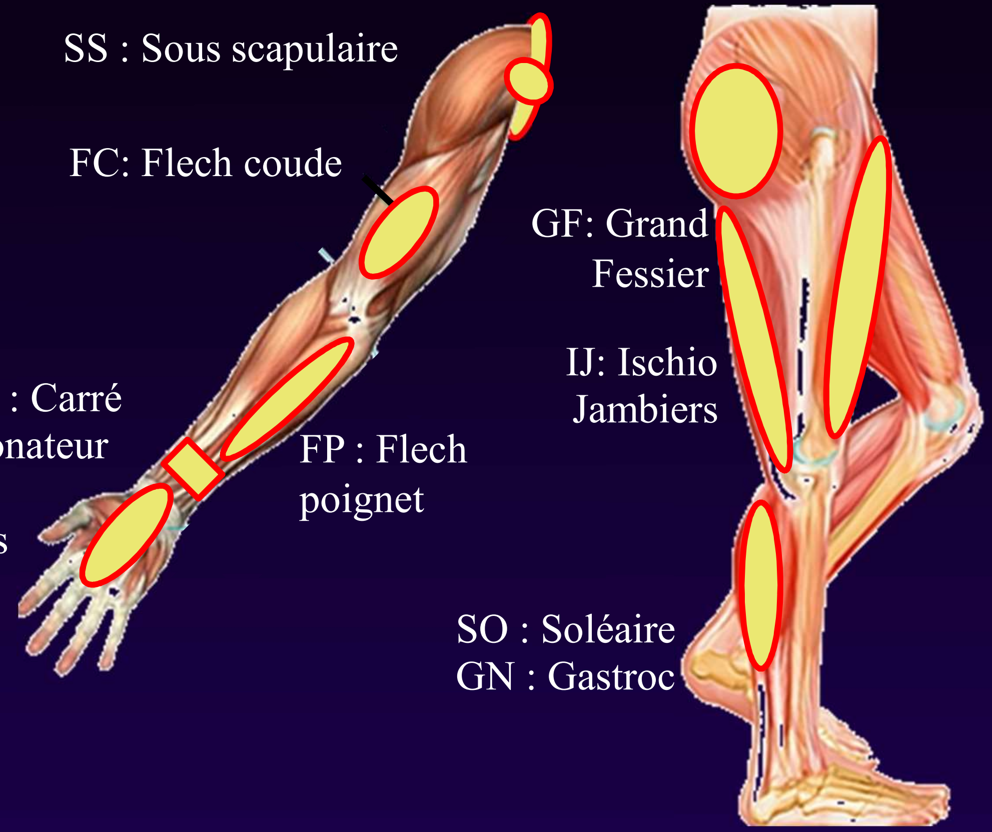
X_A actif

CR coeff raccourcissement

CF coeff faiblesse

MFS (Frenchay)

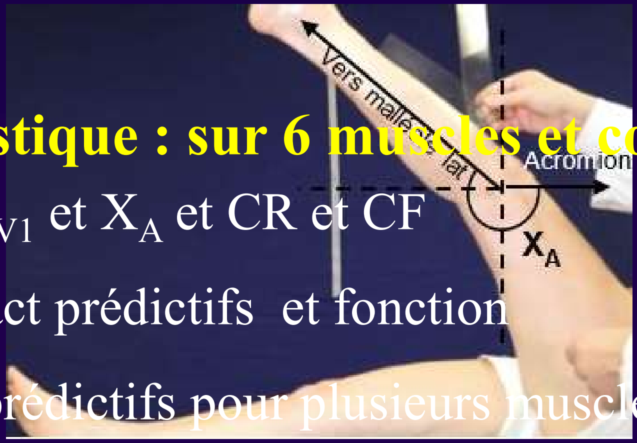
Vitesse marche



Traitement données - Analyse

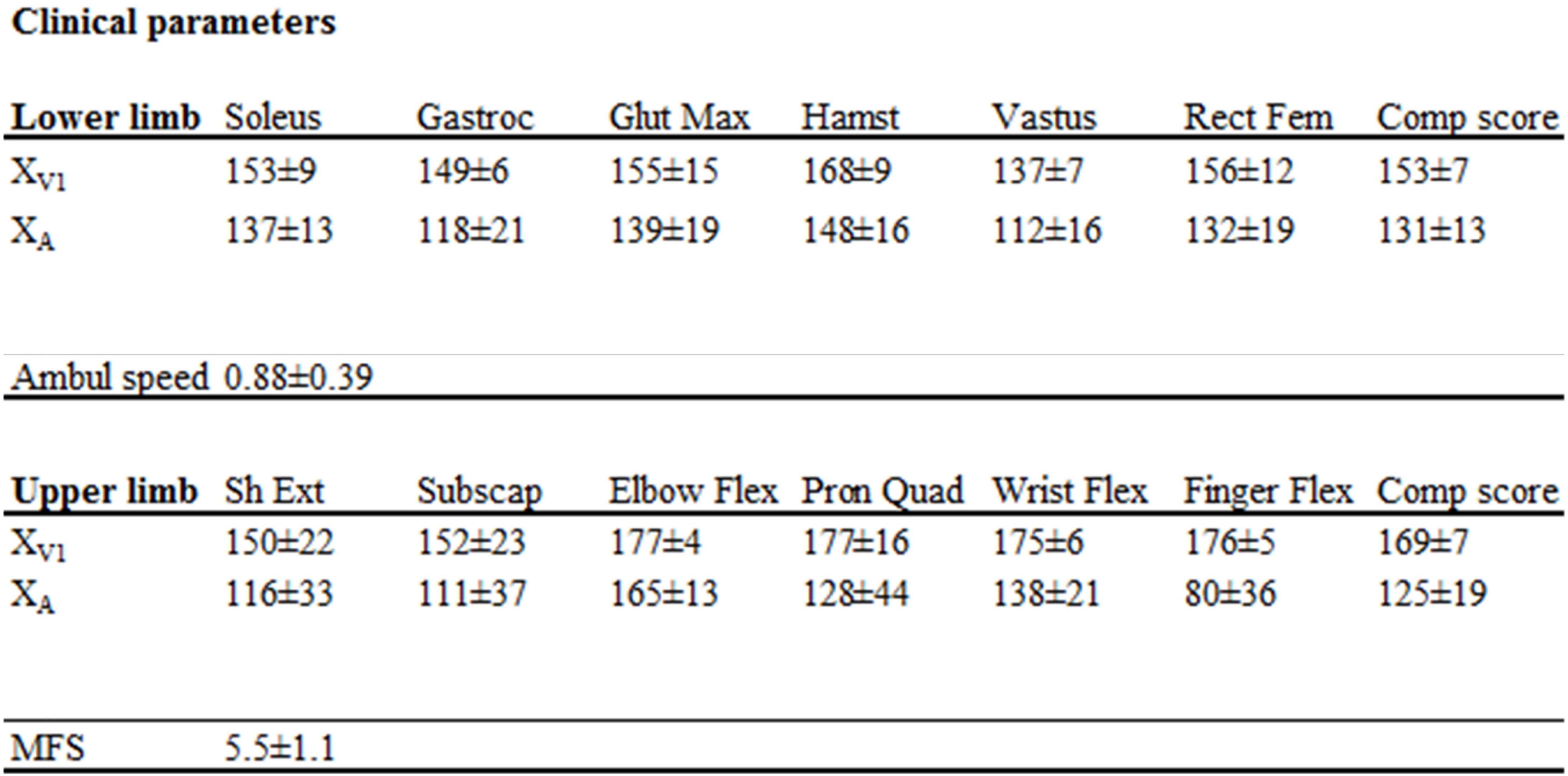
X_N → 180°

X_{V1} X_A CR CF normalisés



Analyse statistique : sur 6 muscles et composite

1. Régression X_{V1} et X_A et CR et CF
2. CR et CF = fact prédictifs et fonction
3. CR ou CF = prédictifs pour plusieurs muscles : multivariable



Clinical parameters

Lower limb	Soleus	Gastroc	Glut Max	Hamst	Vastus	Rect Fem	Comp score
X_{V1}	153±9	149±6	155±15	168±9	137±7	156±12	153±7
X_A	137±13	118±21	139±19	148±16	112±16	132±19	131±13

Ambul speed	0.88±0.39

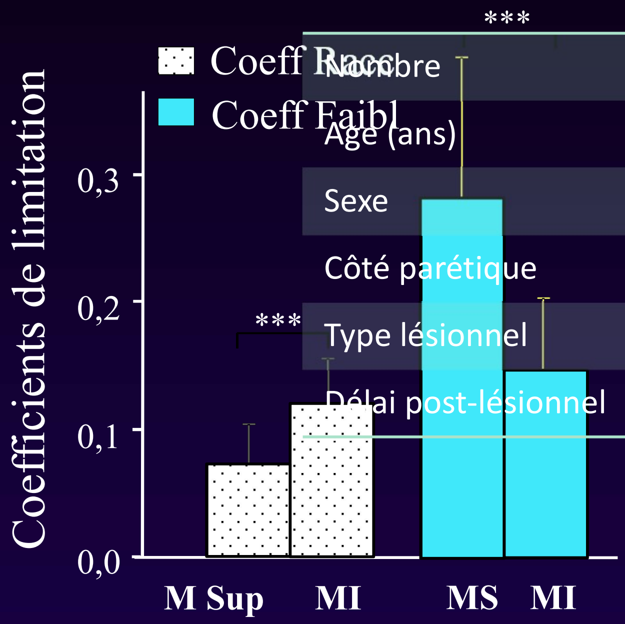
Upper limb	Sh Ext	Subscap	Elbow Flex	Pron Quad	Wrist Flex	Finger Flex	Comp score
X_{V1}	150±22	152±23	177±4	177±16	175±6	176±5	169±7
X_A	116±33	111±37	165±13	128±44	138±21	80±36	125±19

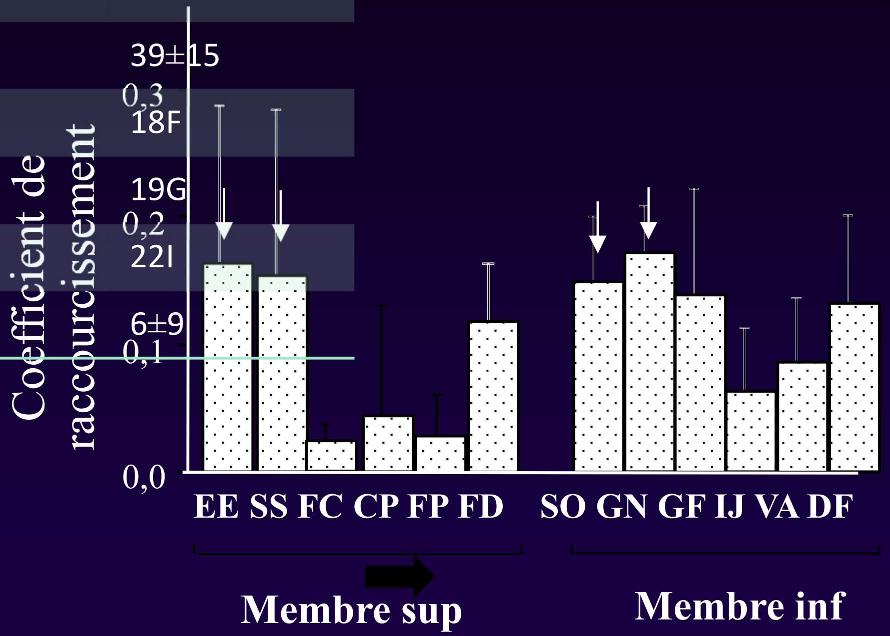
MFS	5.5±1.1

Pradines et al. Ann Phys Rehabil Med 2018

Résultats descriptifs

	Membre Inf	Membre Sup
Nombre	N=80	N=32
Age (ans)	51±16	39±15
Sexe	26F	18F
Côté parétique	42G	19G
Type lésionnel	66 I	22I
Délai post-lésionnel	9±8	6±9





- Raccourcissement :
Mb Sup < Mb Inf
- Faiblesse : Mb Sup > Mb Inf

- Raccourcissement :

→Extenseurs d’épaule
→Sous-scapulaire

→Gastrocnémiens
→Soléaire

Pradines et al Ann Phys Rehabil Med 2018

Spastic Myopathy post Immobilisation = THERAPEUTIC OPTIONS

- Electrical stimulation, vibration, US, shock/short waves?
- Nutrition? → leucine *(Baptista et al, 2010)?*
- Pharmacological?

→ tétracyclines (effects on muscle and bone..)
→ water saturated with hydrogen (antioxydant)

⟶

<u>Minimisation of immobilisation</u>? <u>Stretching?</u>
Kelleher, 2015 = genetic *reversibility* of spastic myopathy

Nagata et al, 2009; Carmeli et al, 2009; Baptista et al., 2010; Dirks et al, 2014

Gracies, 2010

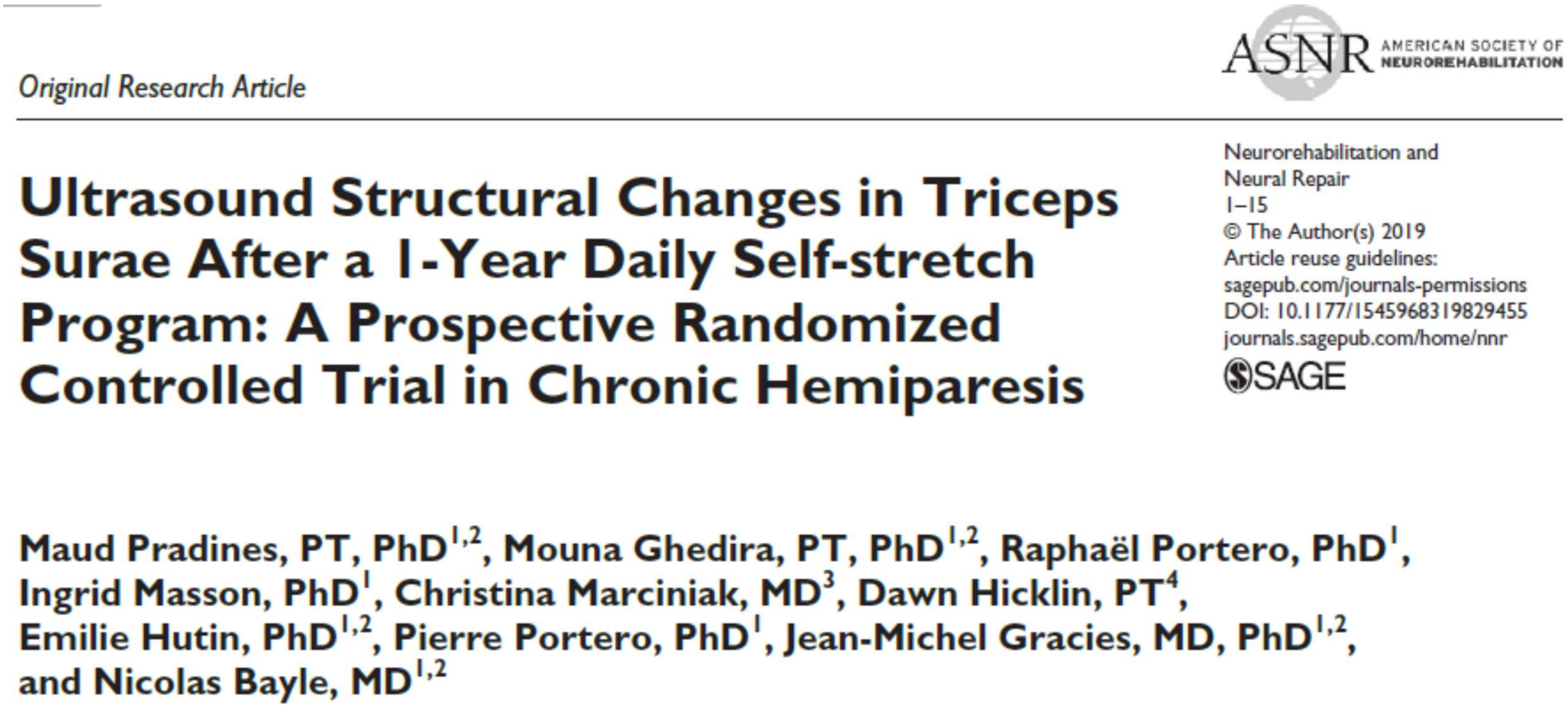
Gracies et al. BMC Neurology (2019) 19:39
https://doi.org/10.1186/s12883-019-1257-y

BMC Neurology

STUDY PROTOCOL Open Access

Guided Self-rehabilitation Contract vs conventional therapy in chronic stroke-induced hemiparesis: NEURORESTORE, a multicenter randomized controlled trial

Jean-Michel Gracies[1,2], Maud Pradines[1,2*], Mouna Ghédira[1,2], Catherine-Marie Loche[2], Valentina Mardale[2], Catherine Hennegrave[2], Caroline Gault-Colas[2], Etienne Audureau[3,4], Emilie Hutin[1,2], Marjolaine Baude[1,2], Nicolas Bayle[1,2] and the Neurorestore Study Group



Original Research Article

ASNR AMERICAN SOCIETY OF NEUROREHABILITATION

Neurorehabilitation and
Neural Repair
1–15

DOI: 10.1177/1545968319829455
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Ultrasound Structural Changes in Triceps Surae After a 1-Year Daily Self-stretch Program: A Prospective Randomized Controlled Trial in Chronic Hemiparesis

Maud Pradines, PT, PhD[1,2], Mouna Ghedira, PT, PhD[1,2], Raphaël Portero, PhD[1],
Ingrid Masson, PhD[1], Christina Marciniak, MD[3], Dawn Hicklin, PT[4],
Emilie Hutin, PhD[1,2], Pierre Portero, PhD[1], Jean-Michel Gracies, MD, PhD[1,2],
and Nicolas Bayle, MD[1,2]

Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Self-stretching and structural muscle changes

Objectives : Assess structural changes and passive extensibility in triceps surae + function, following a guided self-stretching program

Inclusion : 1st stroke > 1 year ; comfortable barefoot walking speed >0.1 et <1.2m/sec

↪ Ancillary to ***Neurorestore***

Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Etude prospective randomisée contrôlée en simple insu – ancillaire PHRC Neurorestore

Recrutement préliminaire: sujets adultes atteints d'hémiparésie chronique observés au centre Hospitalier Mondor (n=31)

Patients non inclus (n=8):
- >1 AVC ou hémiparésie sur autre cause (n=5)
- Troubles cognitifs sévères (n=3)

J1: Evaluation biomécanique/clinique + Randomisation (n=23)

1h30 à dom
1 fois / 2 sem

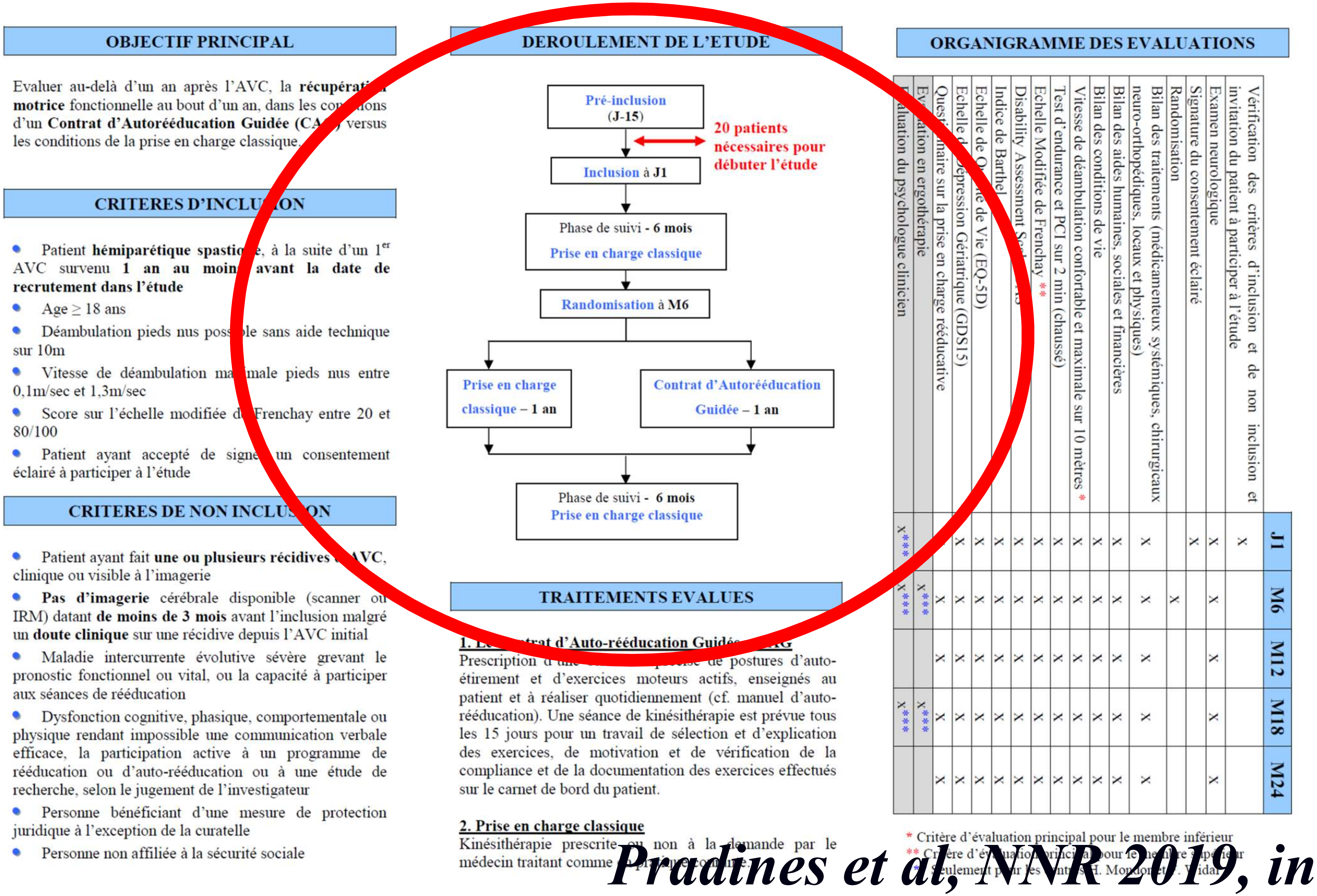
Rééducation conventionnelle (CONV) (n=11)

Contrat d'Autorééducation Guidée (CAG) + Rééduc conv. (n=12)

M12: Analyse biomécanique / Evaluation clinique (n=23)

Toxine botulique autorisée

Publicly funded project *Neurorestore*
HU Mondor



OBJECTIF PRINCIPAL

Evaluer au-delà d'un an après l'AVC, la **récupération motrice** fonctionnelle au bout d'un an, dans les conditions d'un **Contrat d'Autorééducation Guidée (CAG)** versus les conditions de la prise en charge classique.

