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BSNR
Belgian Society for Neurorehabilitation

UCLouvain
Institut de recherche expérimentale et clinique

Assessment and Management of Muscle Overactivity in People with Stroke : Long Term Functional and Biomechanical implications

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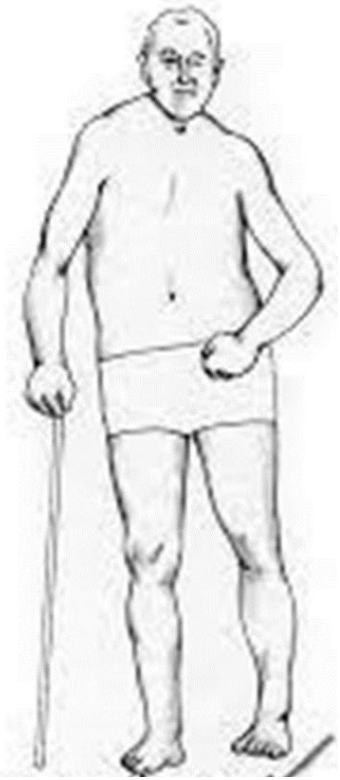
27/11/2025

Plan of the presentation

1. **General introduction**
2. Objectives of the research project
3. Hand flexor stiffness evaluation
4. Spasticity management to improve gait function
5. General discussion and conclusions



STROKE

Frequent : Europe : 1 million people/year

Wafa 2020, Feigin 2022, Preston 2021, Van de Port 2006

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Increase in the coming years (ageing population, lifestyle, etc.)

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STROKE

Frequent : Europe : 1 million people/year

Increase in the coming years (ageing population, lifestyle, etc.)

Quality of life

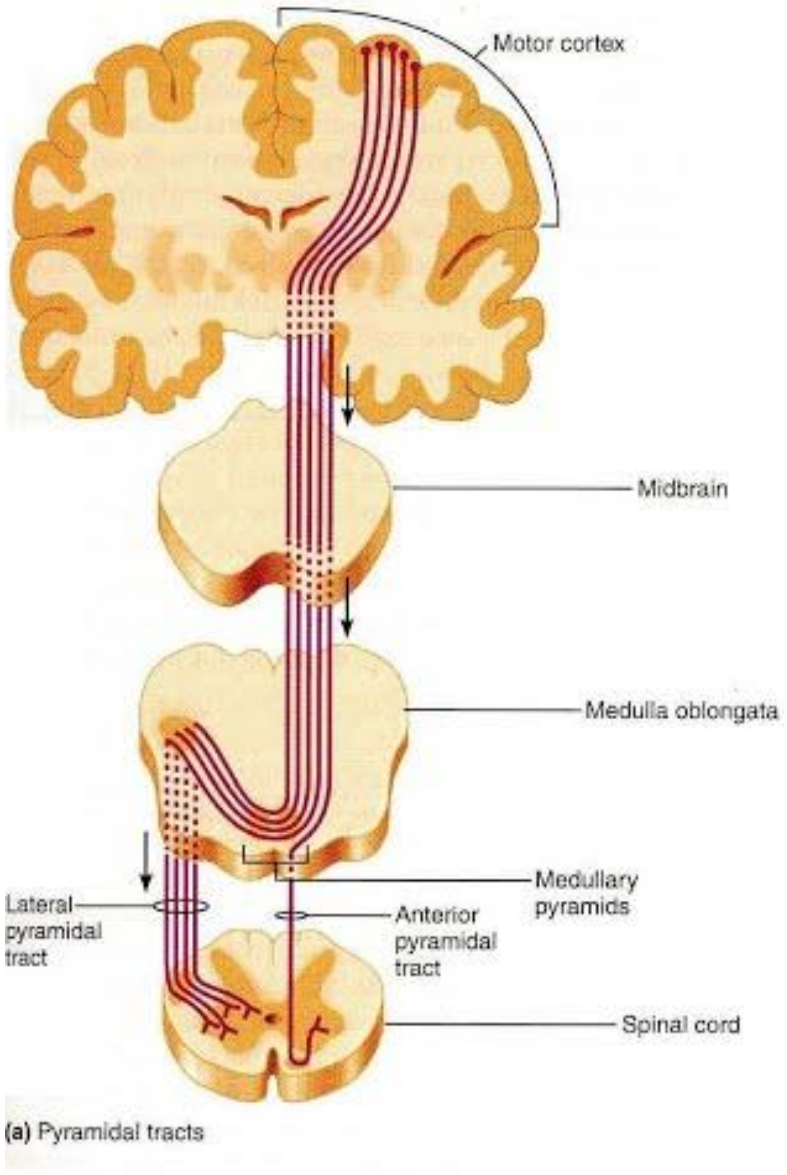
Wafa 2020, Feigin 2022, Preston 2021, Van de Port 2006, Gil-Garcia 2022

Pyramidal syndrome

Cortical and sub-cortical strokes

Negative and positive signs

Negative signs	Positive signs
Weakness	Spasticity
Loss of dexterity	Hyperreflexia
Fatigue	Co-contractions
Loss of motor control	Clonus



Spasticity

‘A **motor disorder** characterized by a velocity dependent increase of the tonic stretch reflex (muscle tone), with increased tendon jerks, as a resultant from hyperexcitability of the stretch reflex and as a component of the UMNS’

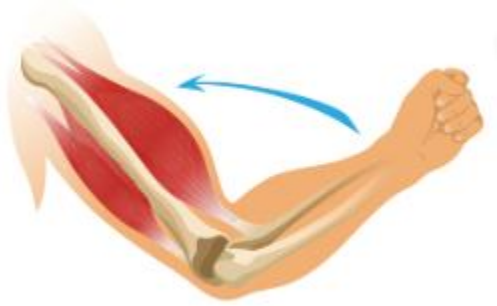
Lance, 1981

Spastic paresis syndrome

*Syndrome combining a **neurological disorder** affecting **sensory-motor** control and a **muscular disorder** with loss of extensibility*

Muscle overactivity

Spastic myopathy



Gracies 2015, Baude 2018

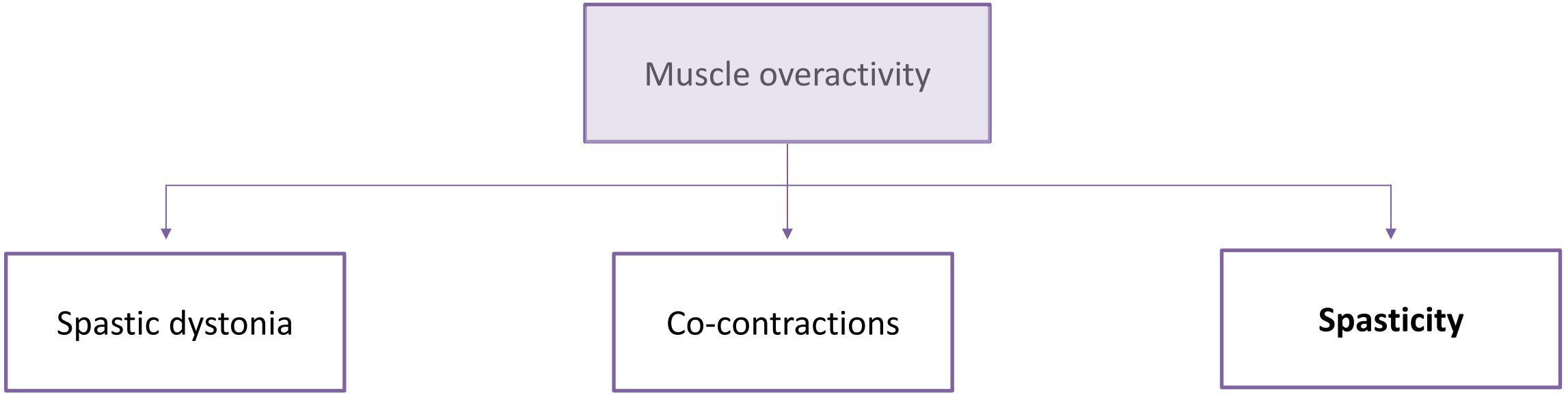
Spastic paresis syndrome

Muscle overactivity ~ ‘spasticity’

Involuntary muscle activity, at rest or during voluntary motor command

Gracies 2015, Baude 2018

Spastic paresis syndrome



Involuntary muscle activity, at rest or during voluntary motor command
Similar physio pathological pathways

Gracies 2015, Baude 2018, Li 2021, Toxnet group 2024

Spasticity syndrome

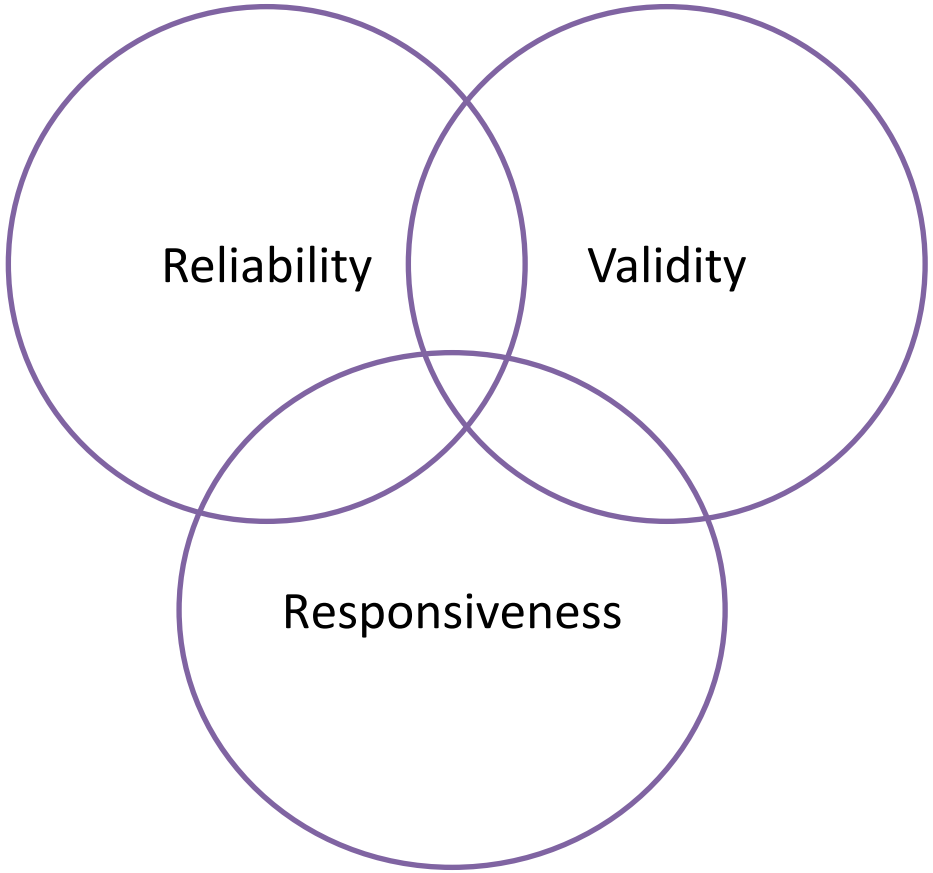
‘A constellation of neurological signs and symptoms secondary to upper motor neuron pathology, accompanied by non-neural peripheral soft-tissue changes’