CRITERES D'INCLUSION

- Patient **hémiparétique spastique**, à la suite d'un 1er AVC survenu **1 an au moins avant la date de recrutement dans l'étude**
- Age ≥ 18 ans
- Déambulation pieds nus possible sans aide technique sur 10m
- Vitesse de déambulation maximale pieds nus entre 0,1m/sec et 1,3m/sec
- Score sur l'échelle modifiée de Frenchay entre 20 et 80/100
- Patient ayant accepté de signer un consentement éclairé à participer à l'étude

CRITERES DE NON INCLUSION

- Patient ayant fait **une ou plusieurs récidives d'AVC**, clinique ou visible à l'imagerie
- **Pas d'imagerie** cérébrale disponible (scanner ou IRM) datant **de moins de 3 mois** avant l'inclusion malgré un **doute clinique** sur une récidive depuis l'AVC initial
- Maladie intercurrente évolutive sévère grevant le pronostic fonctionnel ou vital, ou la capacité à participer aux séances de rééducation
- Dysfonction cognitive, phasique, comportementale ou physique rendant impossible une communication verbale efficace, la participation active à un programme de rééducation ou d'auto-rééducation ou à une étude de recherche, selon le jugement de l'investigateur
- Personne bénéficiant d'une mesure de protection juridique à l'exception de la curatelle
- Personne non affiliée à la sécurité sociale

DEROULEMENT DE L'ETUDE

Pré-inclusion
(J-15)

20 patients nécessaires pour débuter l'étude

Inclusion à **J1**

Phase de suivi **- 6 mois**
Prise en charge classique

Randomisation à **M6**

Prise en charge classique – 1 an

Contrat d'Autorééducation Guidée – 1 an

Phase de suivi - **6 mois**
Prise en charge classique

TRAITEMENTS EVALUES

1. Le [illegible]ntrat d'Auto-rééducation Guidée [illegible]AG
Prescription d'une [illegible] précise de postures d'auto-étirement et d'exercices moteurs actifs, enseignés au patient et à réaliser quotidiennement (cf. manuel d'auto-rééducation). Une séance de kinésithérapie est prévue tous les 15 jours pour un travail de sélection et d'explication des exercices, de motivation et de vérification de la compliance et de la documentation des exercices effectués sur le carnet de bord du patient.

2. Prise en charge classique
Kinésithérapie prescrite ou non à la demande par le médecin traitant comme en pratique courante.

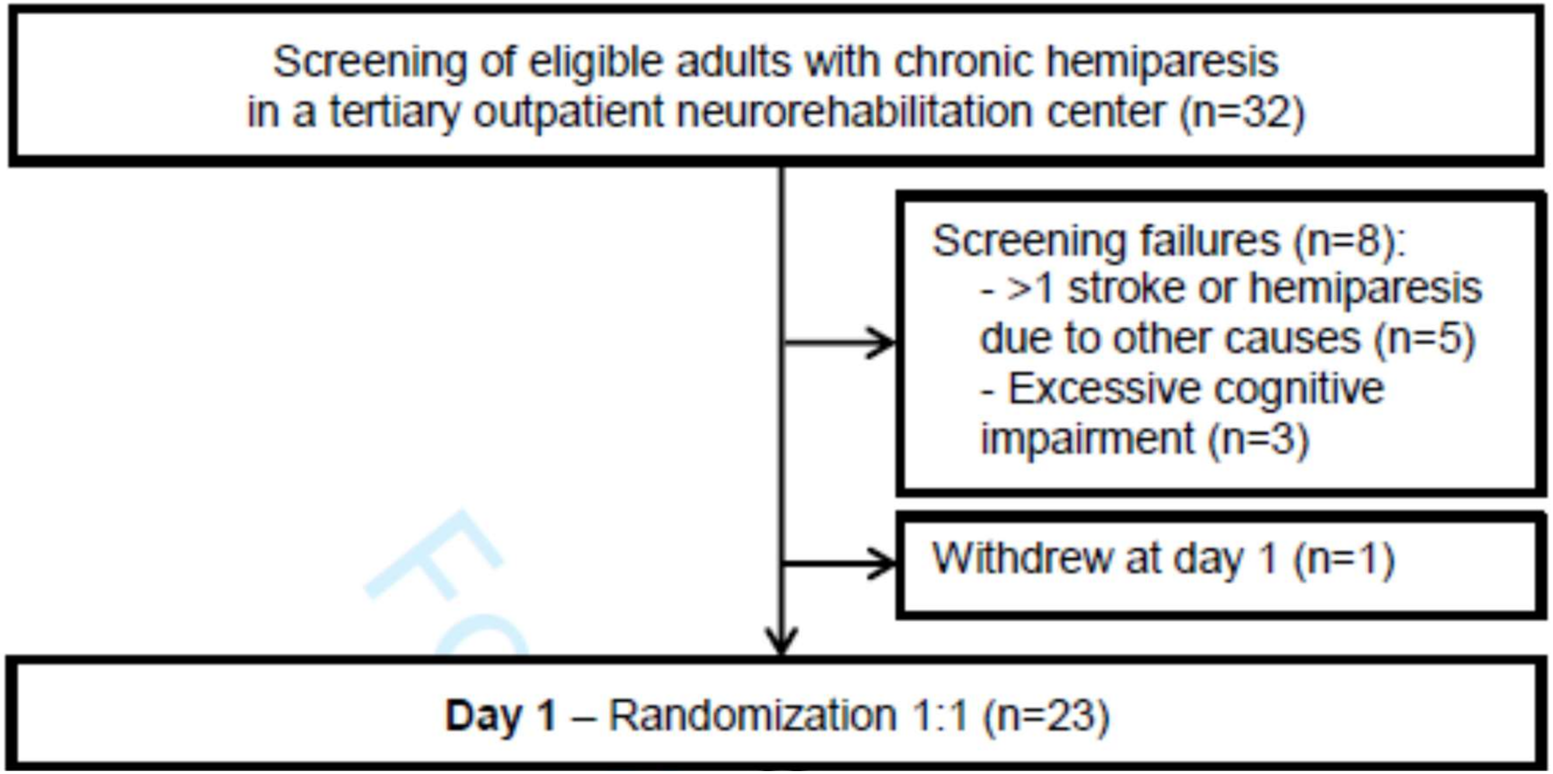
ORGANIGRAMME DES EVALUATIONS

	J1	M6	M12	M18	M24
Vérification des critères d'inclusion et de non inclusion et invitation du patient à participer à l'étude	x				
Examen neurologique	x	x	x	x	x
Signature du consentement éclairé	x				
Randomisation		x			
Bilan des traitements (médicamenteux systémiques, chirurgicaux neuro-orthopédiques, locaux et physiques)	x	x	x	x	x
Bilan des aides humaines, sociales et financières	x	x	x	x	x
Bilan des conditions de vie	x	x	x	x	x
Vitesse de déambulation confortable et maximale sur 10 mètres *	x	x	x	x	x
Test d'endurance et PCI sur 2 min (chaussé)	x	x	x	x	x
Echelle Modifiée de Frenchay **	x	x	x	x	x
Disability Assessment Sc[illegible]AS	x	x	x	x	x
Indice de Barthel	x	x	x	x	x
Echelle de Qualité de Vie (EQ-5D)	x	x	x	x	x
Echelle de Dépression Gériatrique (GDS15)	x	x	x	x	x
Questionnaire sur la prise en charge rééducative	[illegible]	x	x	x	x
Evaluation en ergothérapie		x***		x***	
Evaluation du psychologue clinicien	x***	x***		x***	

* Critère d'évaluation principal pour le membre inférieur
** Critère d'évaluation principal pour le membre supérieur
*** Seulement pour les centres H. Mondor et [illegible] Vidal

Pradines et al, NNR 2019, in press

Publicly funded *Neurorestore* project - Flow chart



Screening of eligible adults with chronic hemiparesis in a tertiary outpatient neurorehabilitation center (n=32)

Screening failures (n=8):
- >1 stroke or hemiparesis due to other causes (n=5)
- Excessive cognitive impairment (n=3)

Withdrew at day 1 (n=1)

Day 1 – Randomization 1:1 (n=23)

Pradines et al.
Neurorehabil
Neural Repair.
2019;33(4):245
-259

Description of the two groups

- **CONV group:** conventional community-based therapy sessions, based upon prescription by physician and patient requests

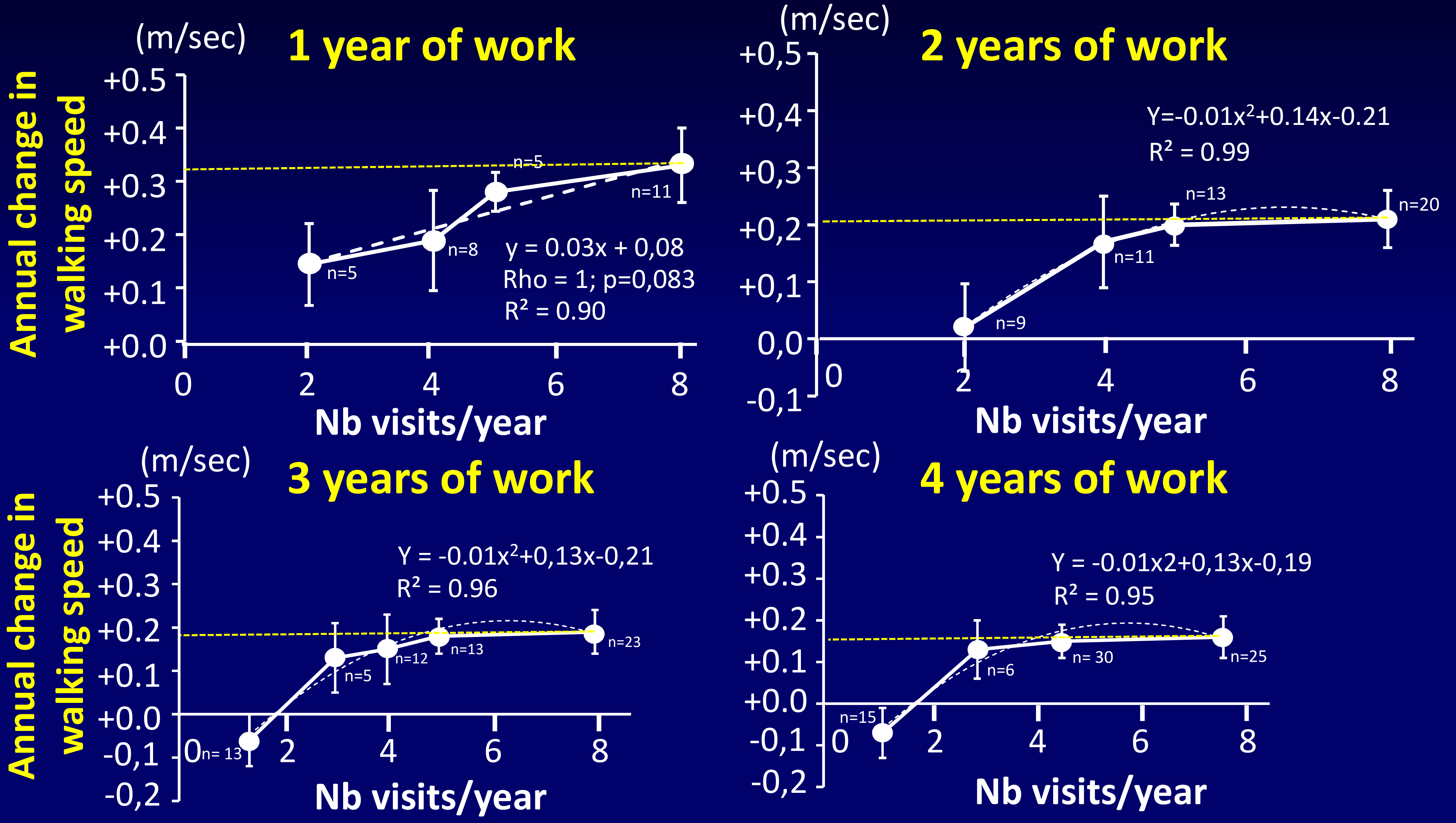
- **GSC group:** conventional sessions allowed, plus one visit every other week by study therapist to prescribe the program, teach self-stretching techniques on specific muscles and verify diaries

- **In both groups:** local treatment with BoNT (+/- systemic) allowed

Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Therapeutic frequency in neurorehabilitation

Annual gain in walking speed *vs* number of clinic visits/year

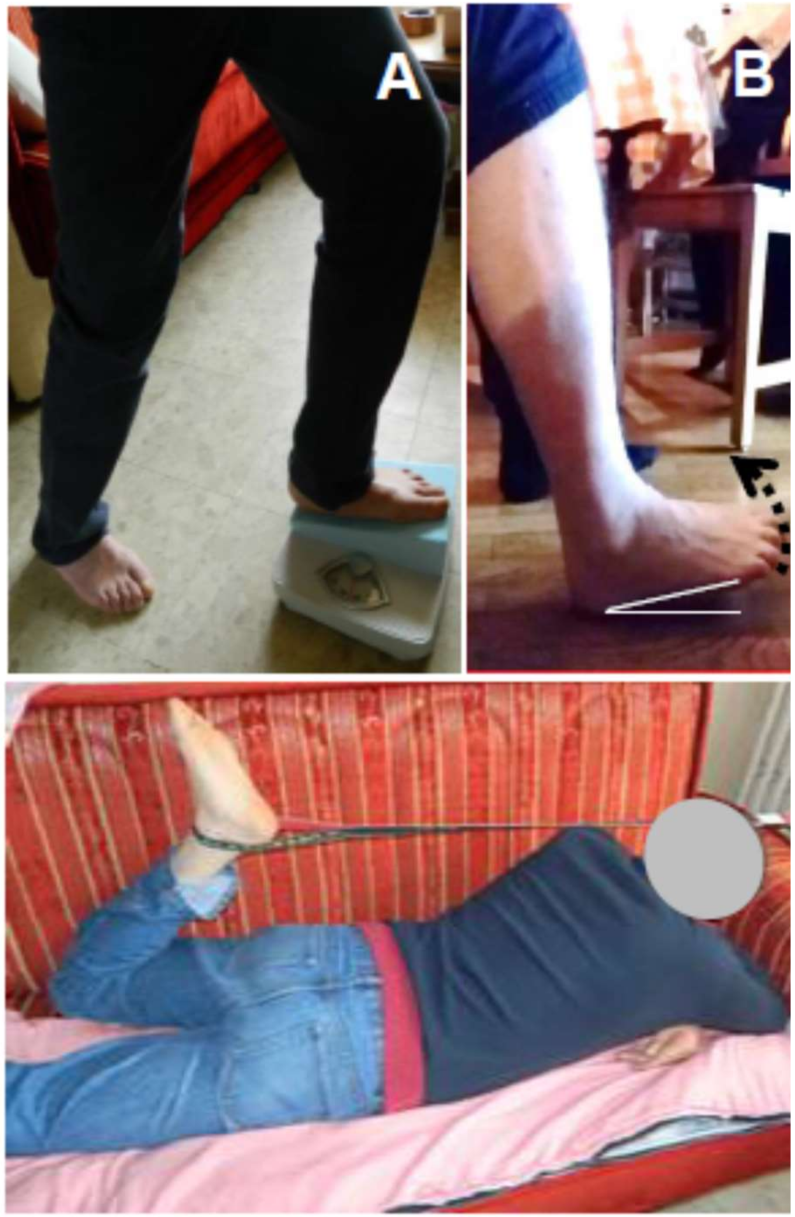

1 year of work

2 years of work

3 years of work

4 years of work

Retrospective study - *Mistry, Gracies, in preparation*

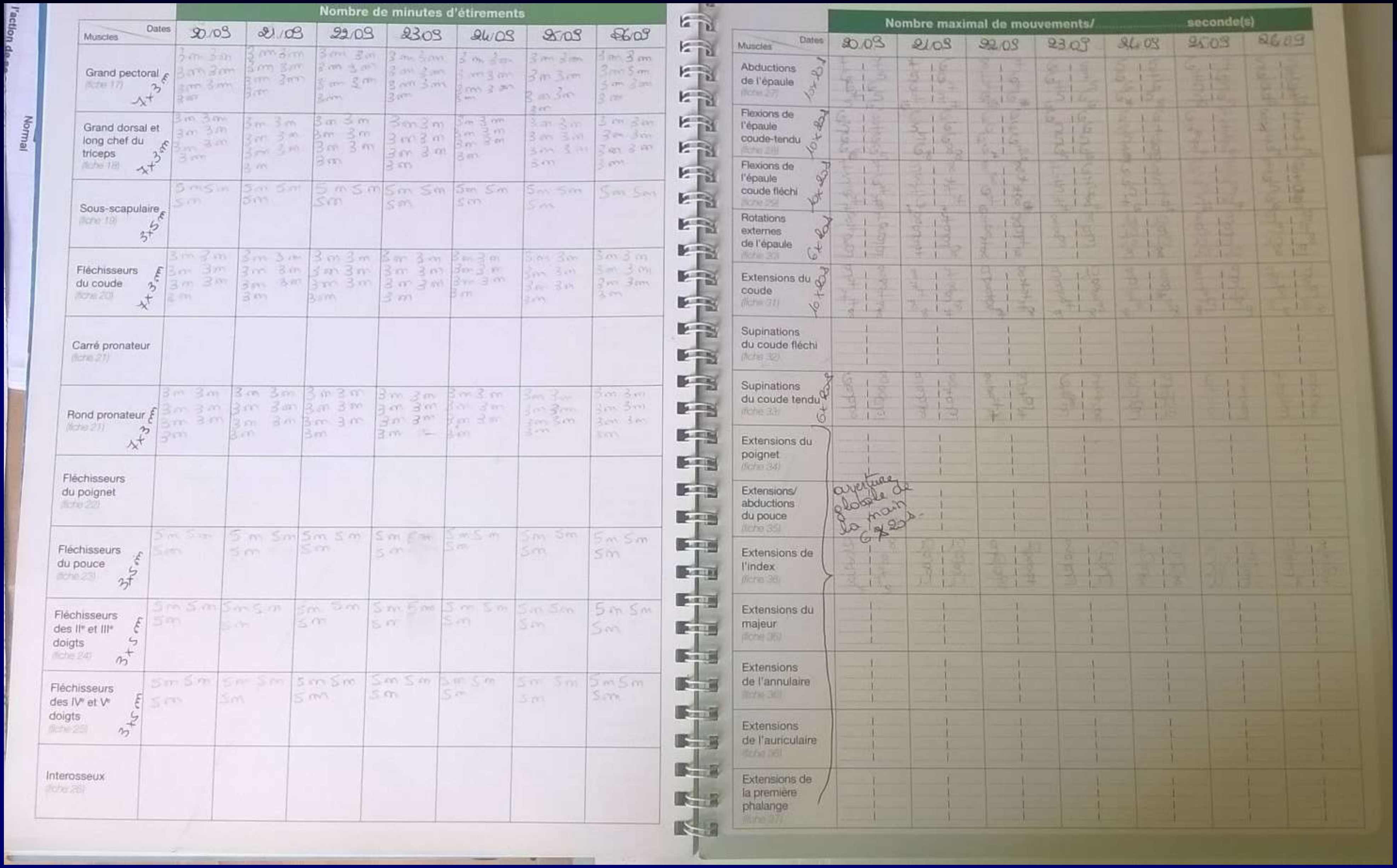


Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Quantified Diary+++++

Catherine		20 mn Etirement Grand Fessier	Flexion/mn hanche genou plié	20 mn Etirement Ischio jambier	Flexion/mn hanche genou droit	15 mn Etirement Droit antérieur	Flexion/mn genou fesse	Soléaire	Moment	Divers	relevés de Pied
jeudi	26/01/12	20	3X21	20	3X23	10	3X26	3	10H00	Kiné	3X19
vendredi	27/01/12										
samedi	28/01/12	20	3X21	20	3X24	10	3X27		17H00		3X18
dimanche	29/01/12										
lundi	30/01/12										3X17
mardi	31/01/12	20	3X20	20	3X25	10	3X26	5	10H00	Kiné	3X19
mercredi	01/02/12										
jeudi	02/02/12	20	3X21	20	3X24	10	3X26	5	10H00	Kiné	3X19
vendredi	03/02/12										
samedi	04/02/12	20	3x20	20	3X23	10	3X25		18H00		3X19
dimanche	05/02/12										4X17
lundi	06/02/12										3X17
mardi	07/02/12	20	3X21	20	3X24	10	3X26	5	10H00	Kiné	3X17
mercredi	08/02/12										3X17
jeudi	09/02/12	20	3X21	20	3X24	10	3X26	5	10H00	Kiné	3X17
vendredi	10/02/12										
samedi	11/02/12	20	3X21	20	3X23	10	3X26		21H00		3X17
dimanche	12/02/12										3X17
lundi	13/02/12										
mardi	14/02/12	20	3X19	20	3X23	10	3X26	5	10H00	Kiné	3X15
mercredi	15/02/12										3X18
jeudi	16/02/12	20	3X21	20	3X23	10	3X26	5	10H00	Kiné	3X17
vendredi	17/02/12										3X18
samedi	18/02/12	20	3X19	20	3X23	10	3X26		10H00		3X18
dimanche	19/02/12	20	3X21	20	3X24	10	3X26		10H00	Kiné	3X17
lundi	20/02/12										3X19
mardi	21/02/12	20	3X19	20	3X24	10	3X26	5	10H00	Kiné	3X19
mercredi	22/02/12										3X20
jeudi	23/02/12	20	3X20	20	3X24	10	3X26	5	10H00	Kiné	3X19
vendredi	24/02/12										3X20
samedi	25/02/12										3X20
dimanche	26/02/12	20	3X21	20	3X23	10	3X26		10H00		3X21