Spasticity ‘stricto sensu’

‘A disorder of **sensorimotor control** resulting from upper motor neuron disease. It is characterized by velocity- and length-dependent involuntary muscle overactivity, which is intermittent or sustained, during passive stretch’

Francisco et al. under press, Spasticity X Consensus definition, Toxnet group, 2024

Evaluation of spasticity



www.cosmin.nl, Mokkink 2010

Evaluation of spasticity

Physical examination

Modified Ashworth scale (MAS)

Modified Tardieu Scale (MTS)

Bohanon 1984, Fleuren 2011, Van den Noort 2017, Gracies 2010

Evaluation

Physical examination

Modified Ashworth scale (MAS)

Modified Tardieu Scale (MTS)

0	No increase in muscle tone. Normal muscle tone.
1	Slight increased in tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part is moved in flexion or extension.
1+	Slight increased in tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the range of motion.
2	More marked increase in muscle tone through most of the range of motion, but affected parts are easily moved.
3	Considerable increase in muscle tone; passive movements difficult.
4	Affected part rigid in flexion or extension.

Fleuren 2011, Van den Noort 2017, Gracies 2010

Evaluation

Physical examination

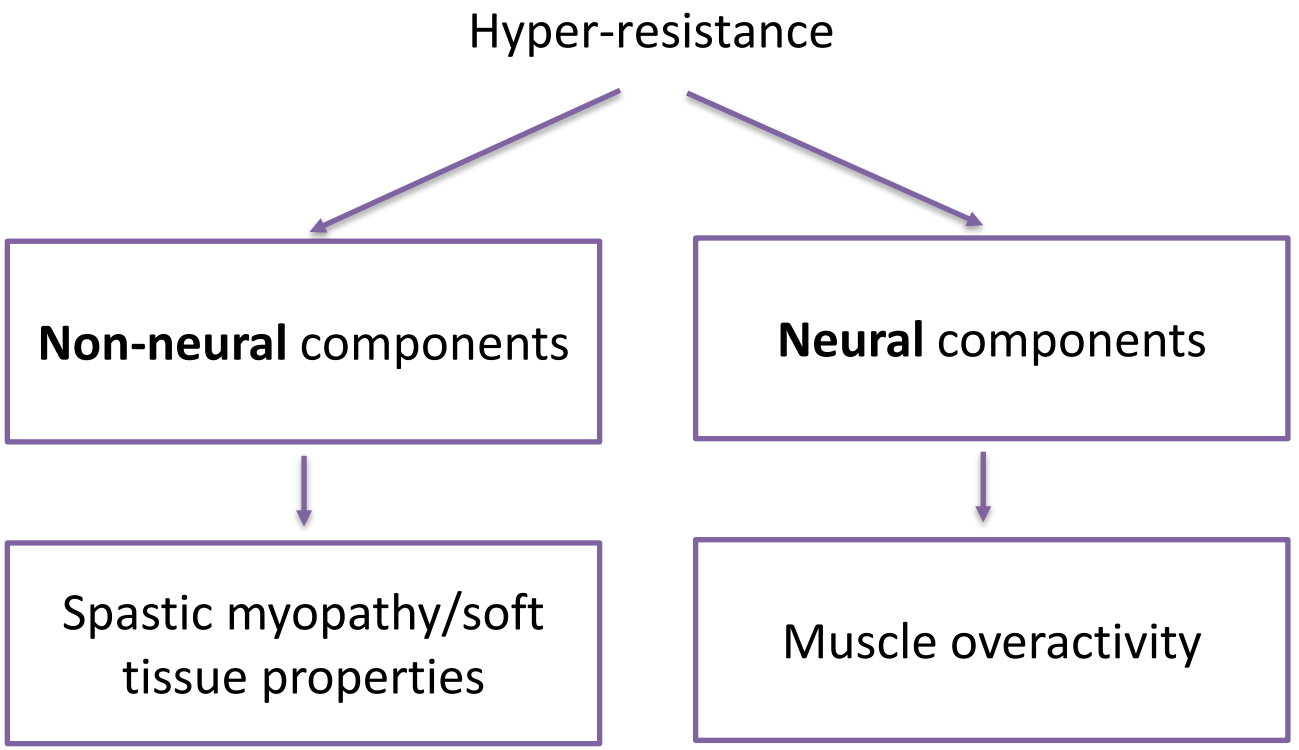
Modified Ashworth scale (MAS)

Modified Tardieu Scale (MTS) → Hyper-resistance

Velocity	Description
V1	As slow as possible (slower than the rate of natural drop of the limb under gravity)
V2	The speed with which the limb falls under gravity
V3	As fast as possible (faster than the natural drop of a limb with gravity)

Fleuren 2011, Van den Noort 2017, Gracies 2010

Evaluation



Baude 2018, Van den Noort 2017

Evaluation : limits

Modified Ashworth scale (MAS)

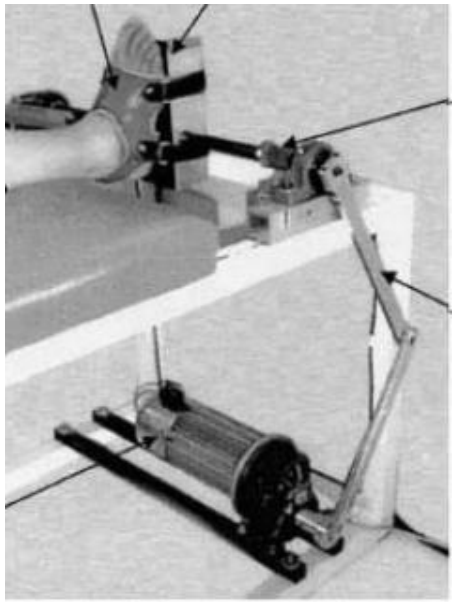
Modified Tardieu Scale (MTS)

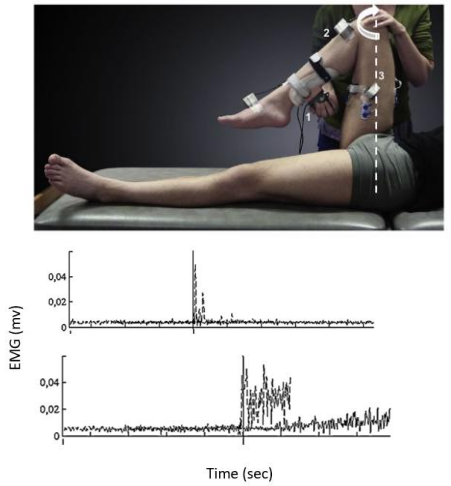
Never validated according to COSMIN taxonomy

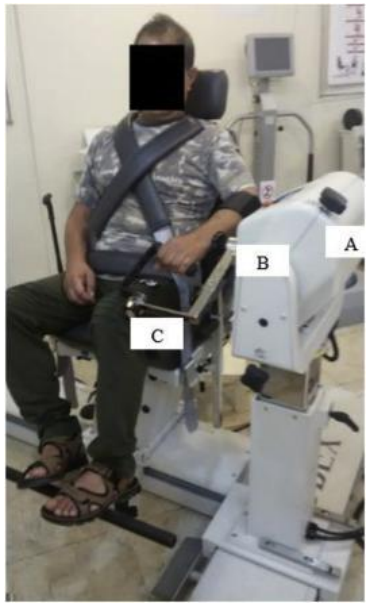
Fleuren 2011, Mehrholz 2005, www.cosmin.nl

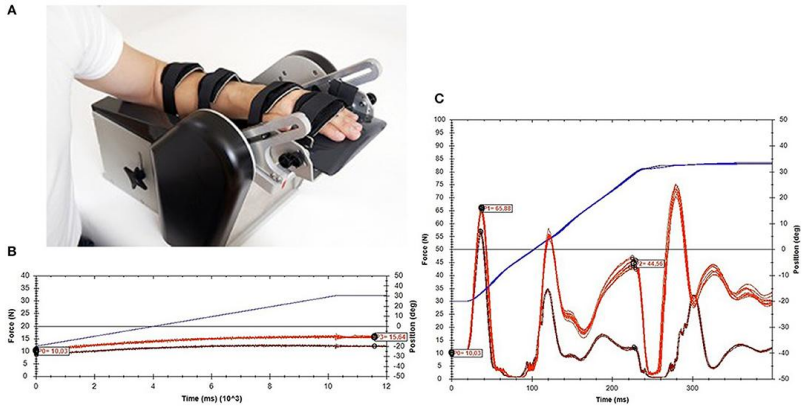
Evaluation of spasticity

Instrumented assessment









Detrembleur et Plaghki 1998, Bar-On 2013, Dehno 2020, Andringa 2019, Luo 2020

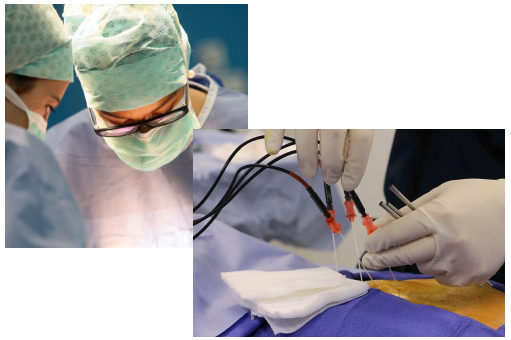
Treatment

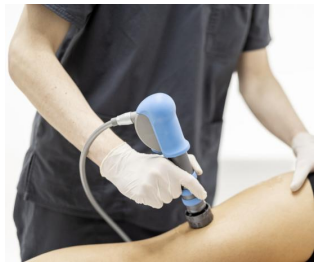
RCP 2018, Turner-Stokes 2018, Reebye 2022

Treatment

Pharmacological

Nonpharmacological





Inspired by Deltombe

Botulinum toxin type A (BT-A)

Neurotoxin

Effects: 3-4 mo

line

cal and multifocal

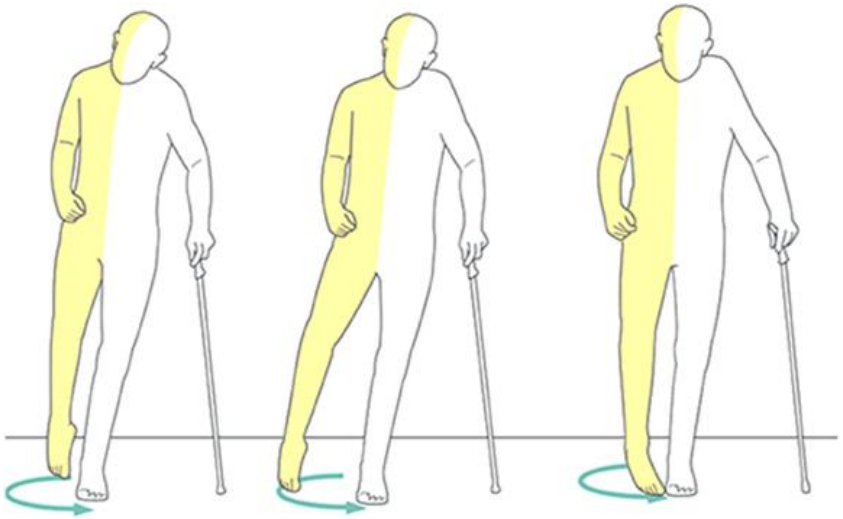
asticity

gmental and multi-

gmental

Wissel 2009, Suputtitada 2024, Wissel 2017, Foley 2010

General Introduction



~ 46% → Spasticity

½ gait impairment

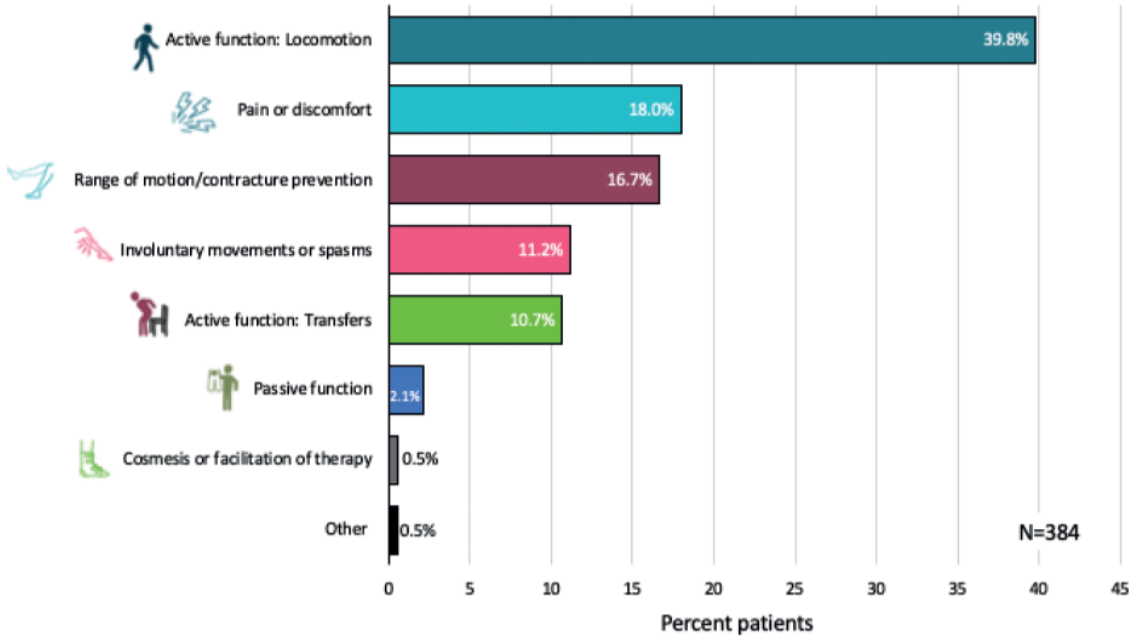


Fig. 2. Primary goal setting by domain.

Carda 2020, Esquenazi 2021, Feigin 2022

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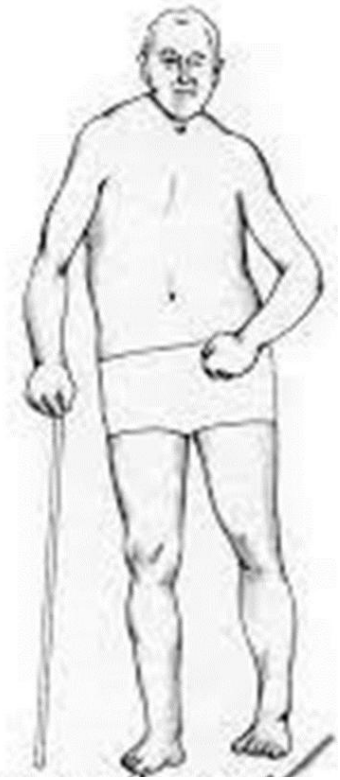
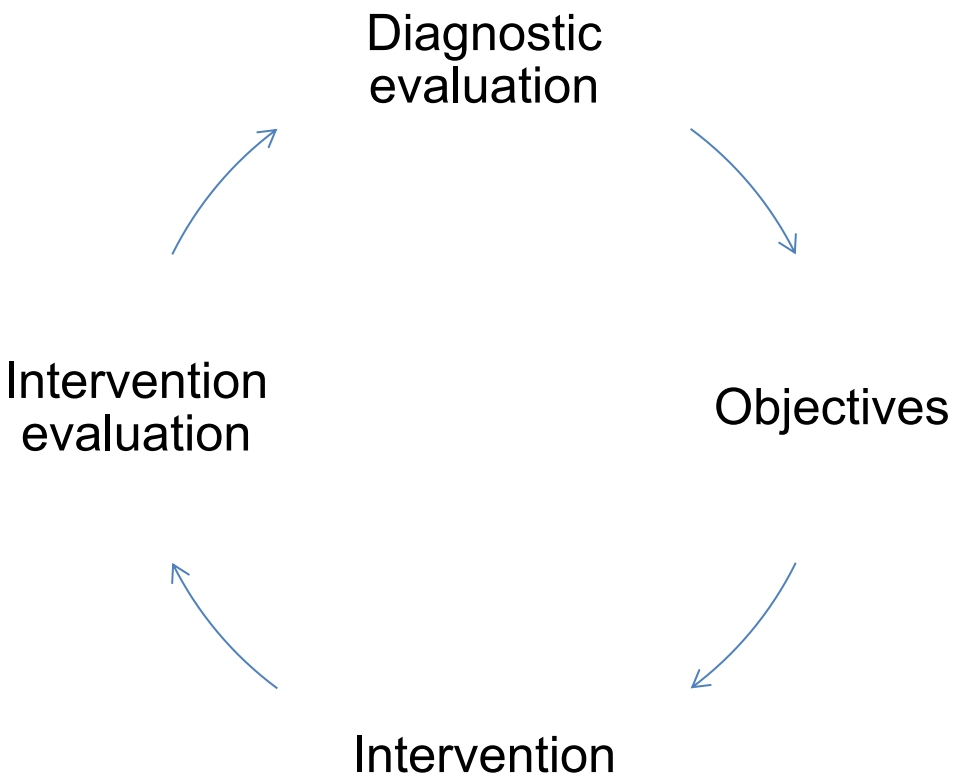


Rehabilitation cycle



Objectives

1- Evaluation

2- Intervention

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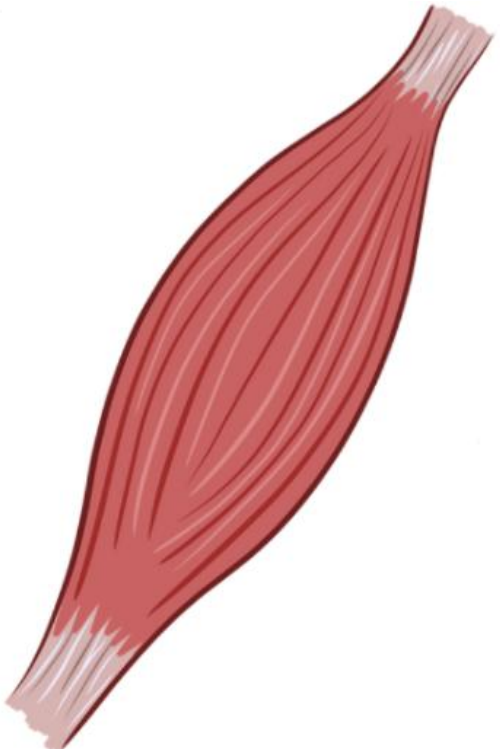
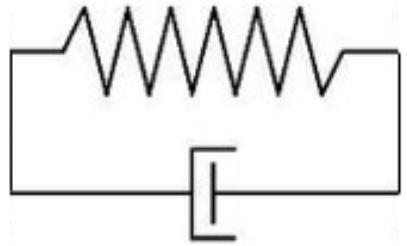
Muscle modelization



Spring

Damper



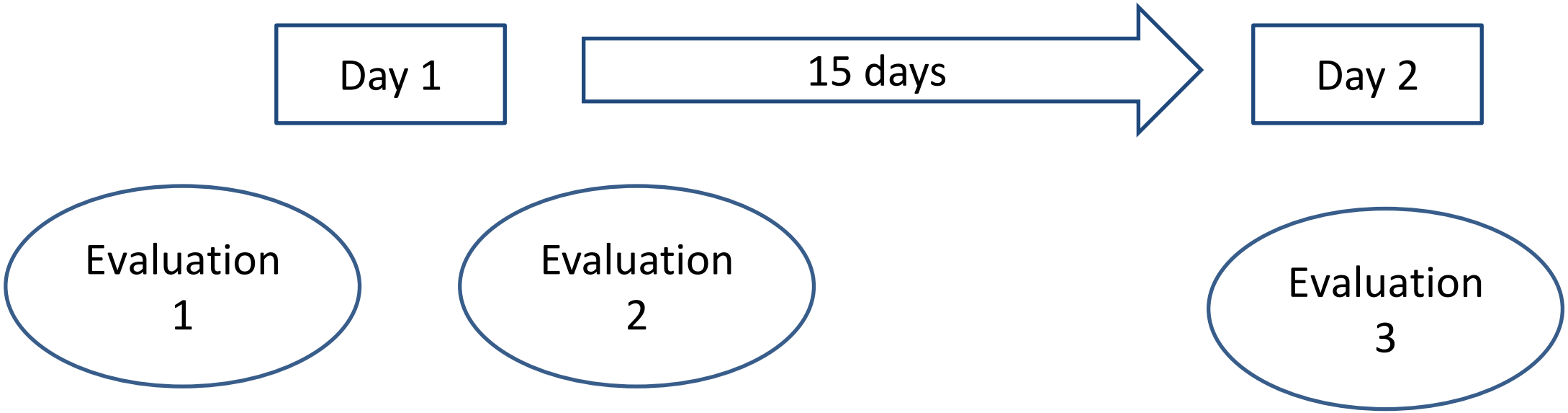
Rack 1966, Lehmann 1989, Detrembleur 1998