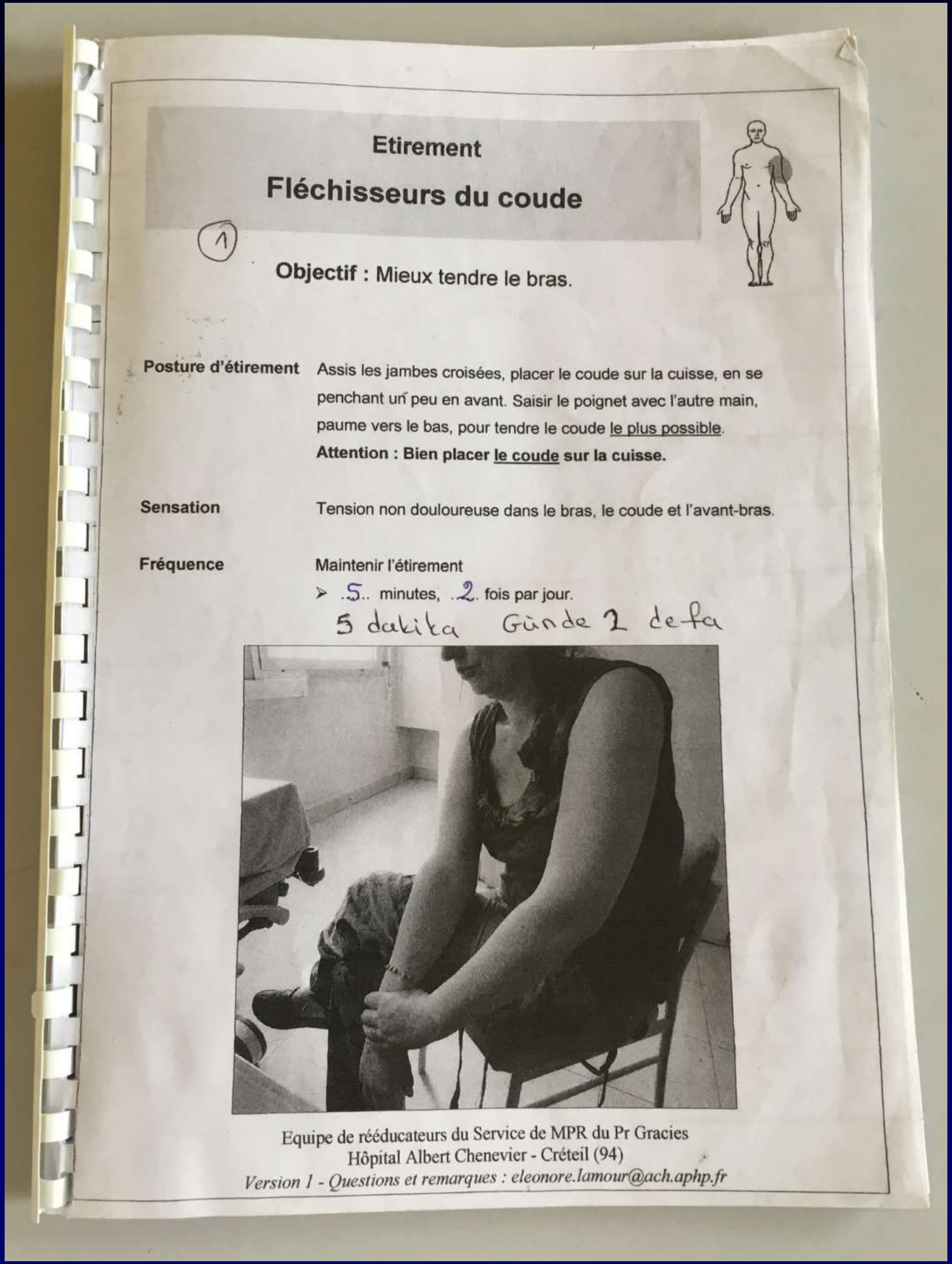


Nombre de minutes d'étirements

Muscles / Dates	20.09	21/09	22/09	23.09	24/09	25/09	26/09
Grand pectoral (fiche 17) 7×3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m
Grand dorsal et long chef du triceps (fiche 18) 7×3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m
Sous-scapulaire (fiche 19) 3×5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m
Fléchisseurs du coude (fiche 20) 7×3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m
Carré pronateur (fiche 21)							
Rond pronateur (fiche 21) 7×3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m –	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m	3m 3m 3m 3m 3m 3m 3m
Fléchisseurs du poignet (fiche 22)							
Fléchisseurs du pouce (fiche 23) 3×5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m
Fléchisseurs des IIe et IIIe doigts (fiche 24) 3×5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m
Fléchisseurs des IVe et Ve doigts (fiche 25) 3×5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m	5m 5m 5m
Interosseux (fiche 26)							

Nombre maximal de mouvements/ .... seconde(s)

Muscles / Dates	20.09	21/09	22/09	23.09	24.09	25.09	26.09
Abductions de l'épaule (fiche 27) 10×20s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Flexions de l'épaule coude-tendu (fiche 28) 10×20s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Flexions de l'épaule coude fléchi (fiche 29) 10×20s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rotations externes de l'épaule (fiche 30) 6×20s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Extensions du coude (fiche 31) 10×20s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Supinations du coude fléchi (fiche 32)							
Supinations du coude tendu (fiche 33) 6×20s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Extensions du poignet (fiche 34)							
Extensions/abductions du pouce (fiche 35)	ouverture globale de la main 6×20s						
Extensions de l'index (fiche 36)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Extensions du majeur (fiche 36)							
Extensions de l'annulaire (fiche 36)							
Extensions de l'auriculaire (fiche 36)							
Extensions de la première phalange (fiche 37)							



Etirement

Fléchisseurs du coude

①

Objectif : Mieux tendre le bras.

Posture d'étirement Assis les jambes croisées, placer le coude sur la cuisse, en se penchant un peu en avant. Saisir le poignet avec l'autre main, paume vers le bas, pour tendre le coude le plus possible. **Attention : Bien placer le coude sur la cuisse.**

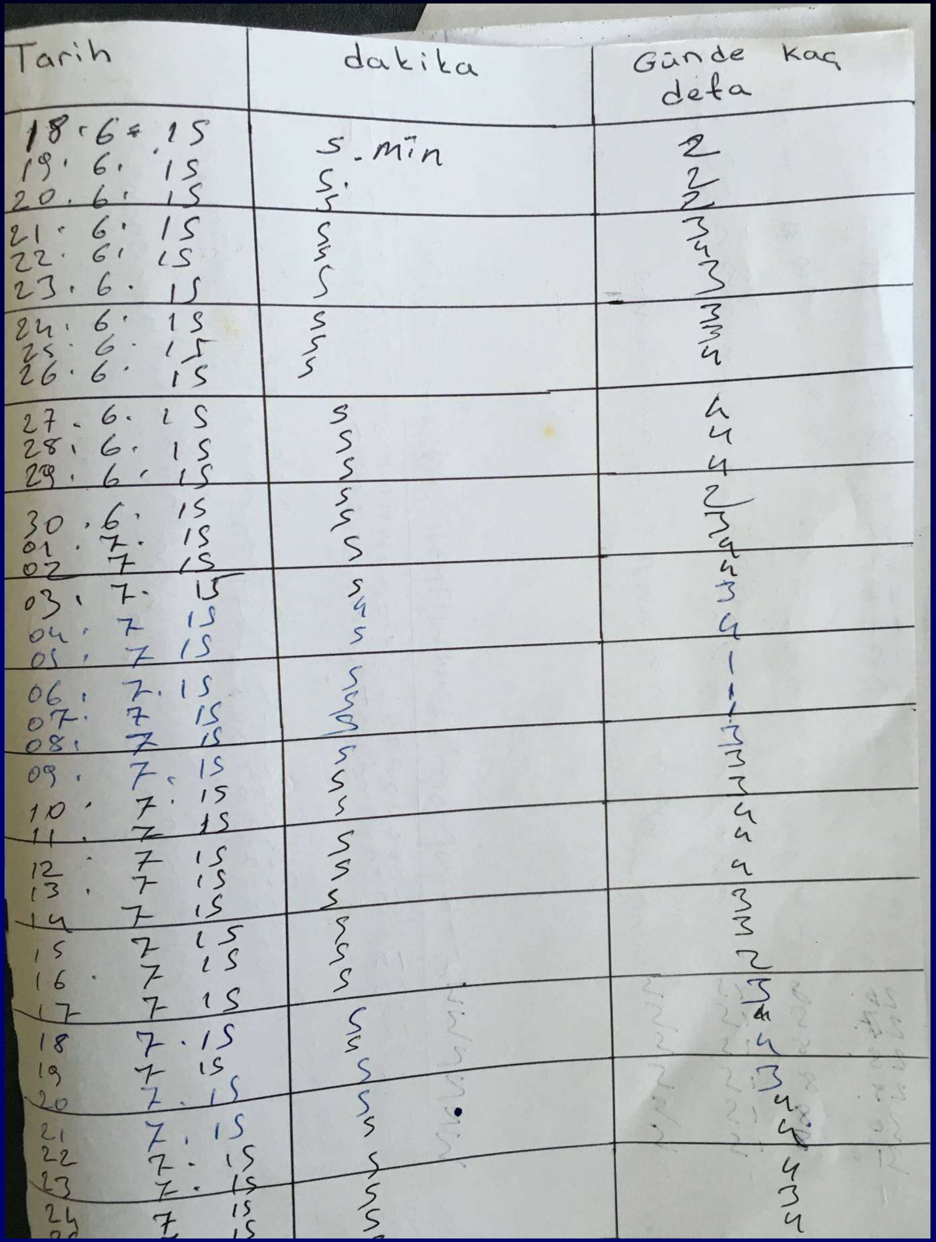
Sensation Tension non douloureuse dans le bras, le coude et l'avant-bras.

Fréquence Maintenir l'étirement

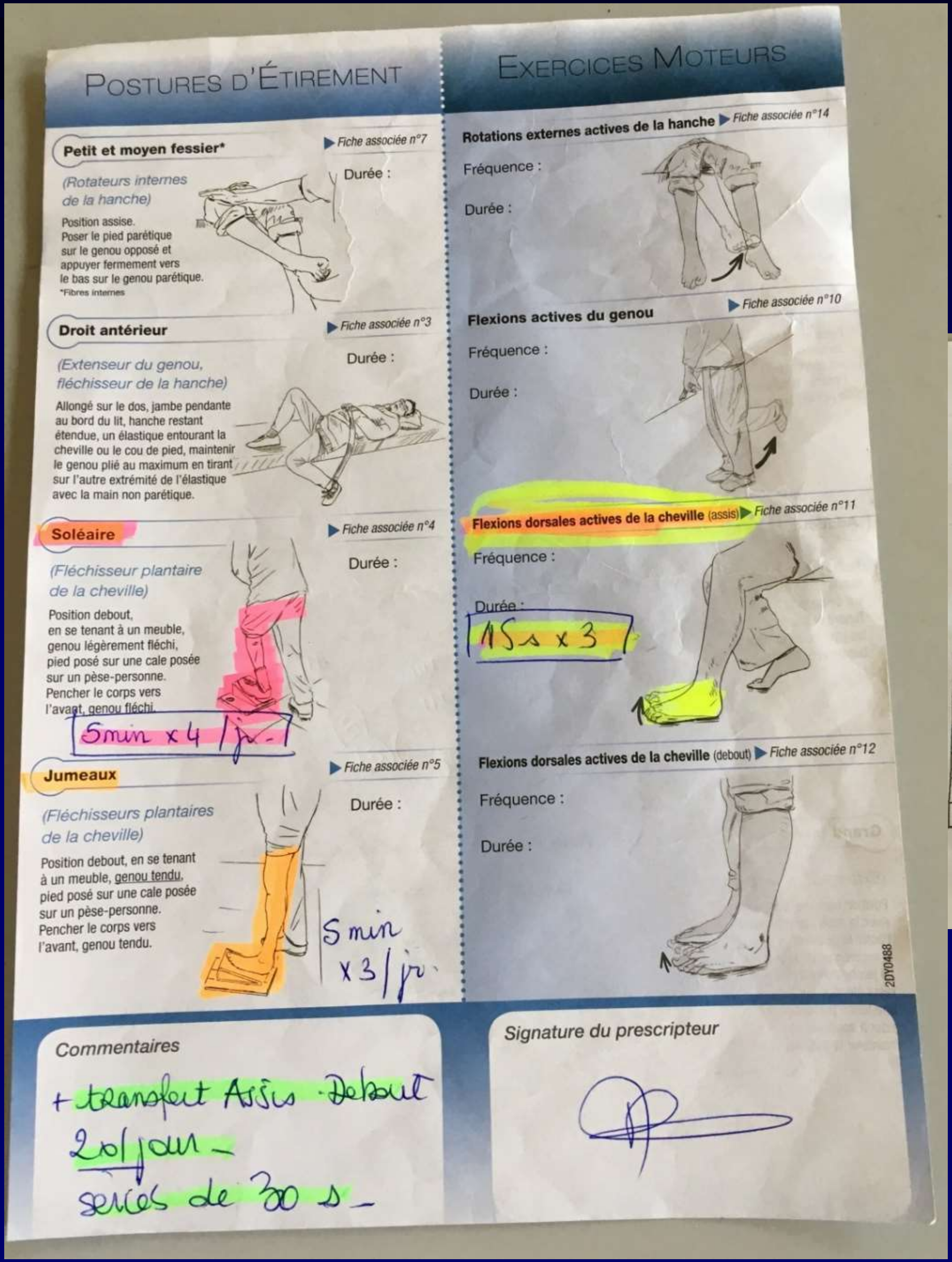
- .5.. minutes, ..2. fois par jour.

5 dakika Günde 1 defa

Equipe de rééducateurs du Service de MPR du Pr Gracies
Hôpital Albert Chenevier - Créteil (94)
Version 1 - Questions et remarques : eleonore.lamour@ach.aphp.fr



Tarih	dakika	Günde kaç defa
18.6.15	5.min	2
19.6.15	5.	2
20.6.15	5	2
21.6.15	5	3
22.6.15	5	4
23.6.15	5	3
24.6.15	5	3
25.6.15	5	3
26.6.15	5	4
27.6.15	5	4
28.6.15	5	4
29.6.15	5	4
30.6.15	5	2
01.7.15	5	3 4
02 7 15	5	4
03.7.15	5	3
04.7 15	4	4
05.7 15	5	1
06.7.15	5	1
07.7 15	5	3
08.7 15	5	3
09.7.15	5	3
10.7.15	5	4
11.7 15	5	4
12.7 15	5	4
13.7 15	5	3
14 7 15	5	3
15 7 15	5	2
16.7 15	5	3
17 7 15	5	4
18 7.15	5	4
19 7 15	5	3
20 7.15	5	4
21 7.15	5	4
22 7.15	5	4
23 7.15	5	3
24 7 15	5	4



POSTURES D'ÉTIREMENT

Petit et moyen fessier* ▶ *Fiche associée n°7*

(Rotateurs internes de la hanche)

Position assise.
Poser le pied parétique sur le genou opposé et appuyer fermement vers le bas sur le genou parétique.
*Fibres internes

Durée :

Droit antérieur ▶ *Fiche associée n°3*

(Extenseur du genou, fléchisseur de la hanche)

Allongé sur le dos, jambe pendante au bord du lit, hanche restant étendue, un élastique entourant la cheville ou le cou de pied, maintenir le genou plié au maximum en tirant sur l'autre extrémité de l'élastique avec la main non parétique.

Durée :

Soléaire ▶ *Fiche associée n°4*

(Fléchisseur plantaire de la cheville)

Position debout, en se tenant à un meuble, genou légèrement fléchi, pied posé sur une cale posée sur un pèse-personne. Pencher le corps vers l'avant, genou fléchi.

5min x 4 / jr -

Durée :

Jumeaux ▶ *Fiche associée n°5*

(Fléchisseurs plantaires de la cheville)

Position debout, en se tenant à un meuble, genou tendu, pied posé sur une cale posée sur un pèse-personne. Pencher le corps vers l'avant, genou tendu.

Durée :

5 min x 3 / jr.

EXERCICES MOTEURS

Rotations externes actives de la hanche ▶ *Fiche associée n°14*

Fréquence :

Durée :

Flexions actives du genou ▶ *Fiche associée n°10*

Fréquence :

Durée :

Flexions dorsales actives de la cheville (assis) ▶ *Fiche associée n°11*

Fréquence :

Durée :

15 s x 3

Flexions dorsales actives de la cheville (debout) ▶ *Fiche associée n°12*

Fréquence :

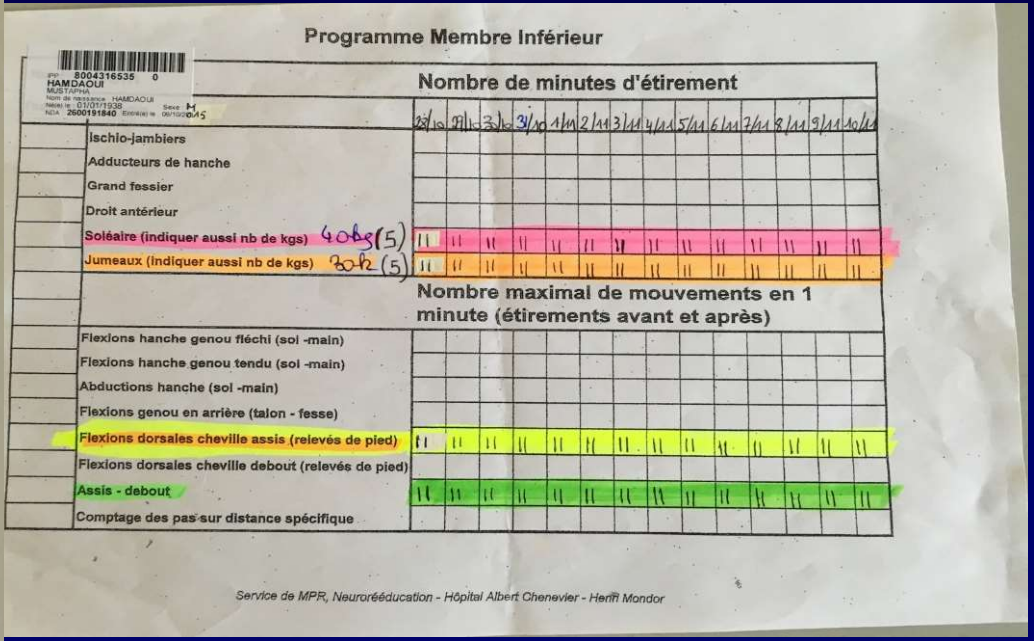
Durée :

2D0488

Commentaires

+ transfert Assis Debout
20/jour –
series de 30 s –

Signature du prescripteur

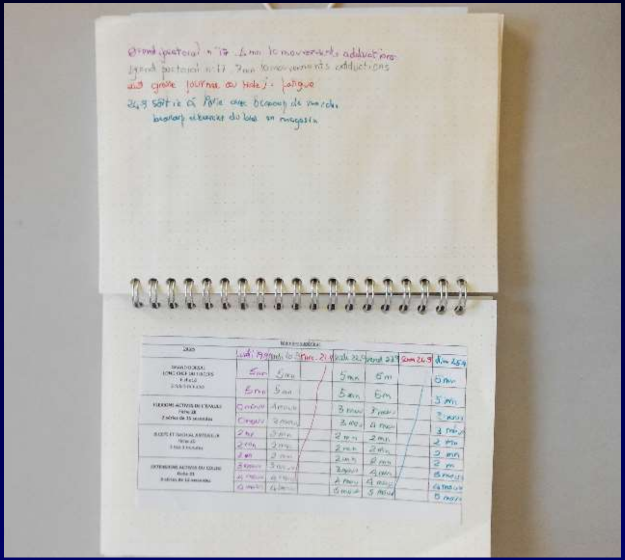


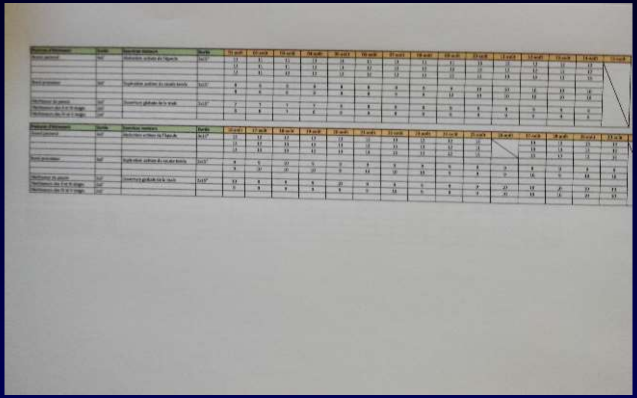
Programme Membre Inférieur

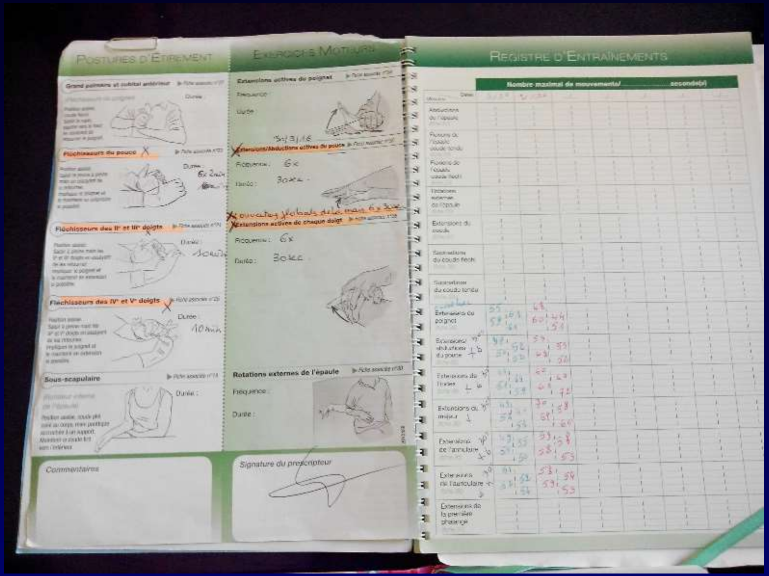
IPP 8004316535 0
HAMDAOUI
MUSTAPHA
Nom de naissance HAMDAOUI
Né(e) le 01/01/1938 Sexe M
NDA 2600191840 Entré(e) le 06/10/2015

	Nombre de minutes d'étirement													
	28/10	29/10	30/10	31/10	1/11	2/11	3/11	4/11	5/11	6/11	7/11	8/11	9/11	10/11
Ischio-jambiers														
Adducteurs de hanche														
Grand fessier														
Droit antérieur														
Soléaire (indiquer aussi nb de kgs) 40kg (5)	II	II	II	II	II	II	II	II	II	II	II	II	II	II
Jumeaux (indiquer aussi nb de kgs) 30k (5)	II	II	II	II	II	II	II	II	II	II	II	II	II	II
	Nombre maximal de mouvements en 1 minute (étirements avant et après)													
Flexions hanche genou fléchi (sol -main)														
Flexions hanche genou tendu (sol -main)														
Abductions hanche (sol -main)														
Flexions genou en arrière (talon - fesse)														
Flexions dorsales cheville assis (relevés de pied)	II	II	II	II	II	II	II	II	II	II	II	II	II	II
Flexions dorsales cheville debout (relevés de pied)														
Assis - debout	II	II	II	II	II	II	II	II	II	II	II	II	II	II
Comptage des pas sur distance spécifique														

Service de MPR, Neurorééducation - Hôpital Albert Chenevier - Henri Mondor


Grand pectoral n°17 1mn 10 mouvements adductions
grand pectoral n°17 2mn 10 mouvements adductions
21.9 grosse journée au lycée → fatigue
24.9 sortie à Paris avec beaucoup de marche, beaucoup d'escaliers du bus en magasin




POSTURES D'ÉTIREMENT

Grand palmaire et cubital antérieur
Durée

Fléchisseurs du pouce
Durée : 6x 2min

Fléchisseurs des II^e et III^e doigts
Durée : 10min

Fléchisseurs des IV^e et V^e doigts
Durée : 10min

Sous-scapulaire
Durée :

Commentaires

EXERCICES MOTEURS

Extensions actives du poignet
Fréquence :
Durée :

31/3/16

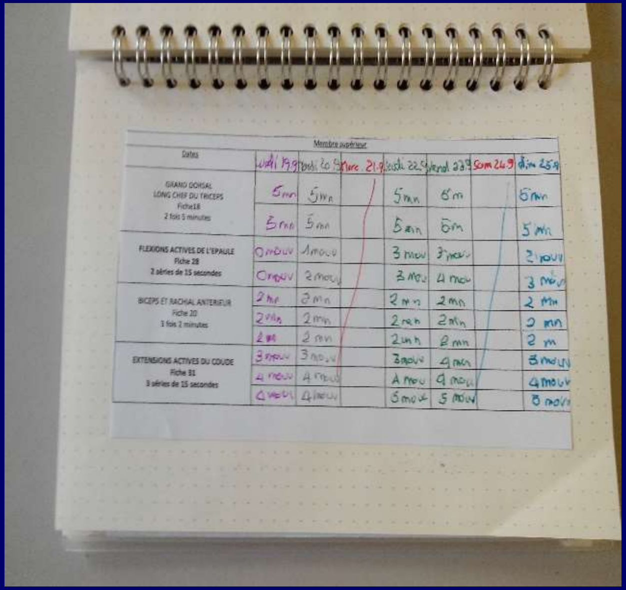
Extensions/Abductions actives du pouce
Fréquence : 6x
Durée : 30sec.

ouverture globale de la main 6 x 30sec
Extensions actives de chaque doigt
Fréquence : 6x
Durée : 30sec.

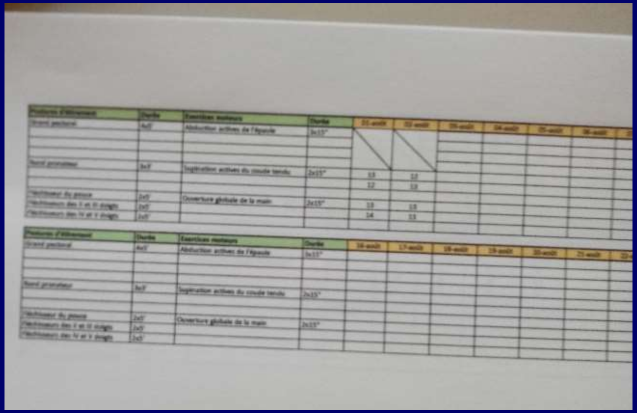
Rotations externes de l'épaule
Fréquence :
Durée :

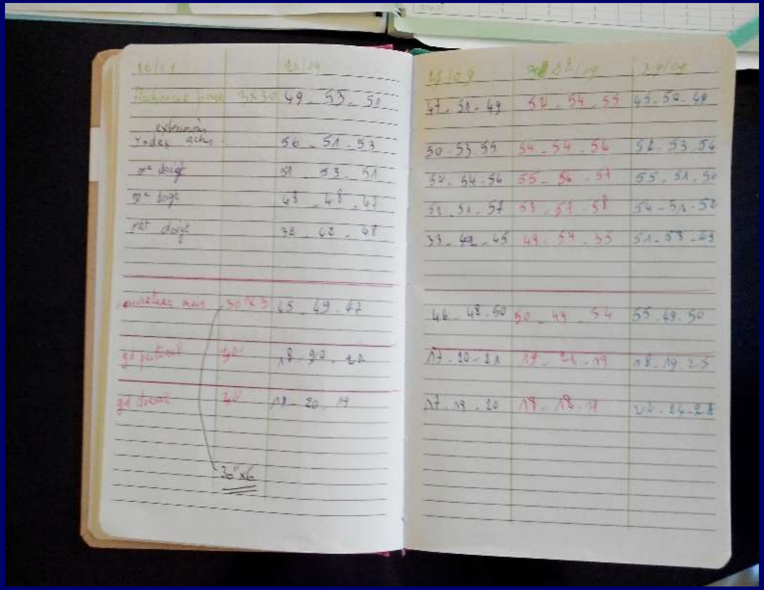
Signature du prescripteur

REGISTRE D'ENTRAÎNEMENTS



Membre supérieur							
Dates	Lundi 19.9	Mardi 20.9	Merc. 21.9	Jeudi 22.9	Vend 23.9	Sam 24.9	dim 25.9
GRAND DORSAL LONG CHEF DU TRICEPS Fiche18 2 fois 5 minutes	5mn	5mn		5mn	5m		5mn
	5mn	5mn		5min	5m		5mn
FLEXIONS ACTIVES DE L'EPAULE Fiche 28 2 séries de 15 secondes	0mouv	1mouv		3mouv	3mouv		2mouv
	0mouv	2mouv		3mouv	4mouv		3mouv
BICEPS ET RACHIAL ANTERIEUR Fiche 20 3 fois 2 minutes	2mn	2mn		2mn	2mn		2mn
	2mn	2mn		2mn	2mn		2mn
	2m	2mn		2mn	2mn		2m
EXTENSIONS ACTIVES DU COUDE Fiche 31 3 séries de 15 secondes	3mouv	3mouv		3mouv	4mn		3mouv
	4mouv	4mouv		4mouv	4mouv		4mouv
	4mouv	4mouv		5mouv	5mouv		5mouv

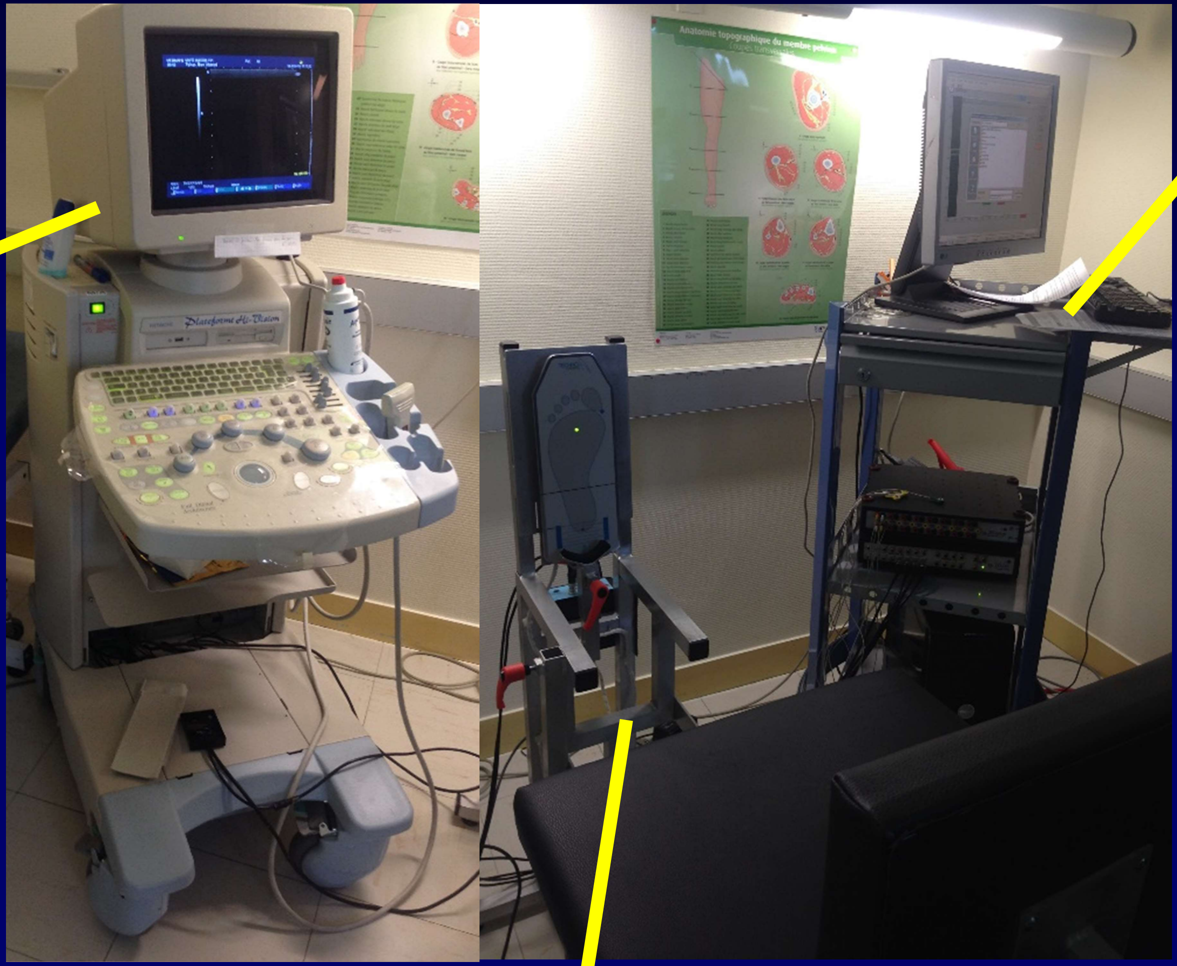




10/09		16/09	19/09	23/09	24/09
Fléchisseur pouce	3x30	49 . 53 . 51	47 . 51 . 49	52 . 54 . 55	45 . 52 . 49
extension actives index		56 . 51 . 53	50 . 53 55	54 . 54 . 56	52 . 53 . 54
3e doigt		51 . 53 . 51	52 . 54 . 56	55 . 56 . 57	55 . 51 . 50
4e doigt		48 . 48 . 47	51 . 51 . 57	53 . 57 . 58	54 . 51 . 52
5e doigt		52 . 62 . 58	53 . 42 . 45	48 . 54 . 55	51 . 53 . 49
ouverture main	30"x3	45 . 49 . 47	46 . 48 . 50	50 . 49 . 54	55 . 49 . 50
gd pectoral	30"	18 . 20 . 22	17 . 20 . 21	19 . 21 . 19	18 . 19 . 25
gd dorsal	30"	18 . 20 . 19	17 . 19 . 20	19 . 18 . 19	22 . 24 . 28

30"x6

Biomechanical assessment



Ultrasound diagnostic scanner model EZU-MT24-S1 (Hitachi)

Calibrated image
Frequency 13Mhz
Depth 50mm

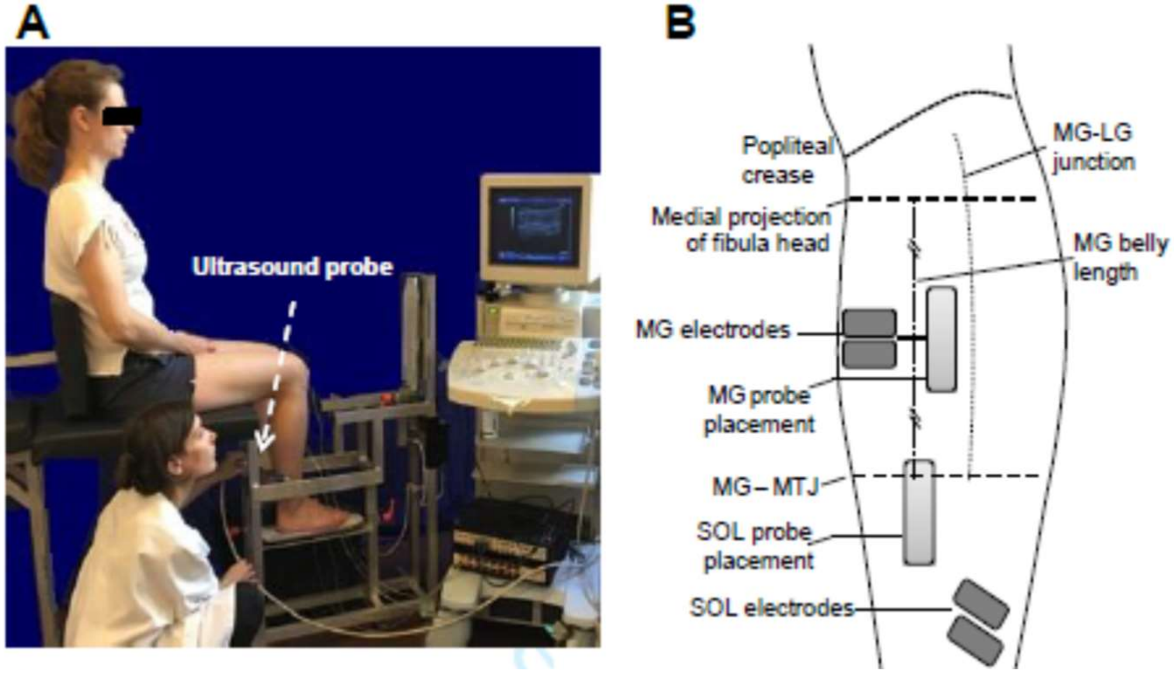
g-BS amp *g-tech*

Surface EMG

Ankle ergometer with two force platforms (*Techno Concept*)

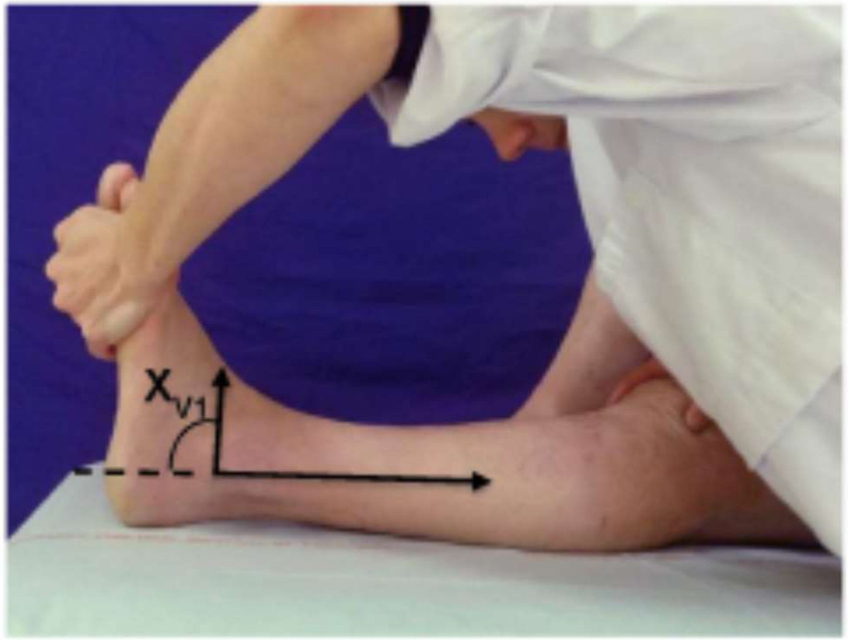
Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Methods



Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Clinical assessment



$$X_{V1}\ \text{Composite} = (X_{V1GAS} + X_{V1SOL} + X_{V1GM} + X_{V1RF}) / 4$$

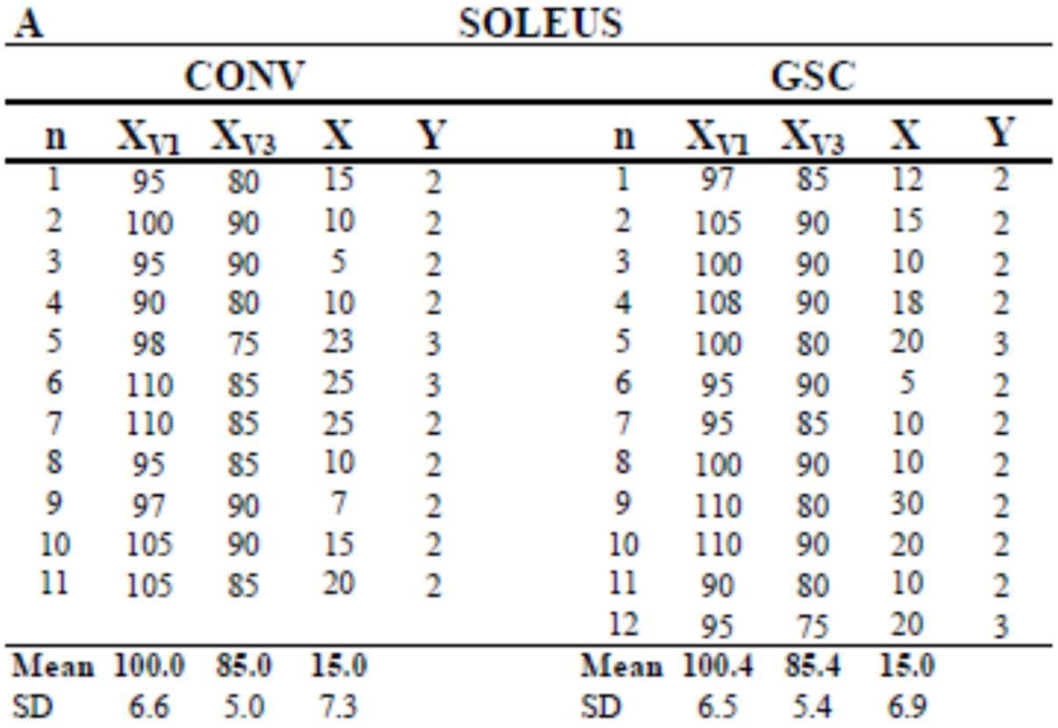
At baseline..