Stiffness evaluation

10 oscillations/frequency, 10 different frequencies (3-12 Hz), at random

Methods

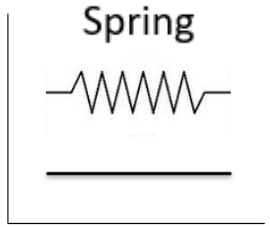
24 people with upper-limb post-stroke spasticity

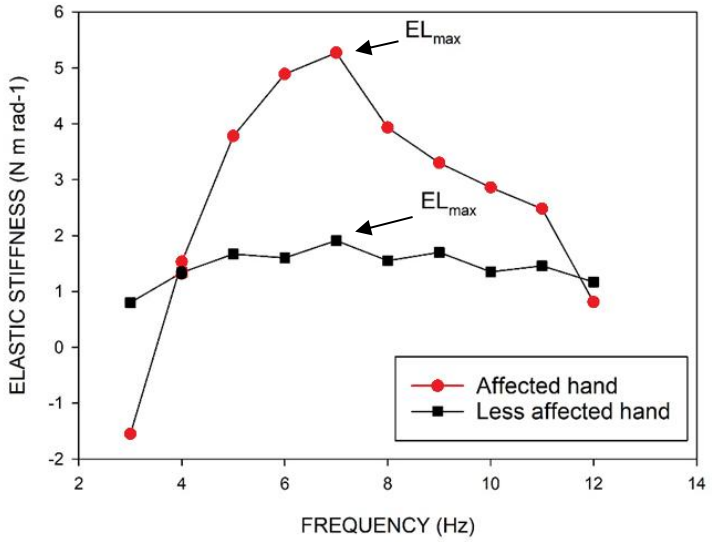


Selves et al. 2022

Hand flexor stiffness evaluation

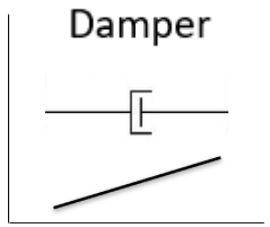
Results : stiffness

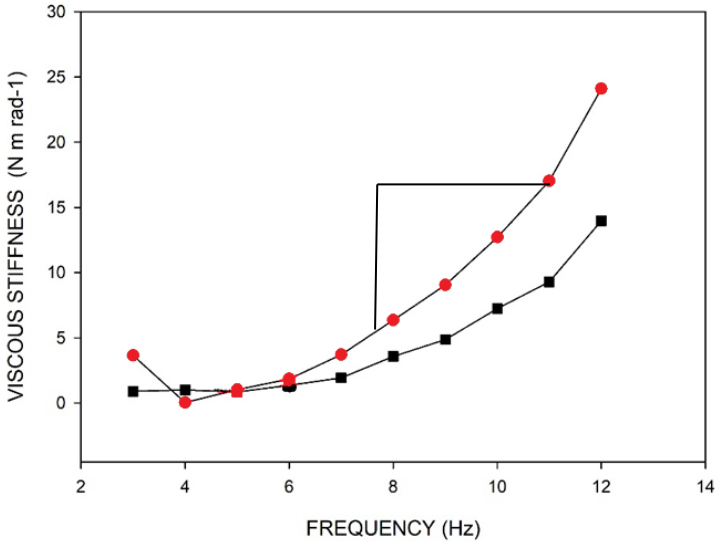


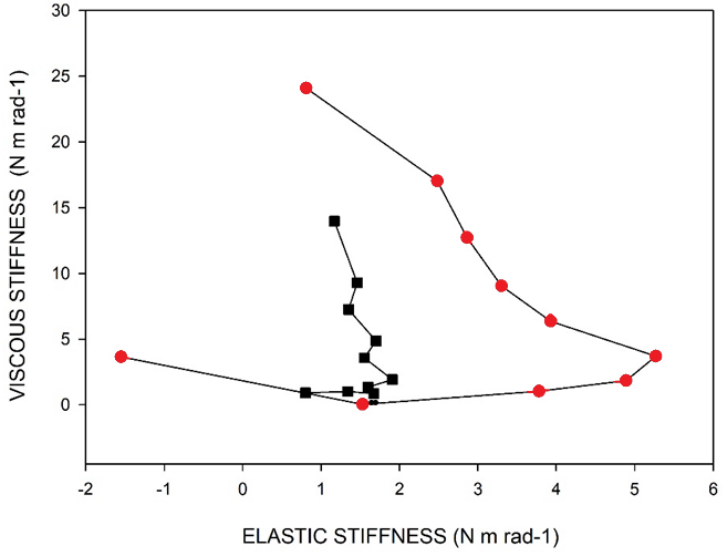


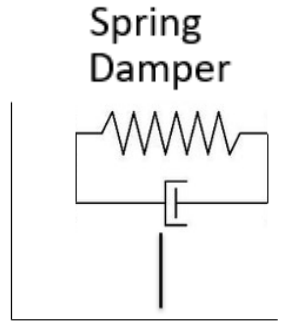
- **EL$_{max}$**
- **VI**
- **L-path**

} Influenced by spasticity









Selves et al. 2022

Results : stiffness

Construct validity (n=24):

EL_{max}, VI et L-path : ↑ most affected side

	Hand flexor muscles (affected arm)	Hand flexor muscles (less-affected arm)
	Mean value three assessments	T1
EL_{max} (N m/rad)	3.1 (1.3–6.9) ± 1.4	2.2 (1.0–3.8) ± 0.9*
VI (N m s/rad)	2.0 (3.1–0.7) ± 0.6	1.8 (3.3–0.6) ± 0.7*
L-path (N m/rad)	23.7 (11.0–37.6) ± 6.8	19.9 (9.3–32.5) ± 6.7*

*$P < 0.001$.

EL_{max}, VI et L-path this study population > norms healthy subjects (Nguyen et al. 2020)

Selves et al. 2022

Results : construct validity

- Finger flexors:
  - $\mathbf{EL_{max}}$ - **MAS** (ρ=0.60, p<0.05)
    - **MTS-V2** (ρ=0.56, p<0.05)
    - **MTS-V3** (ρ=0.55, p<0.05)

- Wrist flexors:
  - $\mathbf{EL_{max}}$ - **MAS** (ρ=0.49, p<0.05)
    - **MTS-V2** (ρ=0.43, p<0.05)
    - **MTS-V3** (ρ=0.49, p<0.05)

- No correlation between VI or L-Path and the clinical scales

Selves et al. 2022

Results : reliability

Table 3 Intraclass correlation coefficients

	ICC (T1–T2)	ICC (T1–T3)
EL_{max}	0.95* (0.88–0.98)	0.87* (0.67–0.94)
VI	0.94* (0.84–0.98)	0.76* (0.44–0.90)
L-path	0.92* (0.82–0.97)	0.82* (0.57–0.92)

Selves et al. 2022

Hand flexor stiffness

W-EOD :

Quantifies hand flexors stiffness

Quantifies hyper-resistance (MAS, MTS), a measure of spasticity

→ **valid and reliable tool**

Selves et al. 2022

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Spasticity management to improve gait function

Botulinum toxin type-A

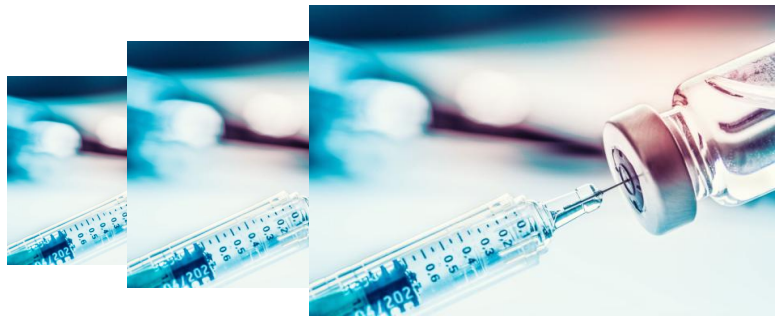
Multifocal and multisegmental spasticity:

Maximal authorized doses → **limit to optimal treatment** (Inco-BT-A : 500 U, usual : 400 U)

Higher doses (up to 800 U Inco-BT-A) → safe *(Tower study)* ✓

More effective ?

1 cycle → ✓



Repeated cycles ?

?

Pittock 2003, Caty 2008, Stoquart 2008, Wissel 2009, Gracies 2017, Wissel 2017, Esquenazi 2021, Bensmail 2021, Suputtitada 2024

Spasticity management to improve gait function



→ 3 cycles of progressively increasing doses of Inco-BT-A (400 – 600 – 800 U)


Spasticity (HR) in the treated muscle groups

Walking activities

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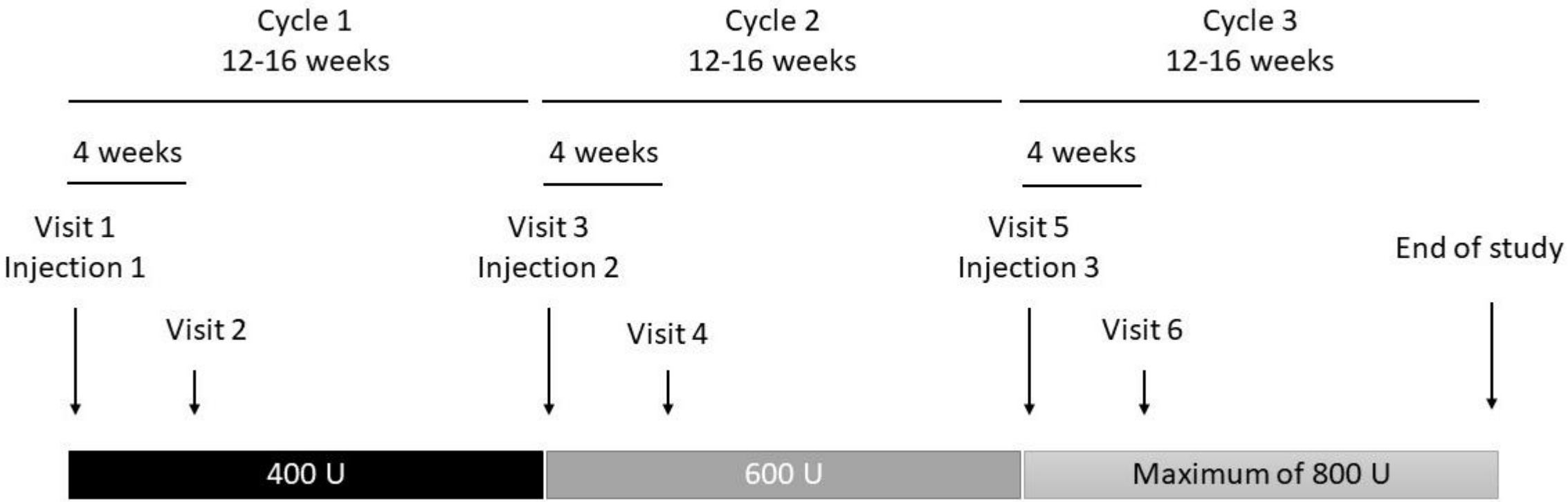
CHU UCL NAMUR