Subject characteristics	CONV (n=11)	GSC (n=12)
Age (years)	55±13	57±11
Time since lesion (years)	8±5	10±9
Gender	8M	5M
Paretic side	6R	6R
Lesion type	8I	8I

Healthy subjects
43 mm
40 mm
15.5 mm
17 mm

Gao et al, Arch Phys Med Rehabil 2009; Zhao, Appl Physiol 2015; Simpson CL et al, Scand J Med Sci Sports. 2017; Maganaris et al, J; Bolsterlee B… Gandevia SC, Herbert RD. J Biomech. 2015;48(6):1133-40

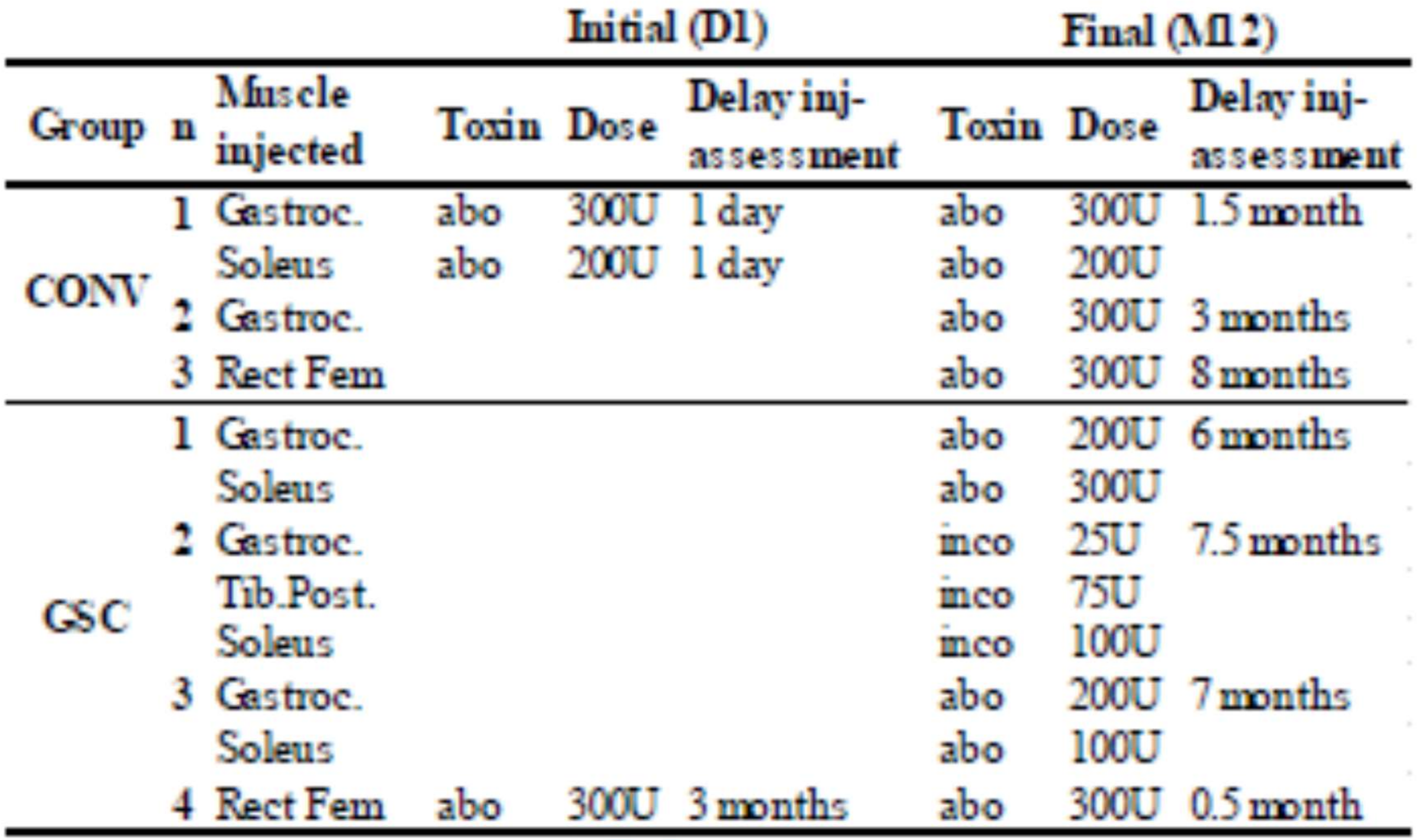
Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259



A **SOLEUS**

CONV					GSC				
n	X_{V1}	X_{V3}	X	Y	n	X_{V1}	X_{V3}	X	Y
1	95	80	15	2	1	97	85	12	2
2	100	90	10	2	2	105	90	15	2
3	95	90	5	2	3	100	90	10	2
4	90	80	10	2	4	108	90	18	2
5	98	75	23	3	5	100	80	20	3
6	110	85	25	3	6	95	90	5	2
7	110	85	25	2	7	95	85	10	2
8	95	85	10	2	8	100	90	10	2
9	97	90	7	2	9	110	80	30	2
10	105	90	15	2	10	110	90	20	2
11	105	85	20	2	11	90	80	10	2
					12	95	75	20	3
Mean	**100.0**	**85.0**	**15.0**		**Mean**	**100.4**	**85.4**	**15.0**	
SD	6.6	5.0	7.3		SD	6.5	5.4	6.9	

Pradines et al, NNR 2019, in press



			Initial (D1)			Final (M12)		
Group	n	Muscle injected	Toxin	Dose	Delay inj-assessment	Toxin	Dose	Delay inj-assessment
CONV	1	Gastroc.	abo	300U	1 day	abo	300U	1.5 month
		Soleus	abo	200U	1 day	abo	200U	
	2	Gastroc.				abo	300U	3 months
	3	Rect Fem				abo	300U	8 months
GSC	1	Gastroc.				abo	200U	6 months
		Soleus				abo	300U	
	2	Gastroc.				inco	25U	7.5 months
		Tib.Post.				inco	75U	
		Soleus				inco	100U	
	3	Gastroc.				abo	200U	7 months
		Soleus				abo	100U	
	4	Rect Fem	abo	300U	3 months	abo	300U	0.5 month

Pradines et al, NNR 2019, in press

Descriptive results: treatments

- **Mean time of conventional therapy:**

  - CONV: 81.8±55 min (1h30)/week = 12 min/d
  - GSC: 57.8±37.5 min (1h)/week = 8 min/d

- **GSC: mean reported daily time of self-stretch/muscle:**

  - Soleus: 5.0±3.3 min/d
  - Gastrocs: 5.0±2.1 min/d
  - Glut Max: 6.3±3.2 min/d
  - Rectus fem: 8.4±3.9 min/d

- **BoNT injections:**

  - Triceps surae: CONV n=2, GSC n=3
  - Rect Fem: CONV n=1, GSC n=1

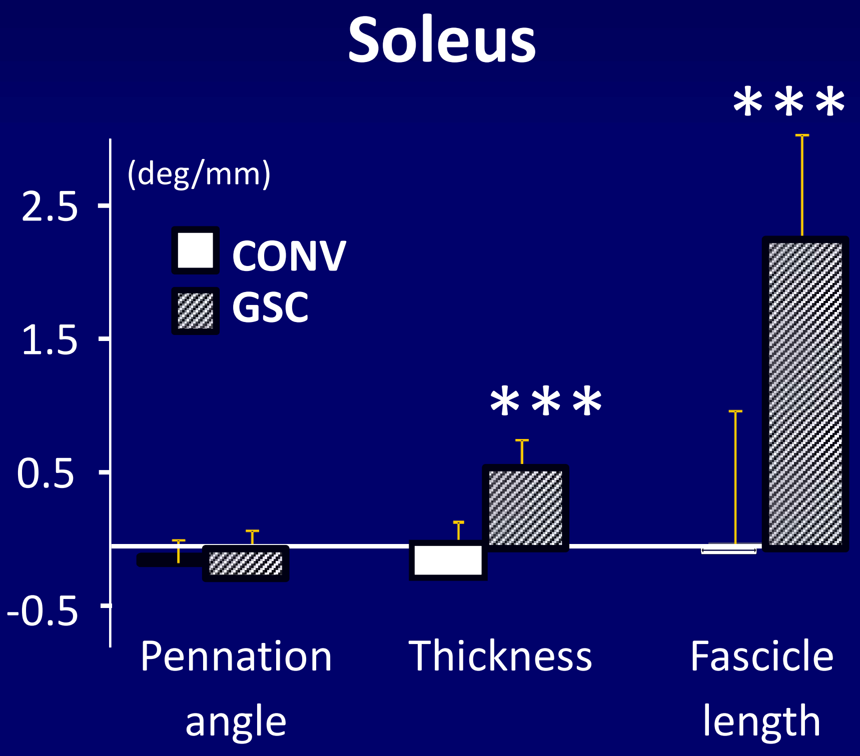
Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

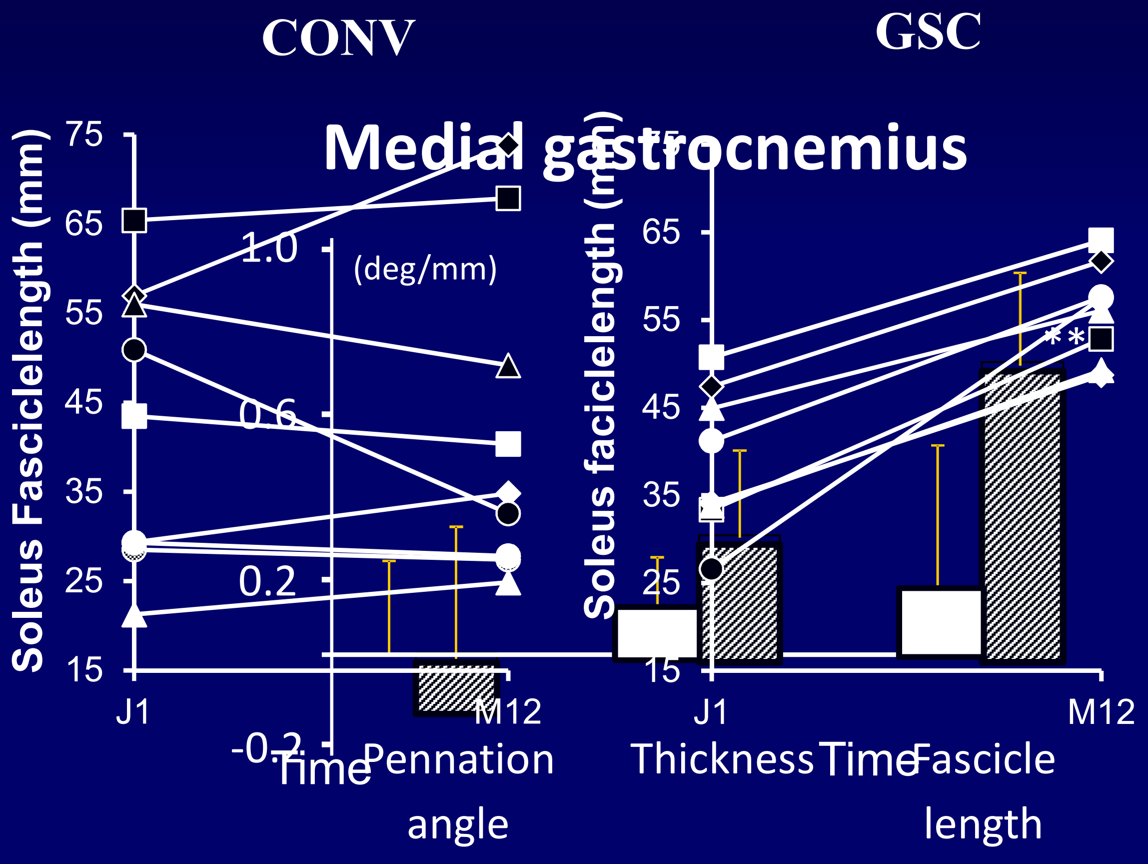
Outcomes

			Differences							Effect size
			Groups				Within groups		Between groups	
	Sample size		Week 0		Week 52		Week 52 - Week 0		Week 52 - Week 0	Cohen's
	CONV	GSC	CONV	GSC	CONV	GSC	CONV	GSC	GSC-CONV	(d)
Muscle architecture (mm)										
Fascicle length - soleus	n=9	n=8	40 (16)	37.9 (9.7)	39.9 (18.4)	55.9 (5)	-0.1 (10.2)	18.0 (7.8)	18.1 [9.3 ;26.9]	2.0 [1.54;2.46]

Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

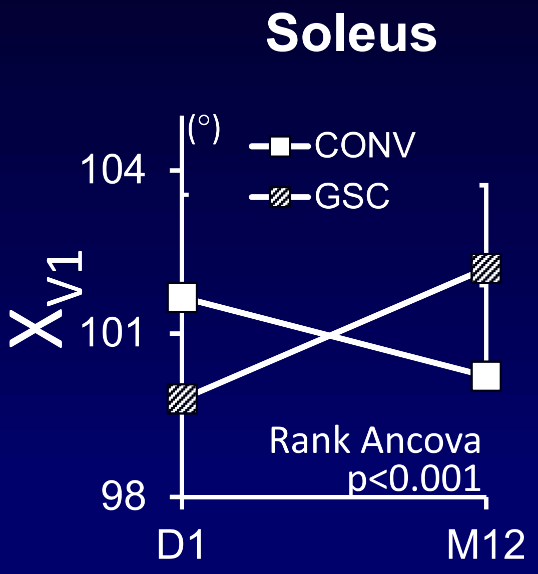
Outcomes: muscle ultrasonography





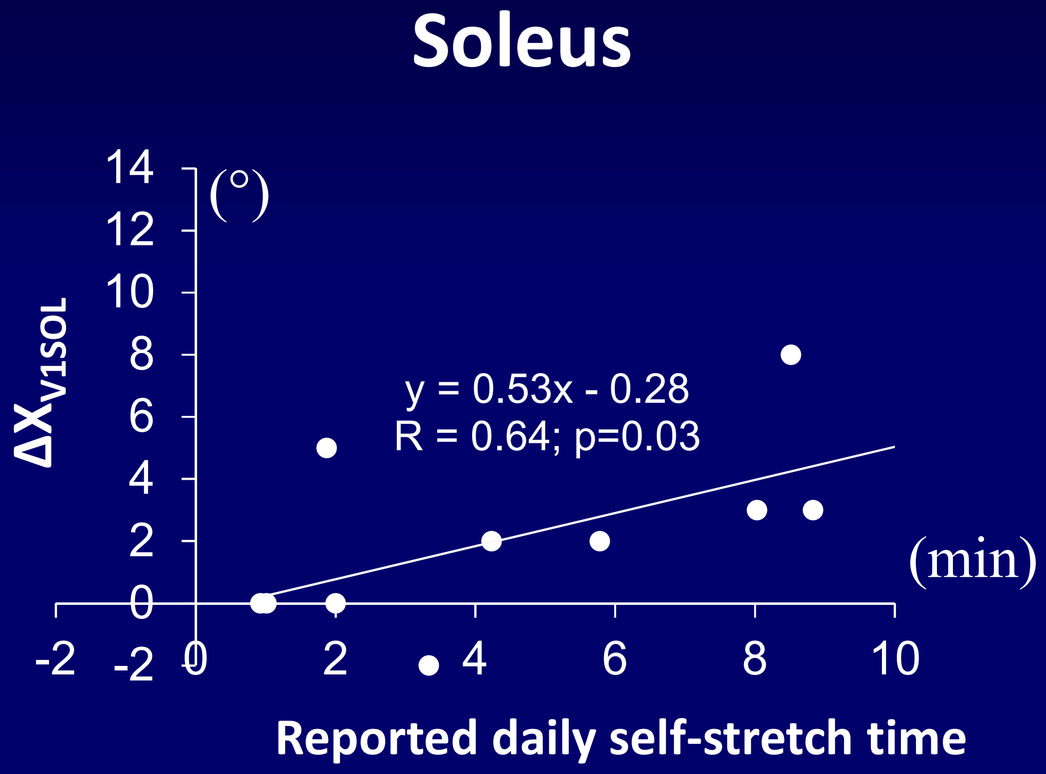
Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Clinical outcomes



Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

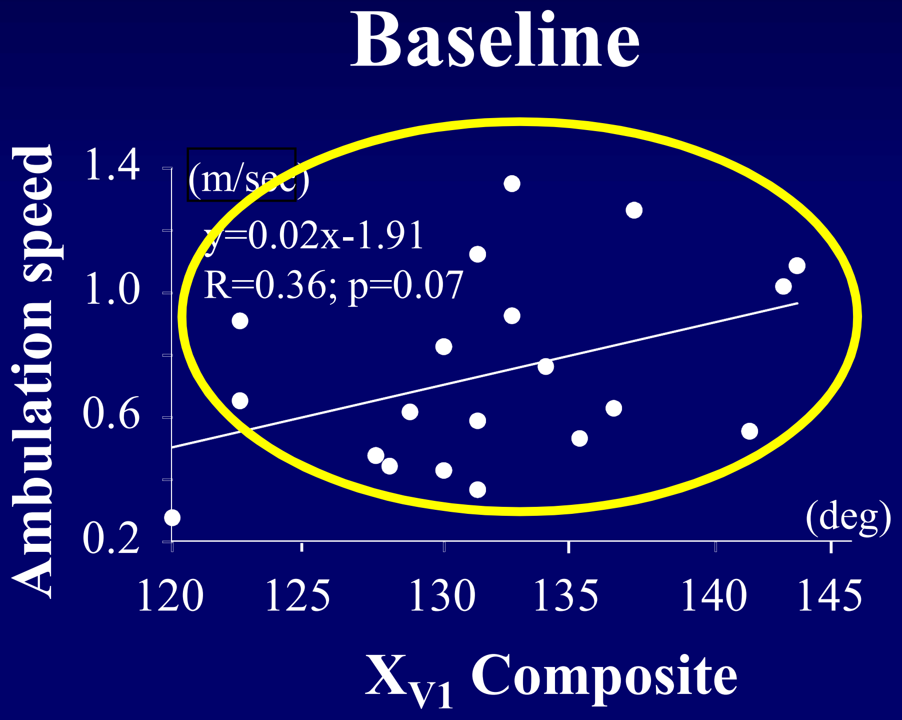
Relation
self-stretch time – extensibility changes



ΔX_{V1GF} → NS
ΔX_{V1DA} → NS

Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Relation extensibility – function



Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

Discussion

Limitations

- Sample size / visibility of fascicles in paretic subjects
- Position in ergometer (soleus pre-tension, not GM)
- Two types of stretching techniques

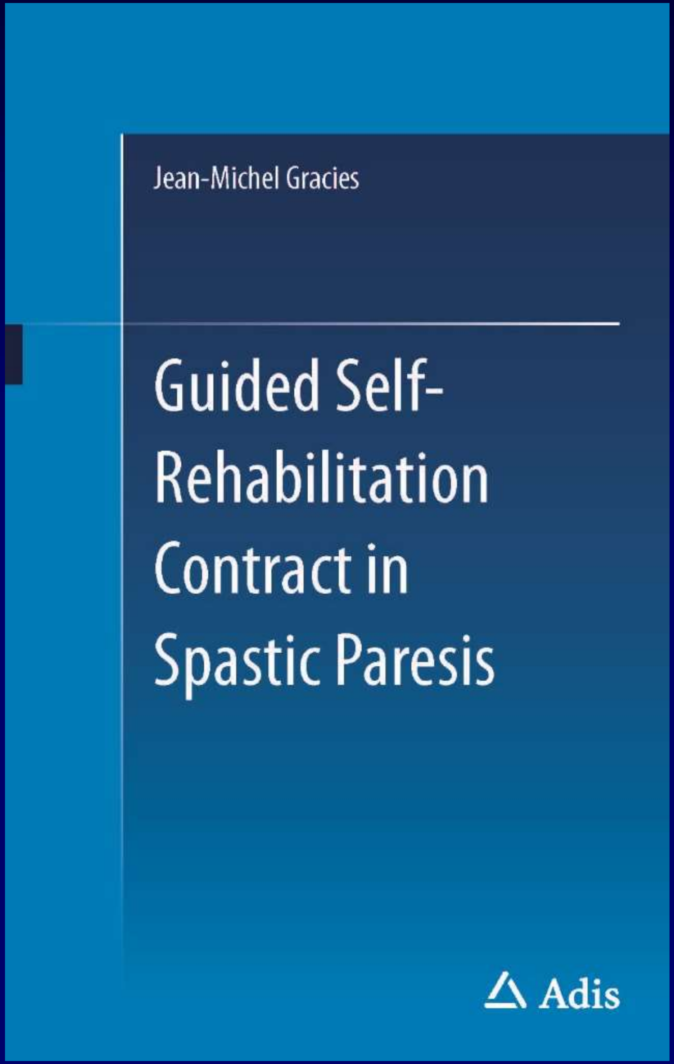
Conclusion: One year prospective randomized controlled trial in chronic spastic paresis: a daily self-stretching program within Guided Self-rehabilitation Contracts (GSC):