3 cycles of progressively increasing doses of Inco-BT-A



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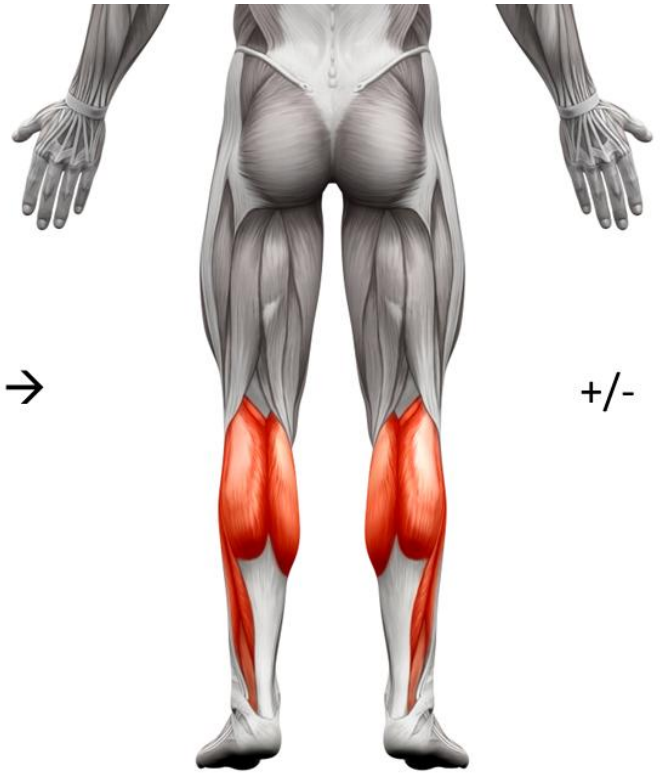
3 cycles of progressively increasing doses of Inco-BT-A

Inclusion criteria:

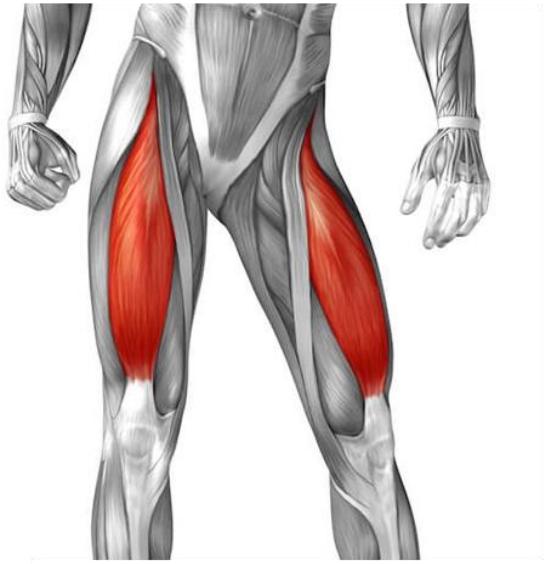
- Adults >18 yo
- Hemiparesis (stroke) >3 months
- Lower limb spasticity (**ankle plantar flexors** (and) knee extensors) → walking impairment
- Indication for focal chemical denervation

3 cycles of progressively increasing doses of Inco-BT-A

→



+/-



+/-

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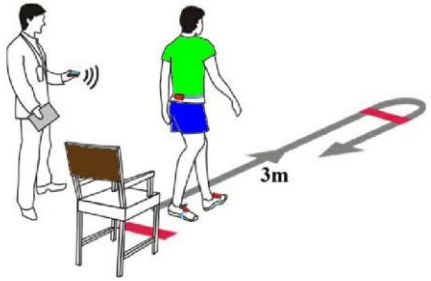
Evaluation

Spasticity : hyper-resistance → MAS & MTS

6 minutes walking test

10m walk test



Timed up and go

Timed stairs test

ABILOCO

Pohl 2020

Results

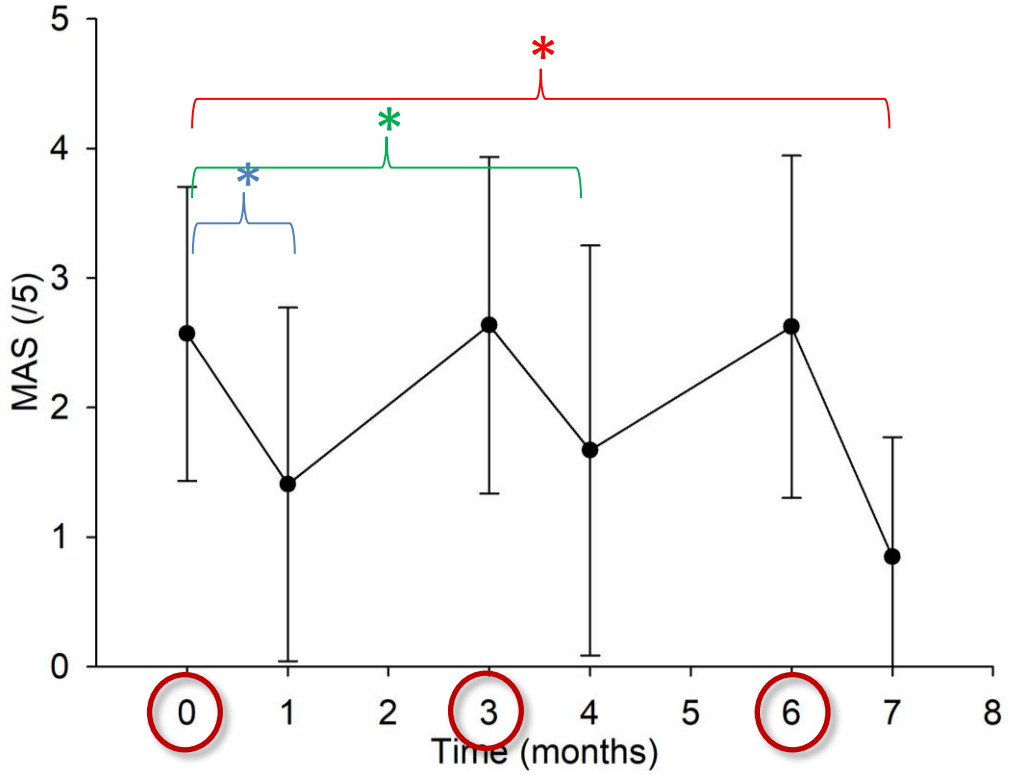
	Participants (n = 32)
Women, n (%)	11 (34,4)
Age, years, mean (SD)	54,5 (12,4)
Affected side, left (%)	19 (59)
Drop-outs, n	5
Serious adverse events	0

Selves et al. 2024

Results

Spasticity (HR)

MAS ankle plantar flexors



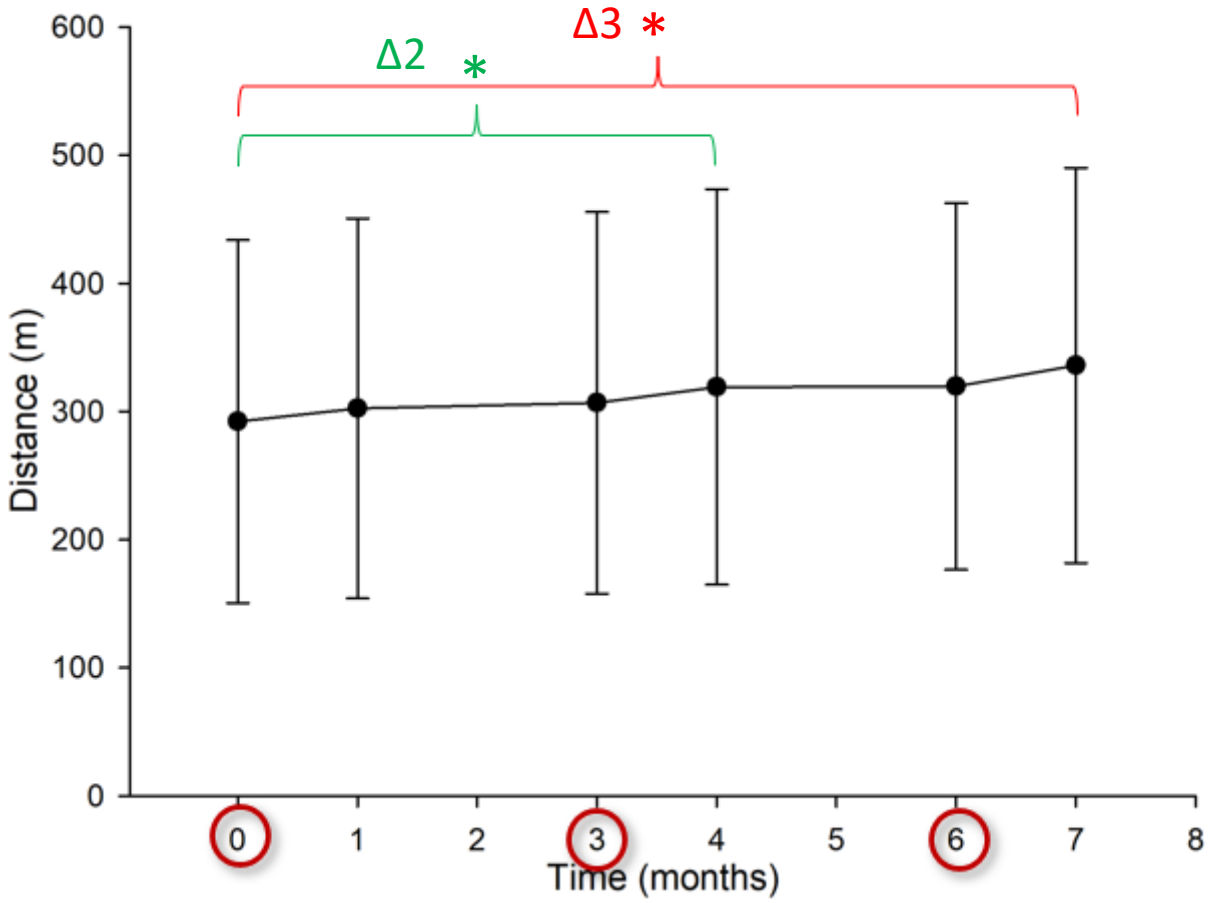
Δ1 = 1,2
Δ2 = 0,9
Δ3 = 1,8
*

* $p < 0.05$

Selves et al. 2024

Results

6 minutes walk test: walking activities (endurance)