↗ fascicle length
↗ muscle extensibility
↗ ambulation speed

} Compared with conventional therapy

Pradines et al. Neurorehabil Neural Repair. 2019;33(4):245-259

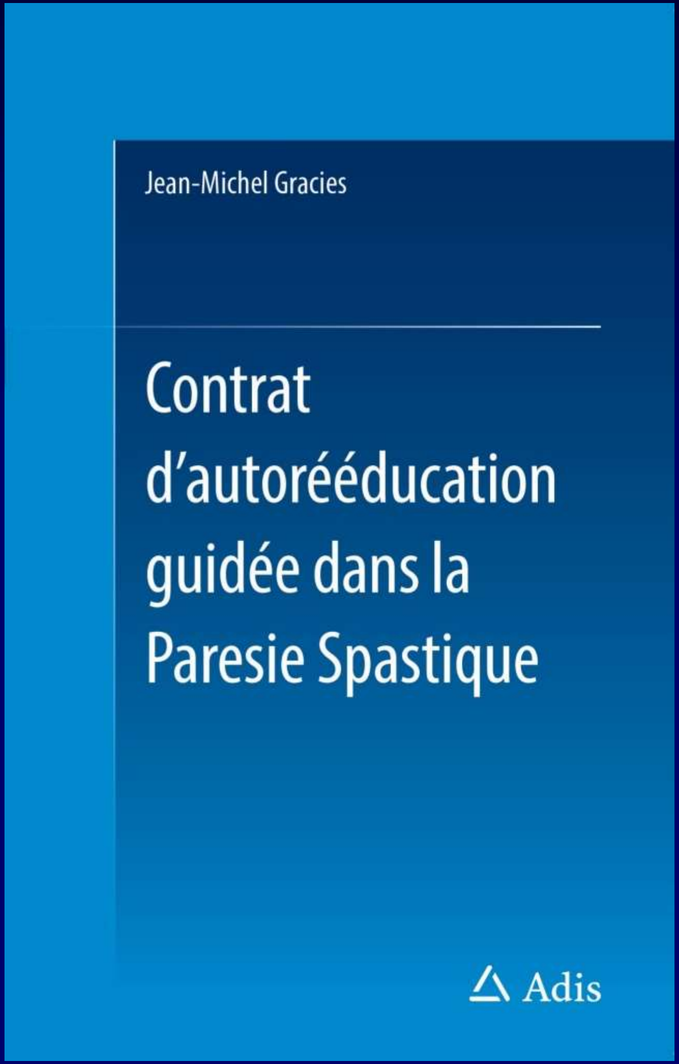
In practice



Jean-Michel Gracies

Guided Self-Rehabilitation Contract in Spastic Paresis

Adis



Jean-Michel Gracies

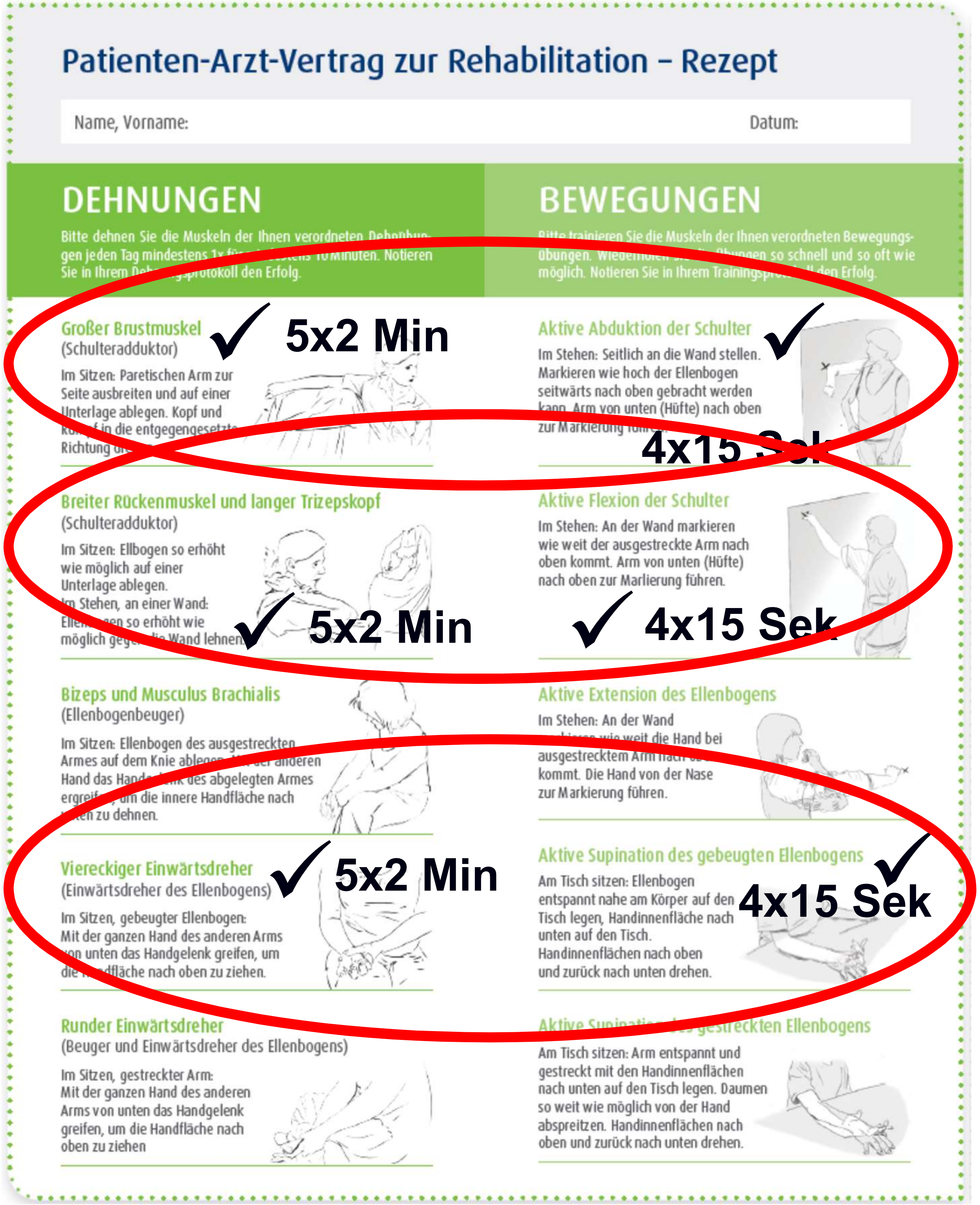
Contrat d'autorééducation guidée dans la Paresie Spastique

Adis

Springer, 2016

Slides developed by Professor Jean-Michel Gracies, MD, PhD (Hôpitaux Universitaires Mondor, Université Paris-Est Créteil, France)

A prescription !



Patienten-Arzt-Vertrag zur Rehabilitation – Rezept

Name, Vorname:

Datum:

DEHNUNGEN

Bitte dehnen Sie die Muskeln der Ihnen verordneten Dehnübungen jeden Tag mindestens 1x für mindestens 10 Minuten. Notieren Sie in Ihrem Dehnungsprotokoll den Erfolg.

Großer Brustmuskel ✓ 5x2 Min
(Schulteradduktor)

Im Sitzen: Paretischen Arm zur Seite ausbreiten und auf einer Unterlage ablegen. Kopf und Rumpf in die entgegengesetzte Richtung drehen.

Breiter Rückenmuskel und langer Trizepskopf
(Schulteradduktor)

Im Sitzen: Ellbogen so erhöht wie möglich auf einer Unterlage ablegen.
Im Stehen, an einer Wand: Ellenbogen so erhöht wie möglich gegen die Wand lehnen.

✓ 5x2 Min

Bizeps und Musculus Brachialis
(Ellenbogenbeuger)

Im Sitzen: Ellenbogen des ausgestreckten Armes auf dem Knie ablegen. Mit der anderen Hand das Handgelenk des abgelegten Armes ergreifen, um die innere Handfläche nach unten zu dehnen.

Viereckiger Einwärtsdreher ✓ 5x2 Min
(Einwärtsdreher des Ellenbogens)

Im Sitzen, gebeugter Ellenbogen:
Mit der ganzen Hand des anderen Arms von unten das Handgelenk greifen, um die Handfläche nach oben zu ziehen.

Runder Einwärtsdreher
(Beuger und Einwärtsdreher des Ellenbogens)

Im Sitzen, gestreckter Arm:
Mit der ganzen Hand des anderen Arms von unten das Handgelenk greifen, um die Handfläche nach oben zu ziehen

BEWEGUNGEN

Bitte trainieren Sie die Muskeln der Ihnen verordneten Bewegungsübungen. Wiederholen Sie die Übungen so schnell und so oft wie möglich. Notieren Sie in Ihrem Trainingsprotokoll den Erfolg.

Aktive Abduktion der Schulter ✓

Im Stehen: Seitlich an die Wand stellen. Markieren wie hoch der Ellenbogen seitwärts nach oben gebracht werden kann. Arm von unten (Hüfte) nach oben zur Markierung führen.

4x15 Sek

Aktive Flexion der Schulter

Im Stehen: An der Wand markieren wie weit der ausgestreckte Arm nach oben kommt. Arm von unten (Hüfte) nach oben zur Marlierung führen.

✓ 4x15 Sek

Aktive Extension des Ellenbogens

Im Stehen: An der Wand markieren wie weit die Hand bei ausgestrecktem Arm nach oben kommt. Die Hand von der Nase zur Markierung führen.

Aktive Supination des gebeugten Ellenbogens ✓ 4x15 Sek

Am Tisch sitzen: Ellenbogen entspannt nahe am Körper auf den Tisch legen, Handinnenfläche nach unten auf den Tisch.
Handinnenflächen nach oben und zurück nach unten drehen.

Aktive Supination des gestreckten Ellenbogens

Am Tisch sitzen: Arm entspannt und gestreckt mit den Handinnenflächen nach unten auf den Tisch legen. Daumen so weit wie möglich von der Hand abspreitzen. Handinnenflächen nach oben und zurück nach unten drehen.

A prescription!

GSC
Guided Self-Rehabilitation Contract
LOWER LIMB

Doctor stamp

Last Name: ....

First Name: ....

PASSIVE STRETCH ACTIVE TRAINING

HIP Gluteus maximus

☐ e stretch (1) .... min .... times/day

✓2Minx5

☐ Active hip flexion,

✓15 Secx4

HIP Hamstrings

☐ Passive stretch (3) .... min .... times/day

☐ Active hip flexion, knee extended (4) .... sec .... times/day

HIP Hip adductors

☐ Passive stretch (5) Hip flexor - adductors .... min .... times/day

☐ Passive stretch (6) Hip extensor-adductors .... min .... times/day

☐ Active hip abduction (7) .... sec .... times/day

HIP Hip internal rotators

☐ Passive stretch (8) .... min .... times/day

☐ Active hip external rotation (9) .... sec .... times/day

KNEE Rectus femoris

☐ Passive stretch (10) .... min .... times/day

☐ Active knee flexion, knee extended (11) .... sec .... times/day

Medical images: Virginie Denis. Pictures: Option K/CComCie - All images have been published with kind permission of © Ipsen, 2016. All rights reserved.

GSC
Guided Self-Rehabilitation Contract
UPPER LIMB

PASSIVE STRETCH ACTIVE TRAINING

THUMB Long thumb flexor

☐ Passive stretch (42) .... min .... times/day

☐ Active long thumb extension (43) .... sec .... times/day

THUMB Short thumb flexor

✓2Minx5

☐ Active short thumb

✓15 Secx4

THUMB ...ponens pollicis and long abductor of thumb

☐ Passive stretch (46) Opponens pollicis .... min .... times/day

☐ Active thumb deopposition (48) .... sec .... times/day

☐ Passive stretch (47) Long abductor of thumb .... min .... times/day

THUMB Adductor pollicis

☐ Passive stretch (49) .... times/day

✓2 Minx5

☐ Active short thumb abduction (50)

✓15 Secx4

Medical images: Virginie Denis. Pictures: Option K/CComCie - All images have been published with kind permission of © Ipsen, 2016. All rights reserved.

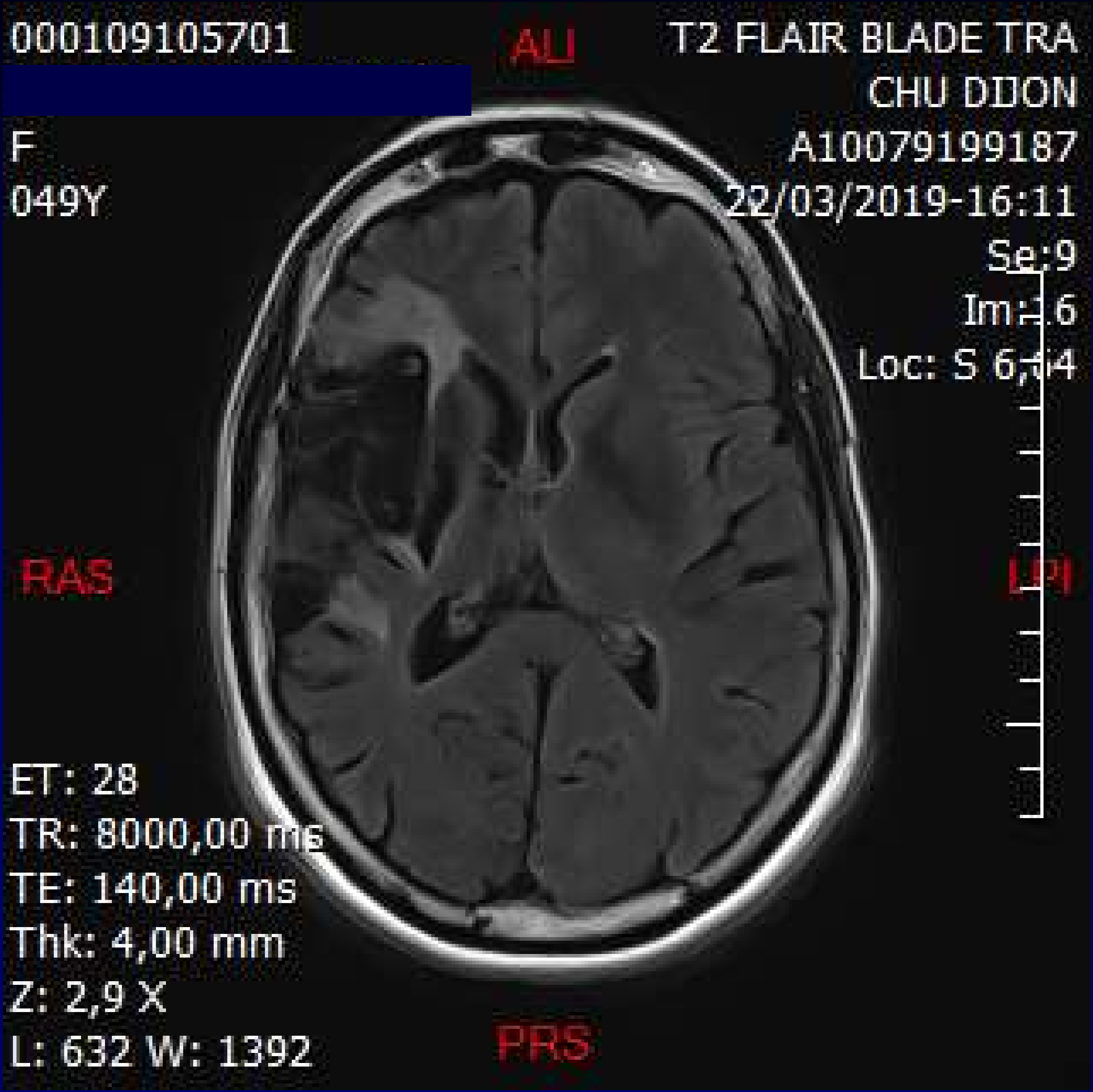
Guided Self-rehab = Contract

1. **Patient works and documents**
2. **Therapist teaches and coaches**

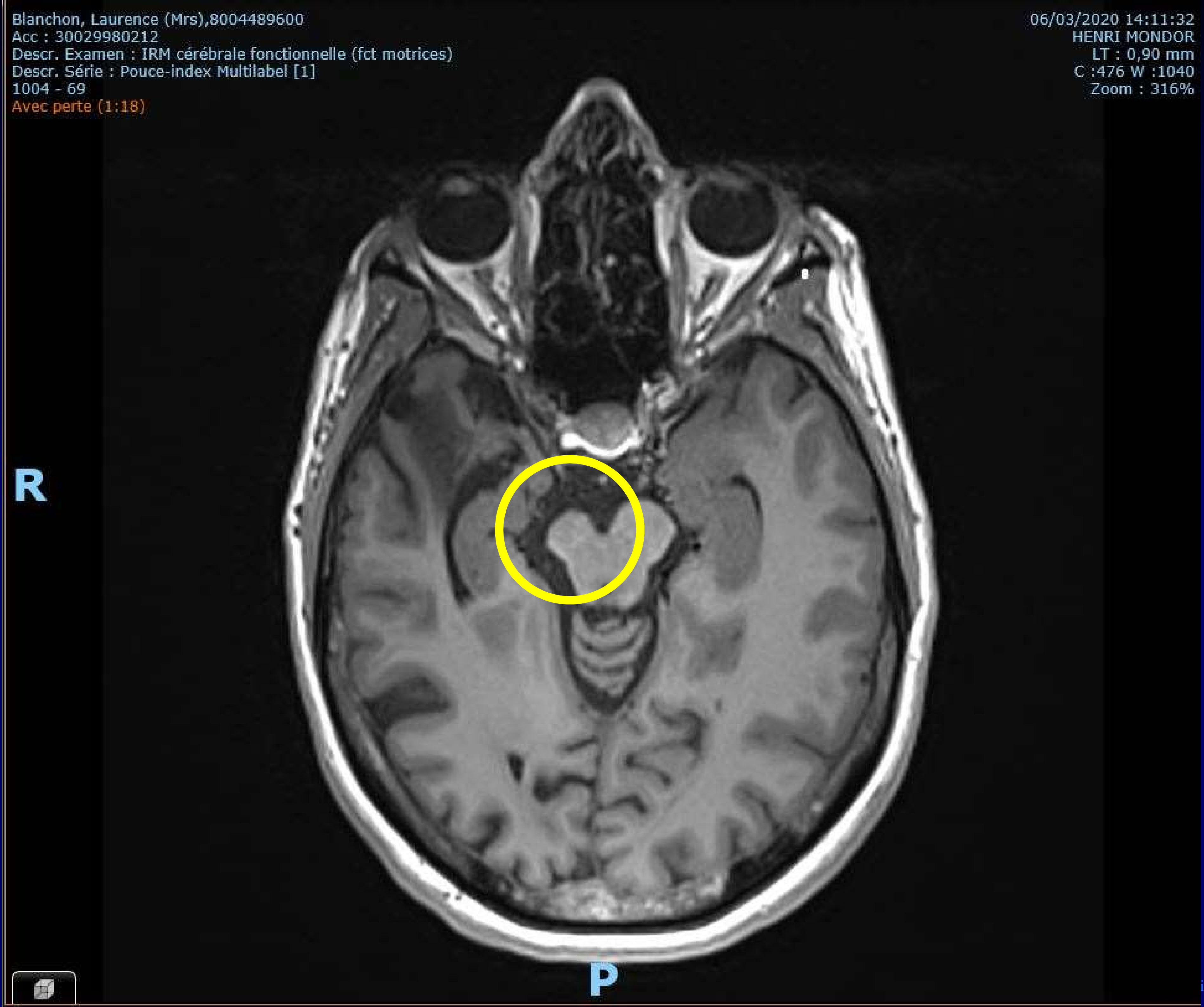
Woman 38 years old
Right MCA stroke Oct 2013
PT twice a week until Feb 2015