- Δ2 V4-V1 = 27 m
- Δ3 V6-V1 = 43,8 m

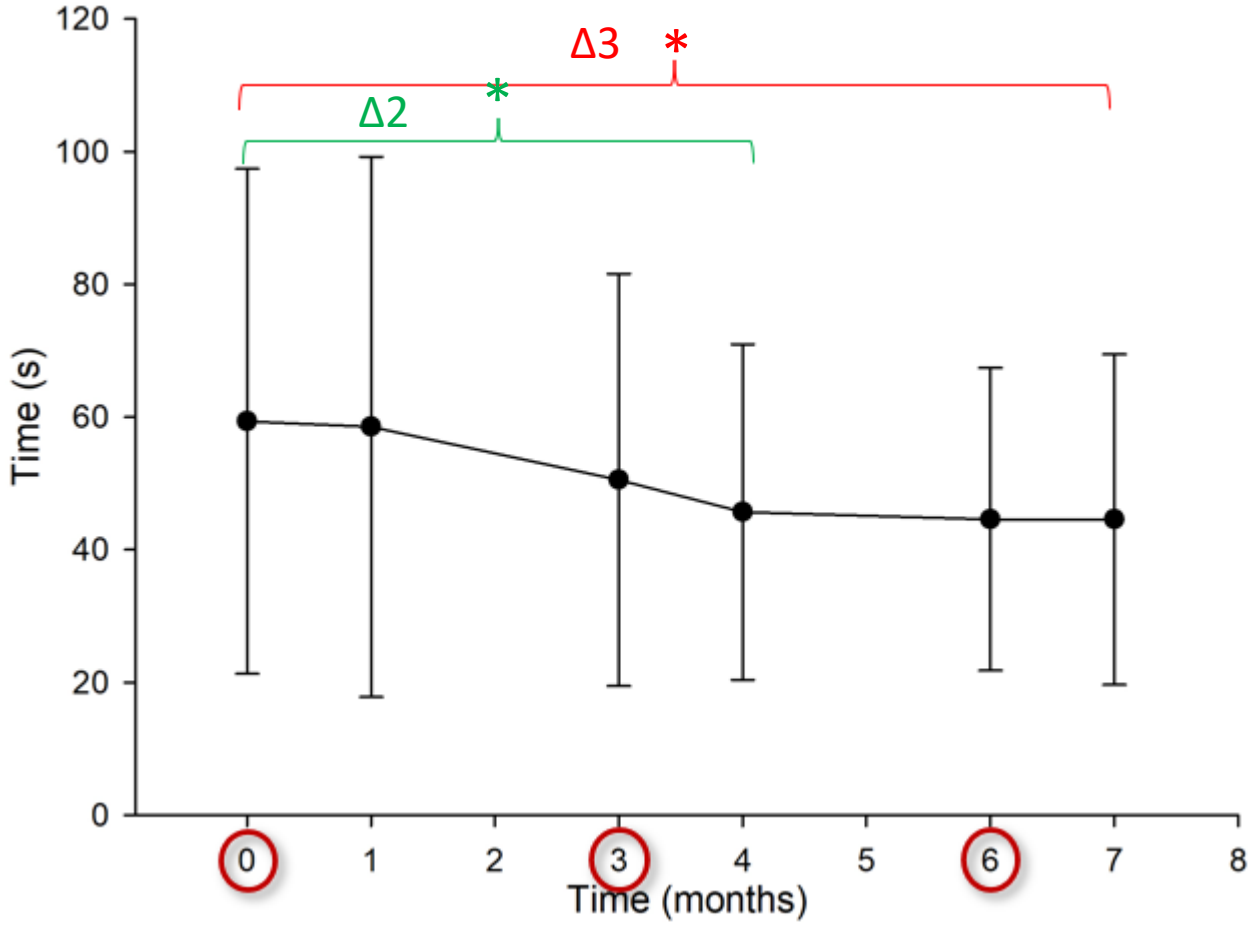
- MCID 6MWT :14-30 m

* p<0.05

Selves et al. 2024, Bohannon 2017

Results

Timed stairs test : walking activities



- Δ2 = 13,7 s
- Δ3 = 14,8 s

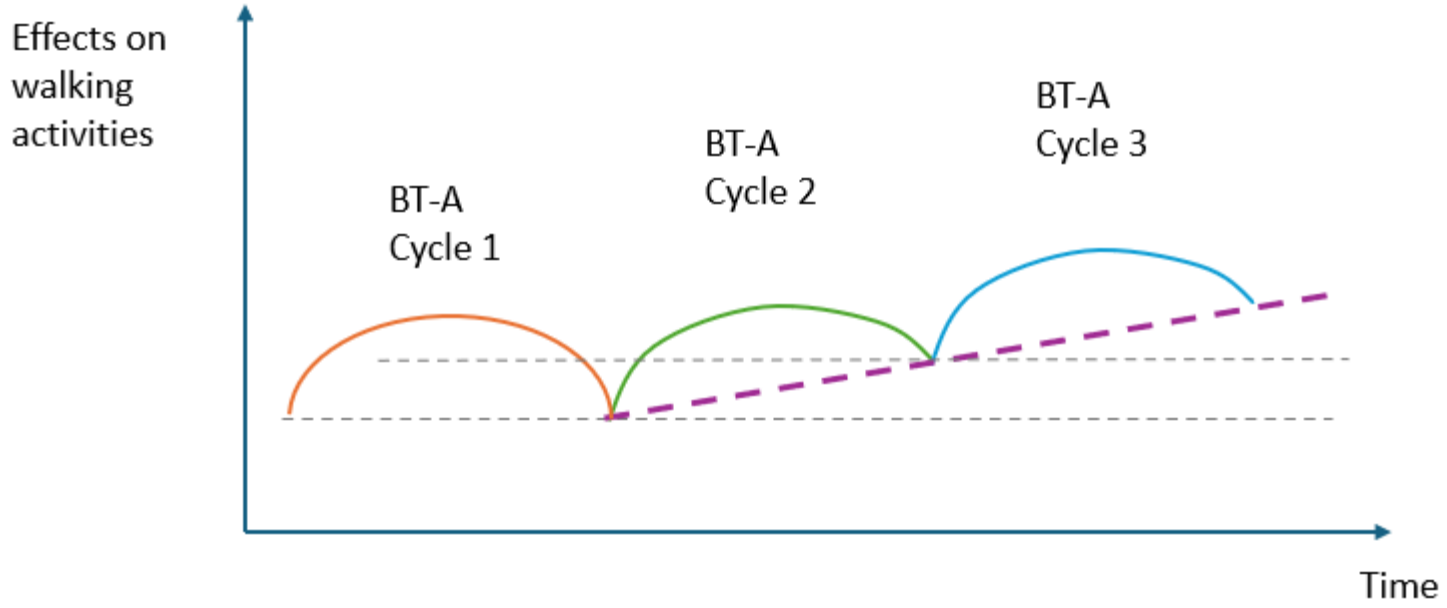
- MDC = 12,5 s

* p<0.05

Selves et al. 2024, Martin 2017

Discussion

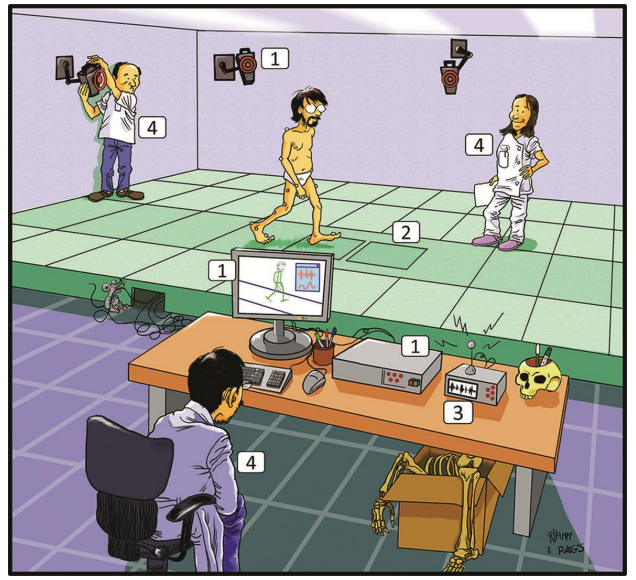
Cumulative effects and dose-dependent effects suggested



Encouraging → clinical pratice

Selves et al. 2024

Discussion



- Capacity : what an individual does in a controlled environment

- Performance : what an individual actually does in their own environment

Selves et al. 2024, WHO, 2008

Discussion

Walking categories :

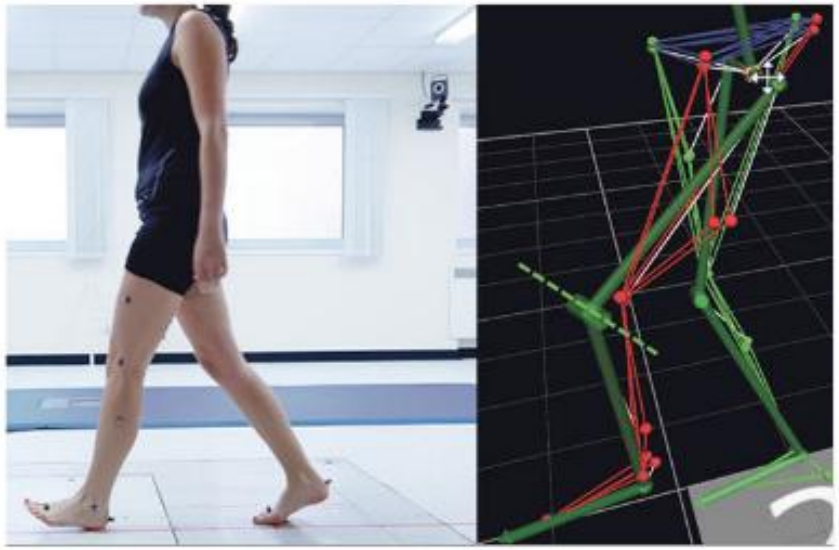
- Limited community ambulators → >225 m (6MWT)
- Unlimited community ambulators → >312 m (6MWT)