Status Feb 2015

Gracies, 2003



Gracies, 2003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Acc : 30029980212
Descr. Examen : IRM cérébrale fonctionnelle (fct motrices)
Descr. Série : Pouce-index Multilabel [1]
1004 - 69
Avec perte (1:18)
06/03/2020 14:11:32
HENRI MONDOR
LT : 0,90 mm
C :476 W :1040
Zoom : 316%
R
P

ies, 2003

Feb 2015
M17 post stroke

Gracies, 2019

Shoulder adductors/extensors

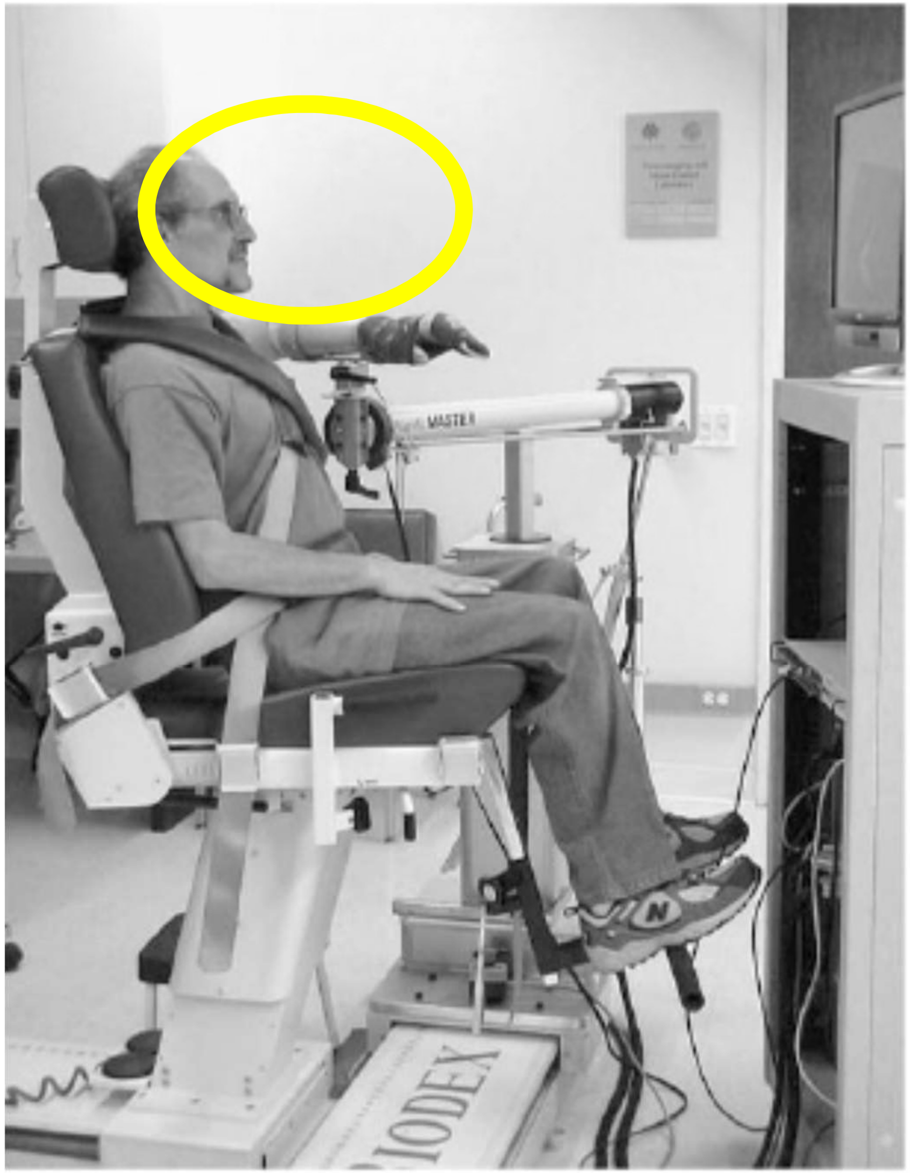


Fig. 2.
Subject seated in the ACT^{3D} system. His trunk is secured by straps and the arm is attached to the HM with the lightweight forearm-hand orthosis. He is looking at the computer monitor for visual feedback, shown in Fig. 3

Sukal TM, Ellis MD, Dewald JP. Shoulder abduction-induced reductions in reaching work area following hemiparetic stroke: neuroscientific implications. Exp Brain Res. 2007;183(2):215-23

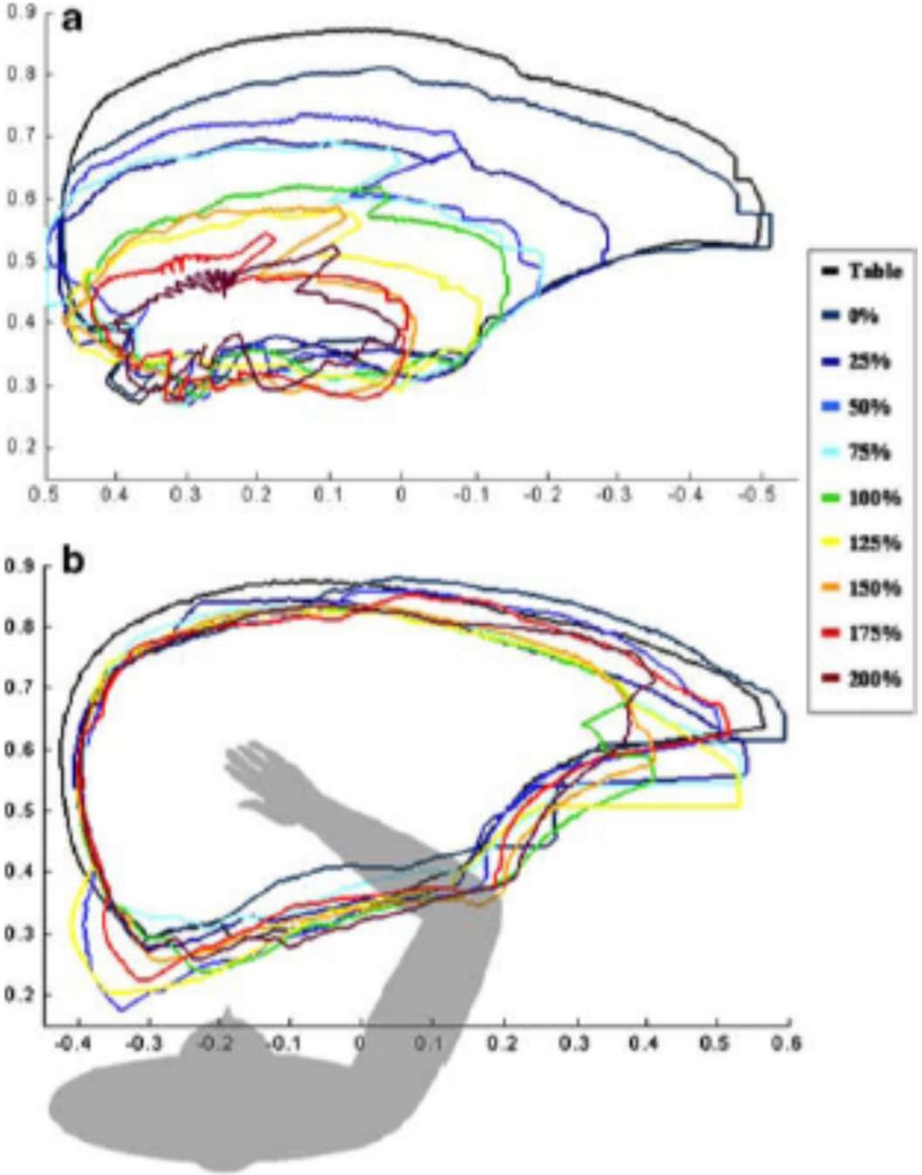


Fig. 4.

Envelope abilities during various levels of limb support in the left, paretic limb (**a**) of a single subject, inverted for comparison to the non-paretic limb shown in (**b**). Axes units are in meters, and an individual's outline is provided in the non-paretic (*right*) side for reference

Sukal TM, Ellis MD, Dewald JP. Shoulder abduction-induced reductions in reaching work area following hemiparetic stroke: neuroscientific implications. Exp Brain Res. 2007;183(2):215-23

Decrease in finger flexor cocontraction when fight ↓ against shouder extensors

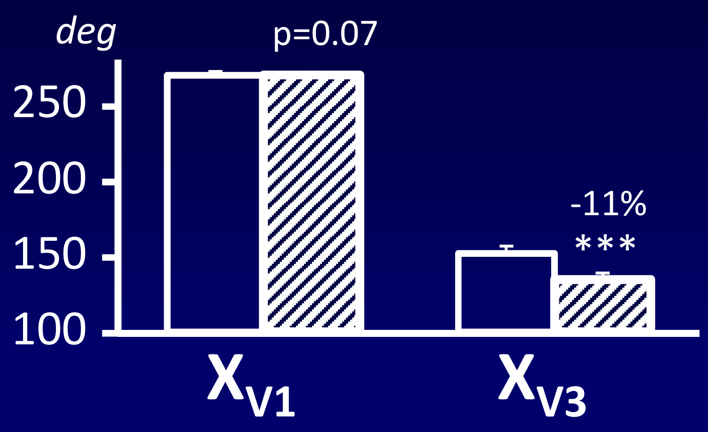
Pre **5 minutes post**

Injection lidocaine 2%

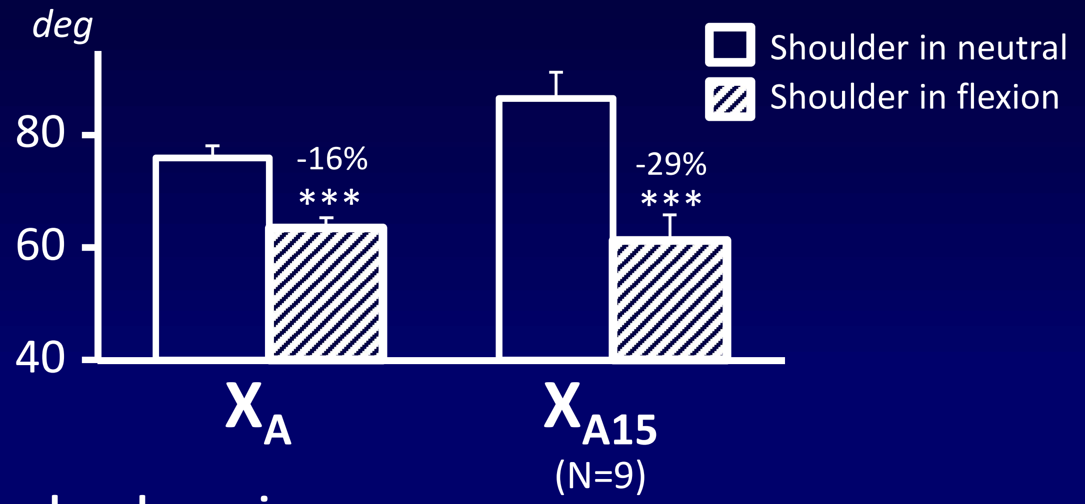
Pectoralis Major:	4 cc
Long head of triceps:	2 cc
Teres major:	1 cc
Latissimus dorsi:	1 cc
Rhomboïds (maj + min)	2 cc

Gracies, 2021

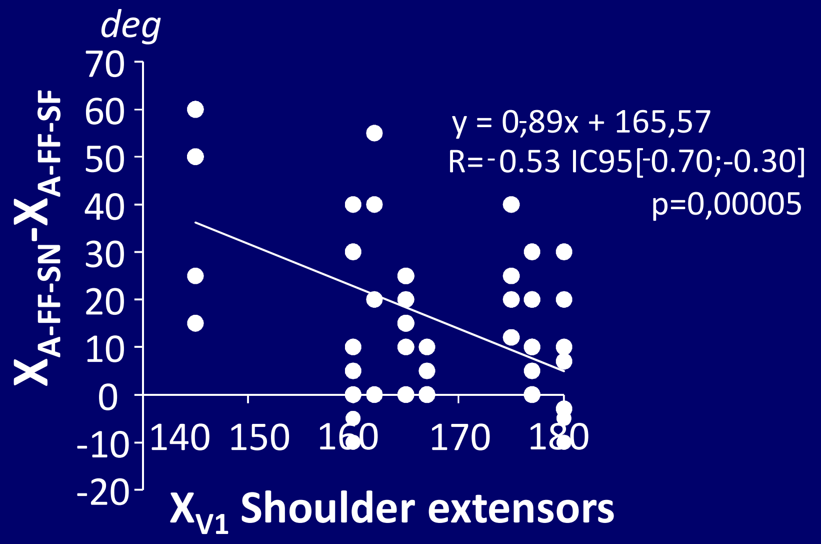
Increase in shoulder extensor extensibility associated with greater hand opening in reaching efforts - n=16



Passive hand opening X_{V1} and X_{V3}



Active hand opening X_A and X_{A15}



Loss of active hand opening
from shoulder neutral to shoulder flexed

Alhajri, Gracies, in preparation

M13 post stroke

24 nov 2014

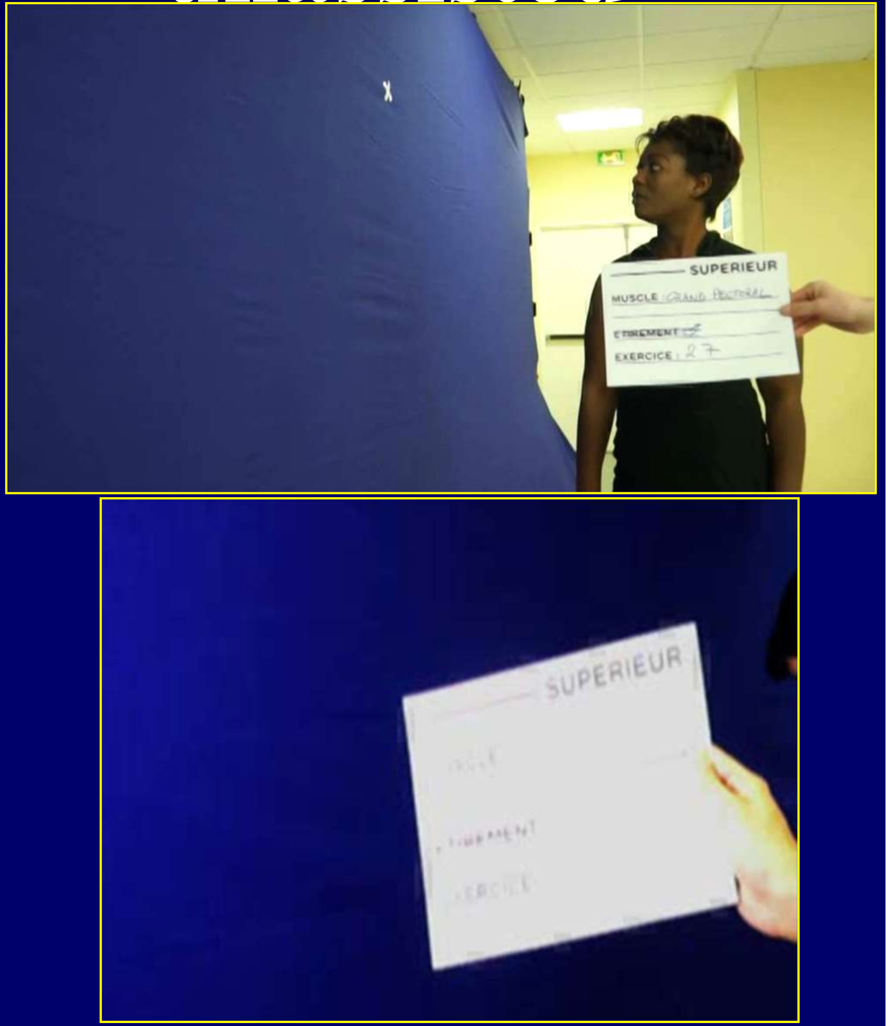
Lang CE, Wagner JM, Bastian AJ, Hu Q, Edwards DF, Sahrmann SA, Dromerick AW. Deficits in grasp versus reach during acute hemiparesis. Exp Brain Res. 2005;166(1):126-36

Against pectoralis major

Treatment of myopathy
= Stretching postures

Treatment of cocontraction

Rapid Alternating Movements of maximal amplitude, unassisted



4 years of Self-Rehabilitation Contract

Nov 14 – M13 post stroke

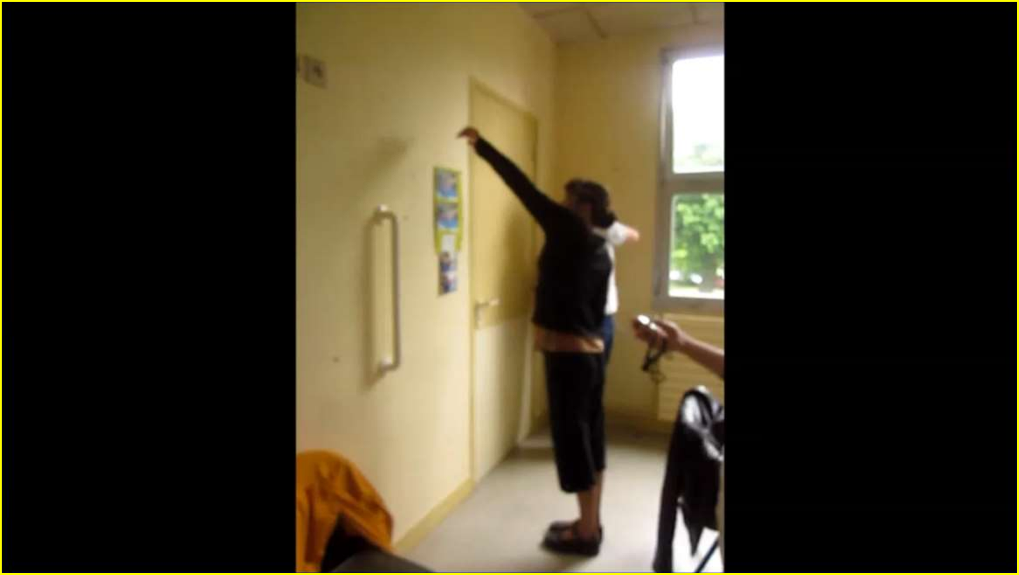
Jul 15 – M21

Mar 16 – 2,5 yrs post

Mar 17 – 3,5 years post stroke

4 years of Self-Rehabilitation Contract


Nov 14 – M13 post stroke


Jul 16 – 2,5 years


Mar 17 – 3,5 years post stroke

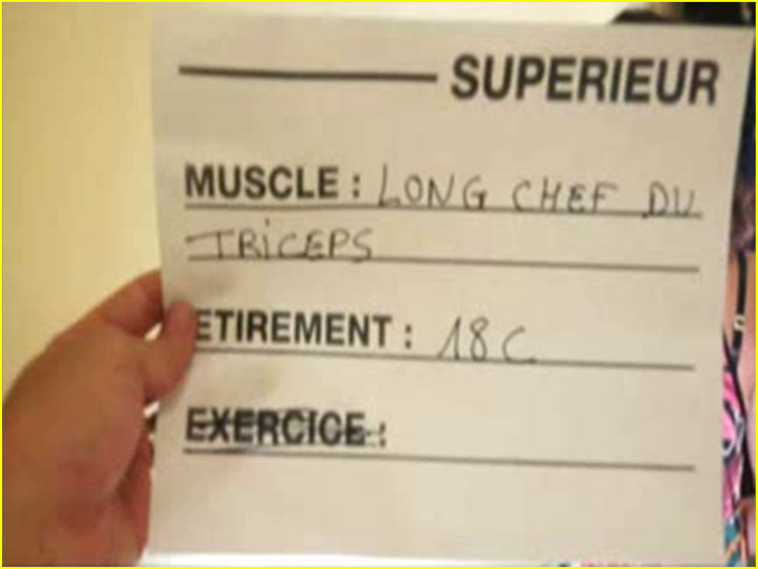

Sept 17 – 4 years post stroke

mp4

Against long head of triceps

Stretching postures

→ Muscle disorder



SUPERIEUR

MUSCLE : LONG CHEF DU TRICEPS

ETIREMENT : 18 C

EXERCICE :

SUPERIEUR

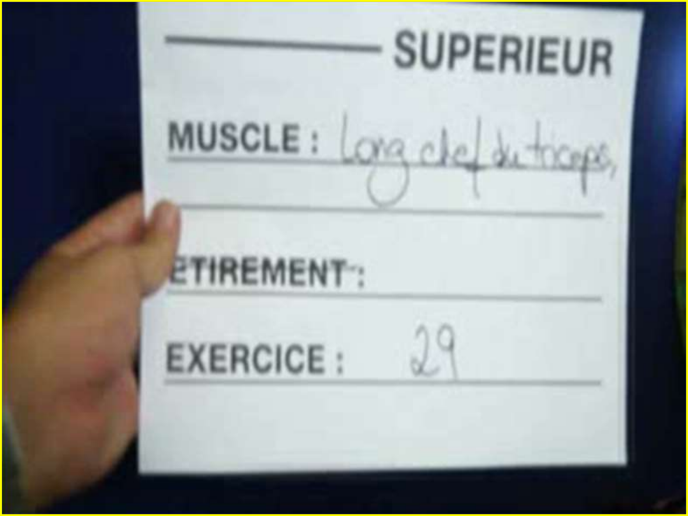
MUSCLE : Long Chef du Triceps

ETIREMENT : 18 B

EXERCICE :