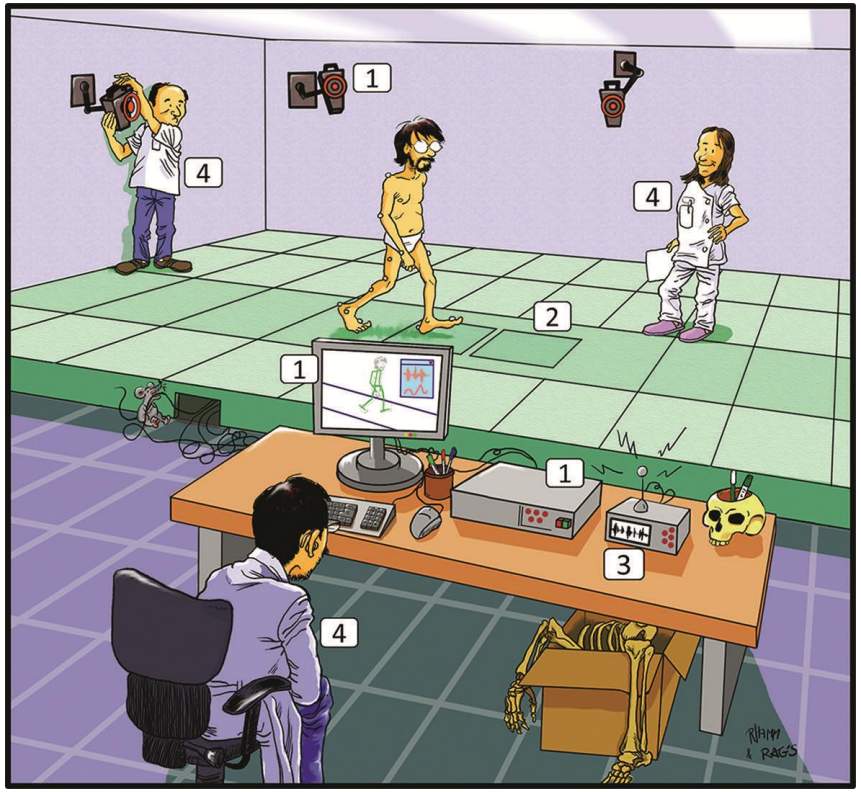
	Baseline (V1)	Post cycle 1 (V2)	Post cycle 2 (V4)	Post cycle 3 (V6)
6MWT (m, mean (SD))	292 (141)	302 (148)	319 (154)	336 (154)
Unlimited	41%	44%	47%	63%

Selves et al. 2024, Bohannon 2017, Fulk 2017

Walking evaluation

Quantified gait analysis (QGA)
Gold standard for gait evaluation
Kinematic variables





Li 2025, Baker 2009, Rozumalski 2011, Correa 2017

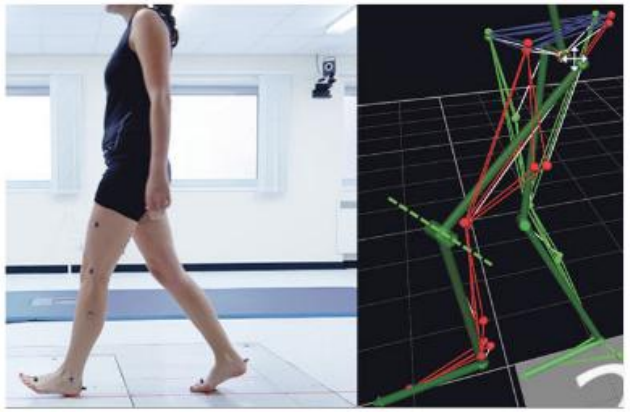
Spasticity management to improve gait function

Évaluation de la marche

✓ **Kinematic variables :**

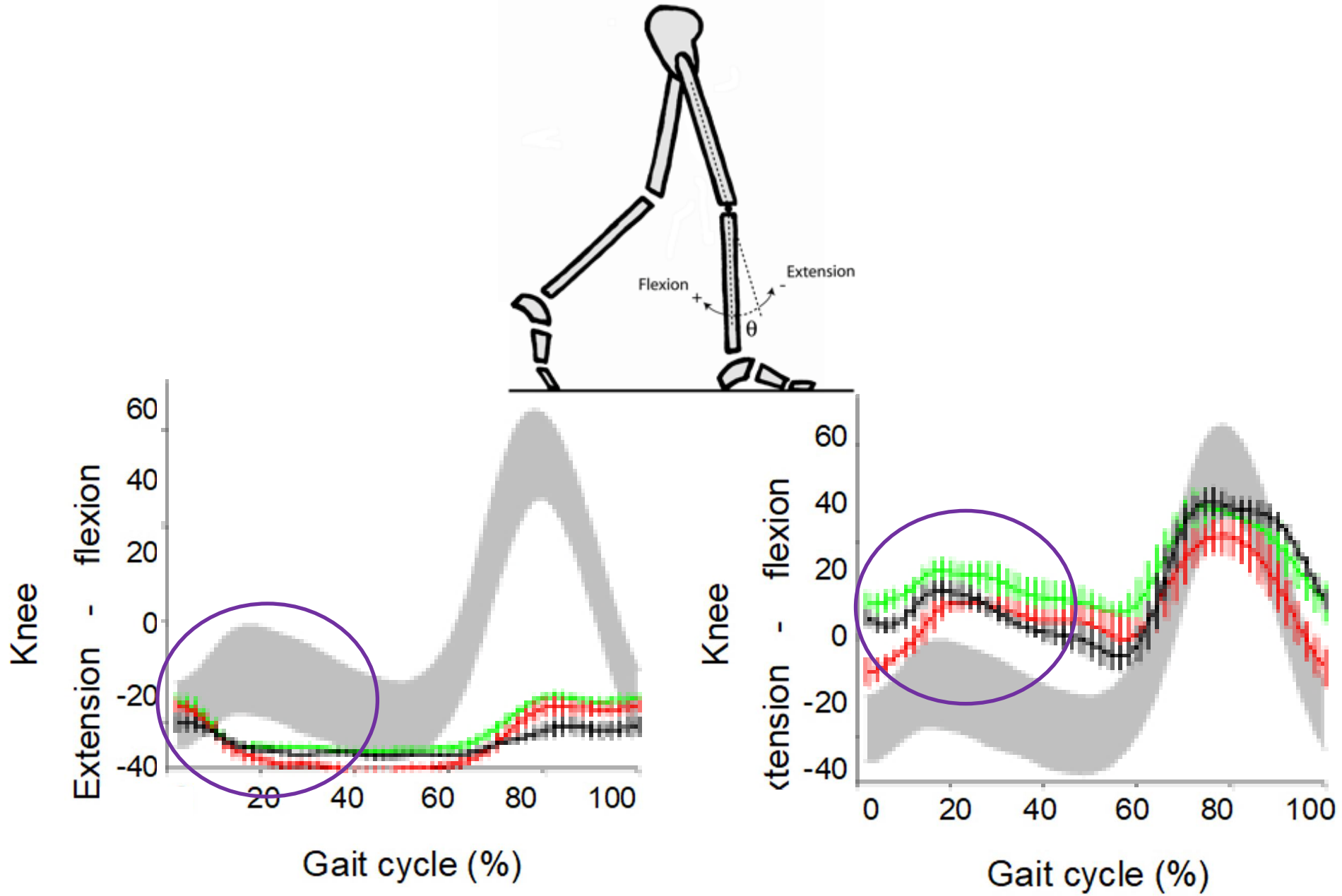
At the individual level : very interesting

At the group level: difficulties to single out deficiencies
Difficult to analyze groups with different postural gait patterns (e.g., recurvatum and flexum)

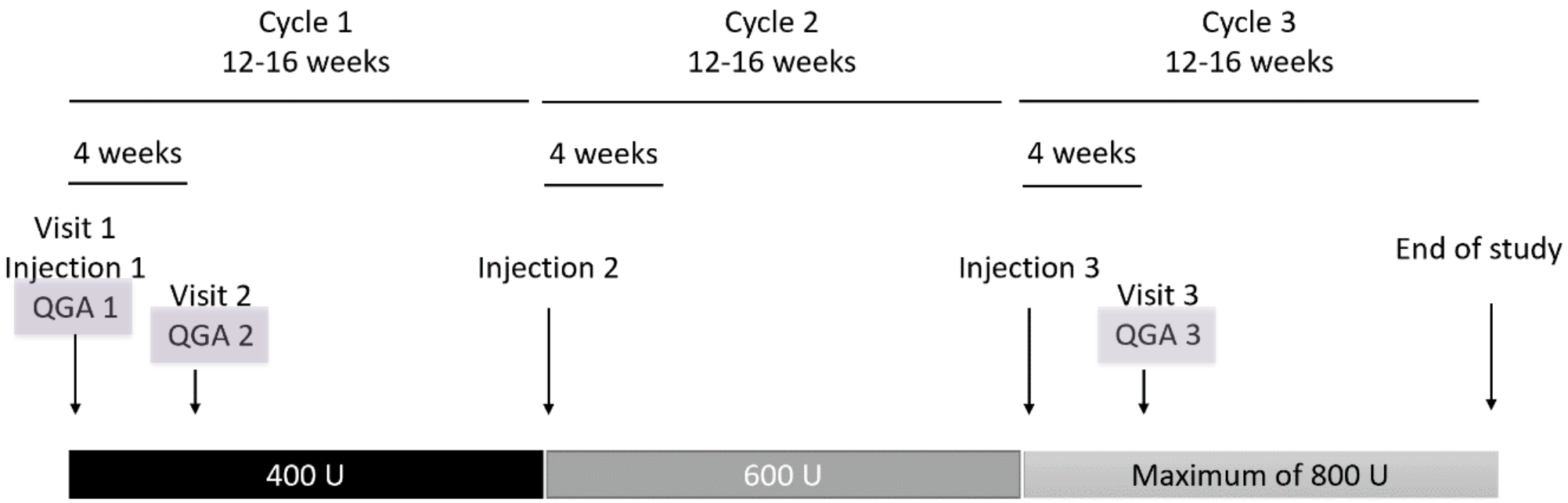


Li 2025, Baker 2009, Rozumalski 2011, Correa 2017

Traitement de la spasticité pour améliorer la fonction de marche



Méthode


Cycle 1
12-16 weeks
Cycle 2
12-16 weeks
Cycle 3
12-16 weeks
4 weeks
4 weeks
4 weeks
Visit 1
Injection 1
QGA 1
Visit 2
QGA 2
Injection 2
Injection 3
Visit 3
QGA 3
End of study
400 U
600 U
Maximum of 800 U