Rapid Alternating Movements of maximal amplitude, unassisted

→ Neurological disorder



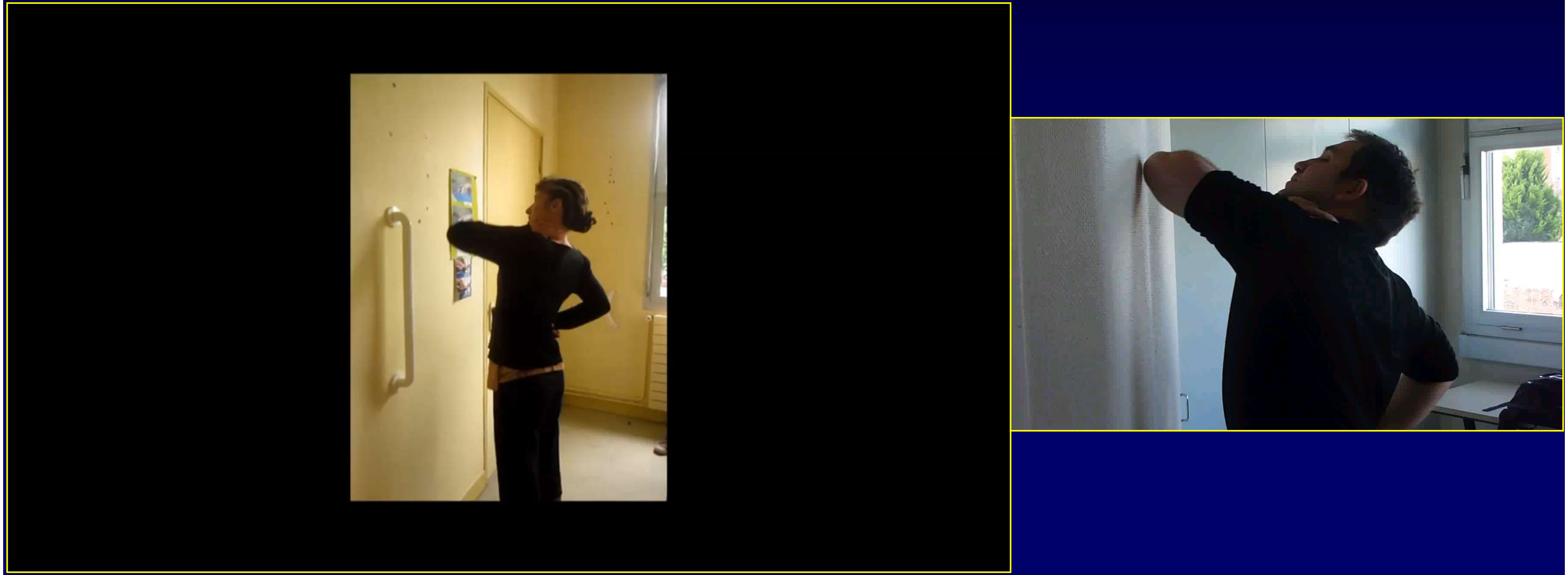
SUPERIEUR

MUSCLE : Long chef du triceps,

ETIREMENT :

EXERCICE : 29

Work against long head of triceps

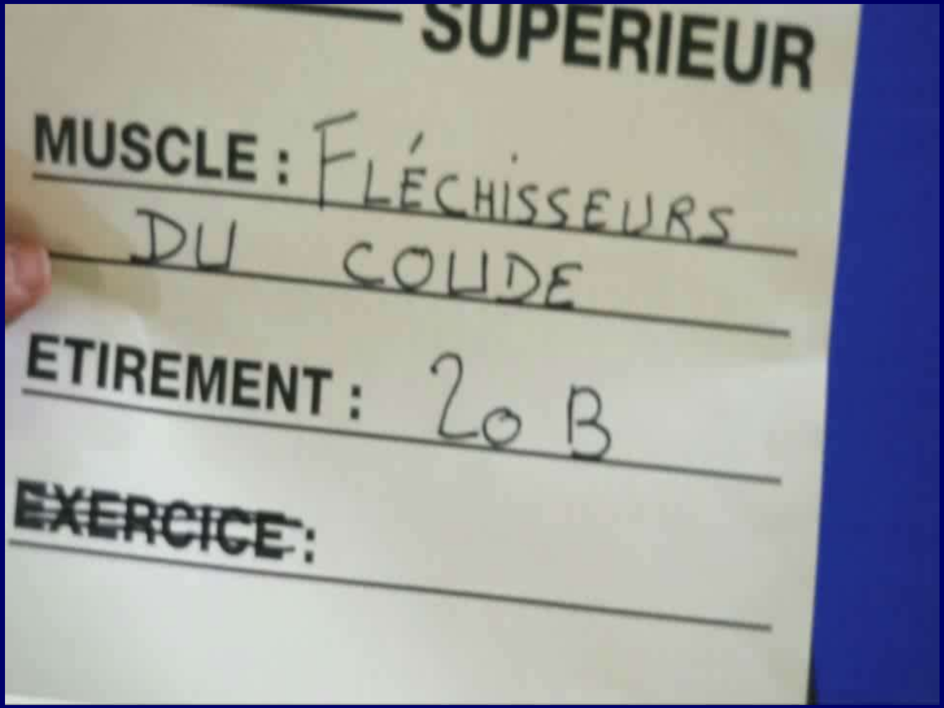


mp4

Against elbow flexors

Stretching postures

→ Muscle disorder



SUPERIEUR

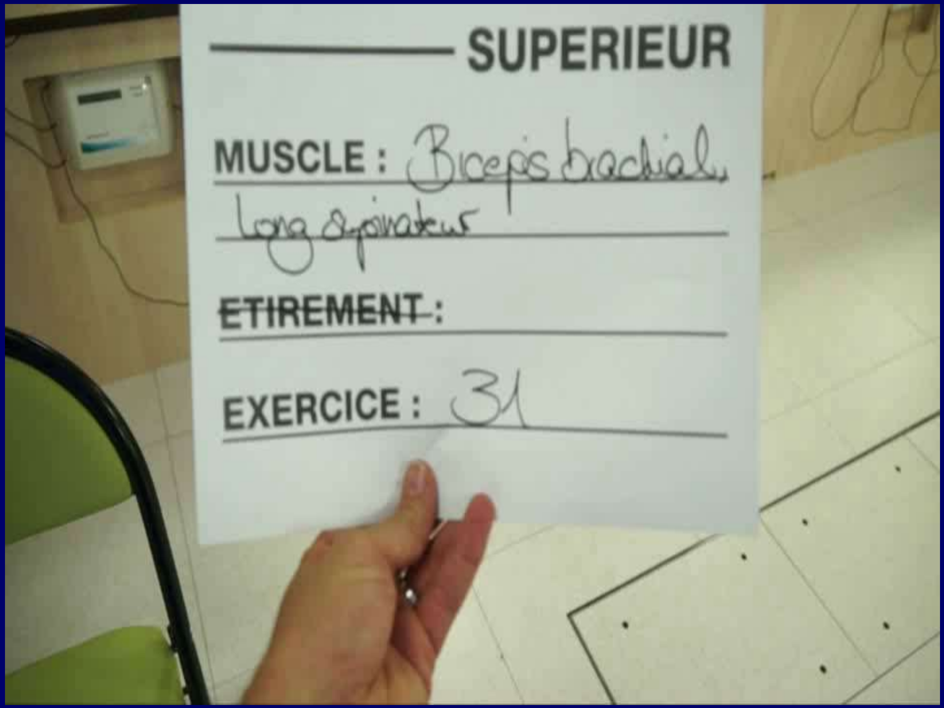
MUSCLE : FLÉCHISSEURS DU COUDE

ETIREMENT : 20 B

~~EXERCICE~~ :

Rapid Alternating Movements of maximal amplitude, unassisted

→ Neurological disorder



SUPERIEUR

MUSCLE : Biceps brachial, long supinateur

~~ETIREMENT~~ :

EXERCICE : 31

4 years of Self-rehabilitation Contract

Nov 14 – M13

Nov 14 - downwards

Dec 16 – M38

Against pronator quadratus
Group workshop

4 years of Self-rehabilitation Contract

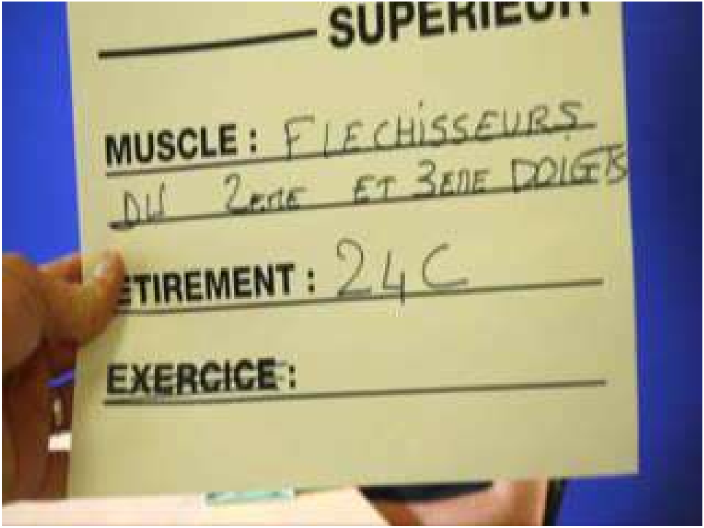
Jan 18 – 4.5 years post stroke

Elbow large supinations *vs* pronator teres

mp4

Against finger flexors

Stretching postures
→ Muscle disorder

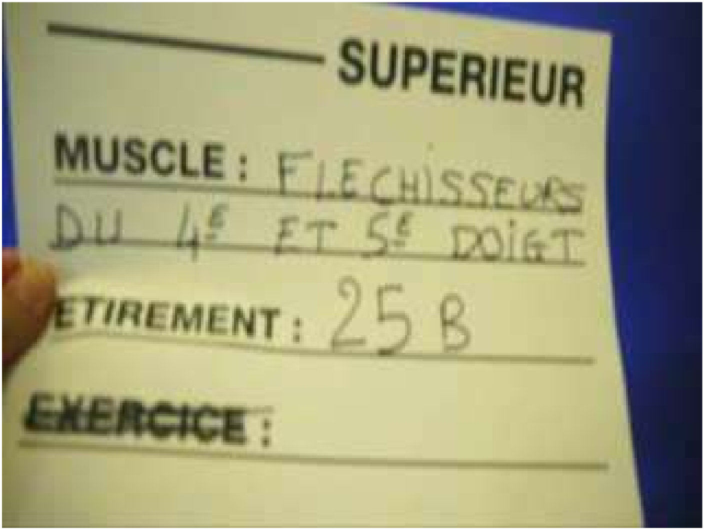


SUPERIEU

MUSCLE : FLECHISSEURS DU 2EME ET 3EME DOIGTS

ETIREMENT : 24C

EXERCICE :



SUPERIEUR

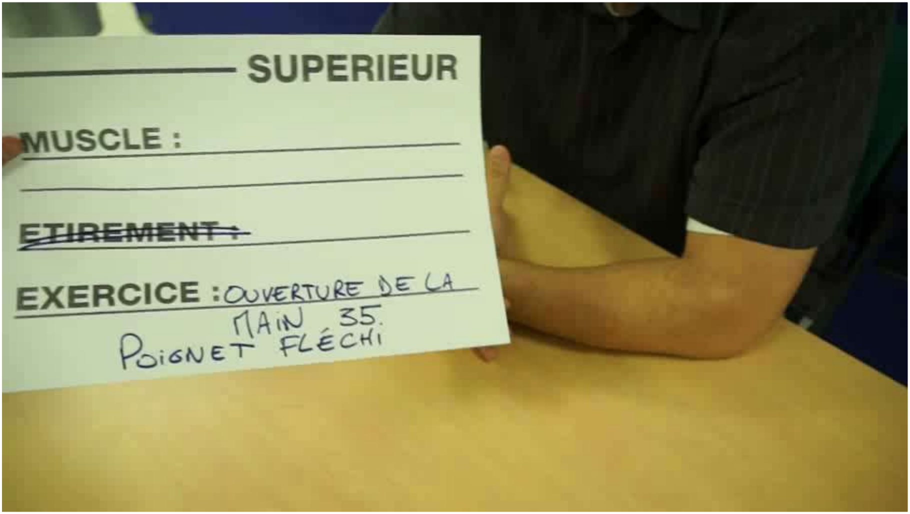
MUSCLE : FLECHISSEURS DU 4E ET 5E DOIGT

ETIREMENT : 25 B

EXERCICE :

Rapid Alternating Movements of maximal amplitude, unassisted
→ Neurological disorder

Wrist flexed



SUPERIEUR

MUSCLE :

~~ETIREMENT :~~

EXERCICE : OUVERTURE DE LA MAIN 35 POIGNET FLÉCHI

Wrist in neutral

Work against cocontraction of extrinsic finger flexors

05/12/17 – Y4

16/01/18 – Y4,2

21/03/18 – Y4,5

19/06/18 – Y4,5

13/09/18 – Y4,9

11/12/18 – Y5

What we need to function is <u>individuation</u>, more than <u>amount of agonist recruitment</u>

Quantification of 2 critical aspects of hand function, ‘strength’, and independent control of fingers (individuation).

n = 54 patients with hemiparesis over first year after stroke.

→ **Most recovery of strength and individuation occurred within the first 3 mo.**

→ Recovery of ‘strength’ and individuation tightly correlated up to a ‘strength’ level of ~60% of estimated premorbid strength; **beyond this threshold, strength improvement was <u>not</u> accompanied by further improvement in individuation.**

Separable systems for recovery of finger strength and control after stroke

Xu J, Ejaz N, Hertler B, Branscheidt M, Widmer M, Faria AV, Harran MD, Cortes JC, Kim N, Celnik PA, Kitago T, Luft AR, Krakauer JW, Diedrichsen J. J Neurophysiol. 2017;118(2):1151-1163

Work against cocontraction of FDS-FDP II

Oct 17 – M44

Dec 17 – M46

Ext II-V Dec 17 – M46

Ext II Mar 18 – M49

Ext II Dec 18 – M58

Lang CE, Schieber MH. Reduced muscle selectivity during individuated finger movements in humans after damage to the motor cortex or corticospinal tract. J Neurophysiol. 2004;91(4):1722-33

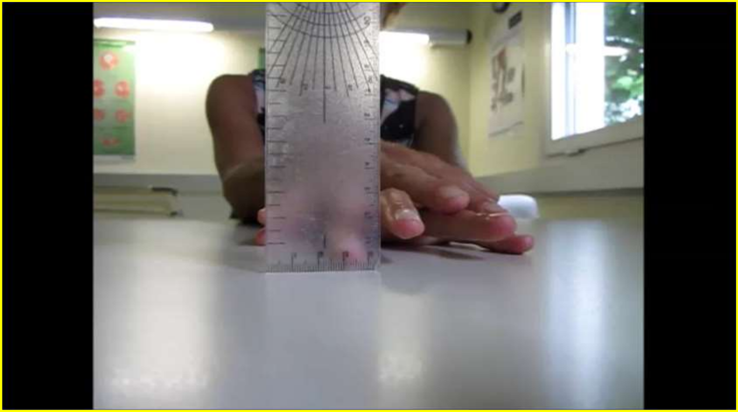
Work against cocontraction of FDS-FDP III

Oct 17 – M44

Ext III post II preT
Dec 17 – M46

Ext III post II post T
Jan 18 – M49

Ext III Mar 18 – M49



Ext III pre T-
Jun 18 – M52

Ext III
post T-
Sep 18 –
M55

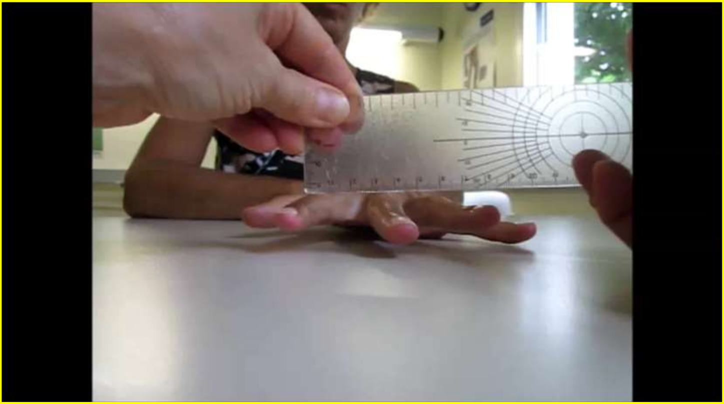
Ext III
post T-
Dec 18 –
M58

Work against cocontraction of Palmar IO

Dec 16 – 3 yrs

Jan 18 – M47

Mar 18 – M49



Jun 18 pre – M52

Sep 18 post – M55

Dec 18 – 5 yrs

Escape

Mar 15 – M17

Dec 18 – Y5

Gracies, 2019

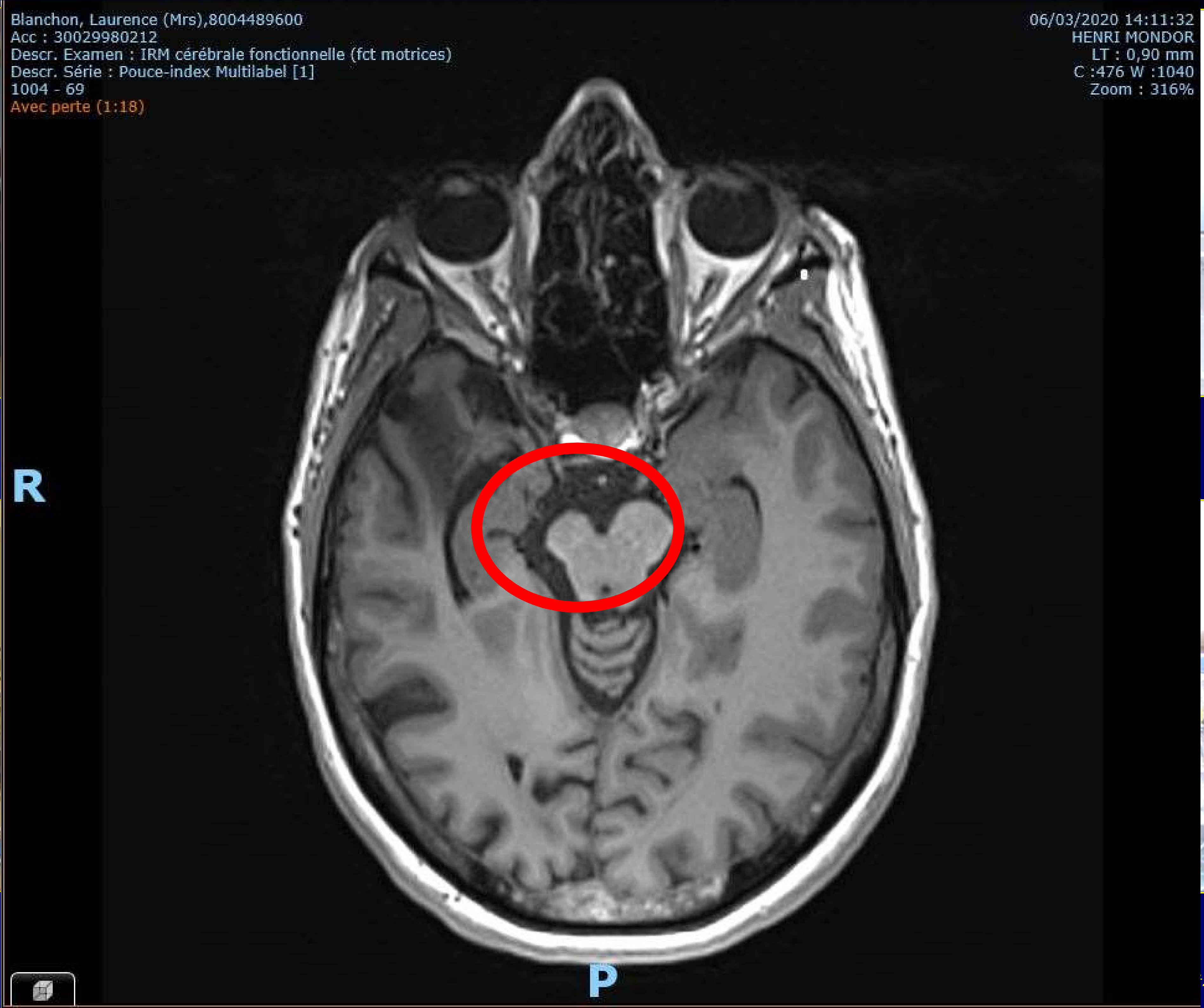
22/03/15 – M18

22/03/16 – M30

15/01/18 – Y4

11/12/18 – Y5

Thank you !



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1004 - 69
Avec perte (1:18)

06/03/2020 14:11:32
HENRI MONDOR
LT : 0,90 mm
C :476 W :1040
Zoom : 316%

Remerciements

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Caroline COLAS, MD
Damien MOTAVASSELI, MD
Etienne SAVARD, MD
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