Methods

Lower limb postural spasticity patterns (physical examination) :

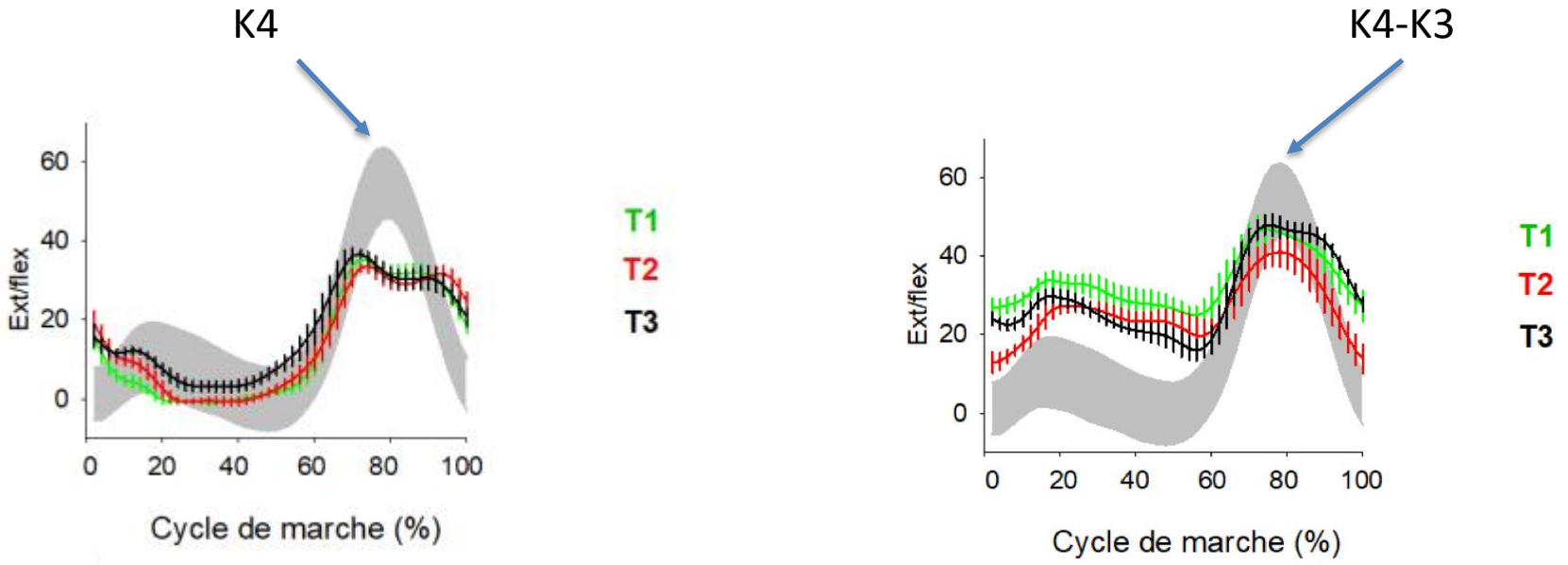
1ary, 2ary and 3ary for every participant (reflected by sagittal kinematics)

→ Guide injection patterns

Postural gait patterns
Equinus during stance
Equinus during swing
Stiff knee gait
Knee recurvatum
Knee flexum

Esquenazi 2017

Methods



Individual identification of the kinematic variables to analyze to better represent the participant's deficiencies

Results

	Participants (n = 25)
Women, n (%)	9 (36)
Age, years, mean (SD)	55,1 (11,6)
Affected side, left (%)	15 (60)
Drop-outs, n	0
Serious adverse events	0

Selves et al. under review

Results

Table 2. Participant's postural gait patterns

	Primary (n)	Secondary (n)	Tertiary (n)
Pes equinus during stance	12	7	3
Pes equinus during swing	3	4	10
Stiff knee	9	9	6
Genu recurvatum	0	2	3
Excessive knee flexion	1	3	3

Selves et al. under review

Spasticity management to improve gait function

Results

Postural gait pattern Sagittal kinematic outcomes	**n**	**Visit 1** (baseline)	**Visit 2** (after 1st injection)	**Visit 6** (after 3rd injection)	**RM-ANOVA,** time (p-value)
Pes equinus during stance					
A1 (°)	3	-16.4 (8.1)	-18.4 (11.2)	-6.4 (9.9)[a,b]	
A2 (°)	8	3.3 (5.3)	3.2 (5.5)	5.8 (6.0)	
A2-A1 (°)	11	17.0 (6.1)	17.7 (7.3)	17.9 (6.9)	
A1+A2+(A2-A1)	22	7.5 (13.0)	8.2 (15.2)	10.2 (11.0)[a,b]	0.008

Results are presented as mean (SD) and median [Q1;Q3]. Post-hoc analysis of the ANOVA are represented by a = significantly different compared to visit 1 ($p<0.05$), b = significantly different compared to visit 2 ($p<0.05$).

Selves et al. under review

Results

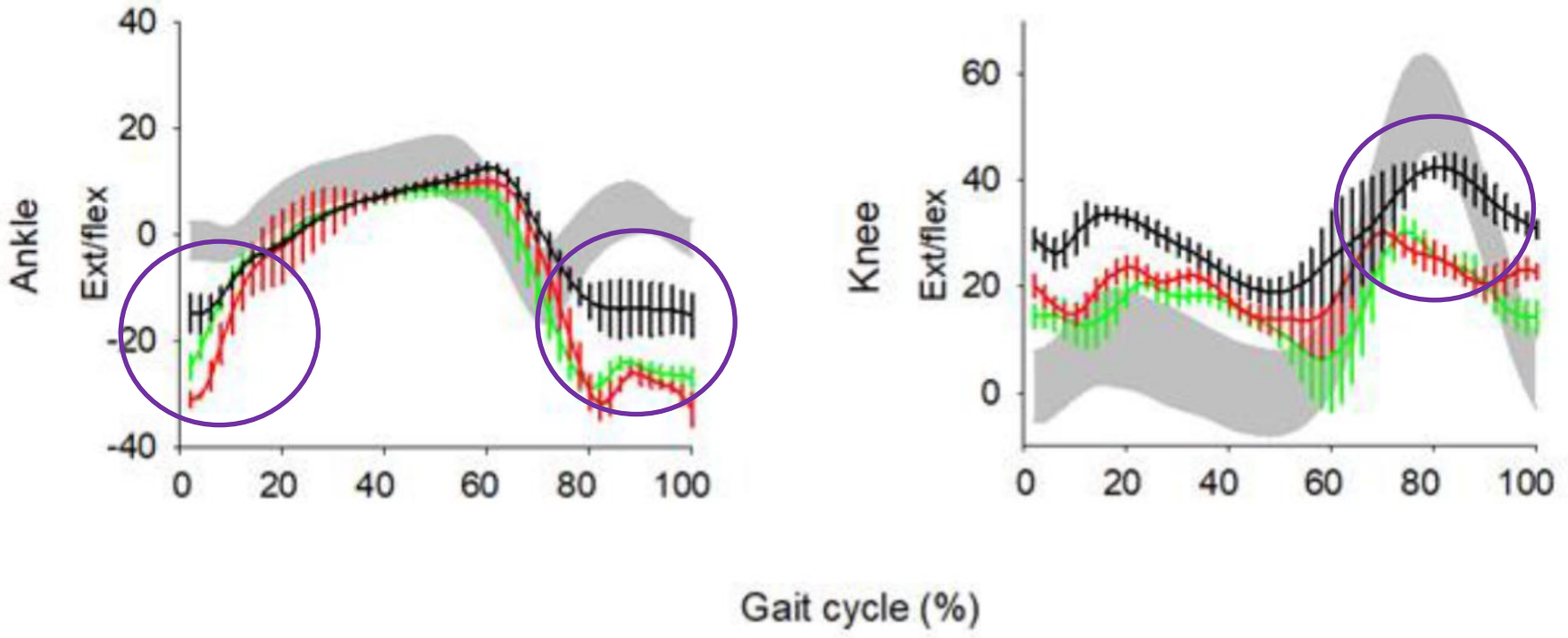
Postural gait pattern Sagittal kinematic outcomes	n	Visit 1 (baseline)	Visit 2 (after 1st injection)	Visit 6 (after 3rd injection)	RM-ANOVA, time (p-value)
Stiff knee					
K4 (°)	19	23.2 (15.1)	23.0 (14.0)	30.3 (15.8)[a,b]	
K4-K3 (°)	5	30.0 (17.3)	24.8 (4.2)	35.2 (16.8)	
K4+(K4-K3)	24	24.6 (15.5)	23.3 (12.7)	31.3 (15.8)[a,b]	<0.001

Results are presented as mean (SD) and median [Q1;Q3]. Post-hoc analysis of the ANOVA are represented by a = significantly different compared to visit 1 ($p<0.05$), b = significantly different compared to visit 2 ($p<0.05$).

Selves et al. under review

Results

Typical trace of knee and ankle sagittal kinematics



T1: baseline
T2: after first injection
T6: after third injection

Selves et al. under review

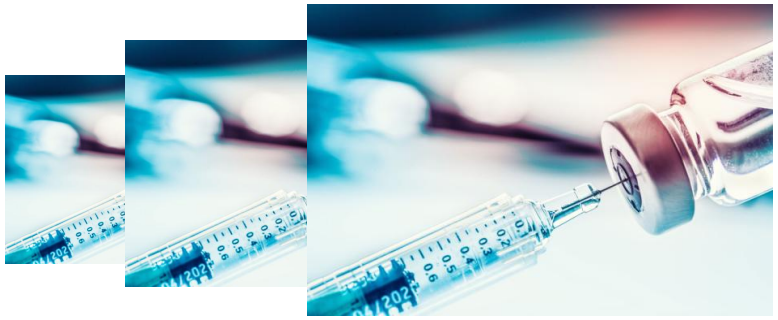
Plan of the presentation

1. General introduction
2. Objectives of the research project
3. Hand flexor stiffness evaluation
4. Spasticity management to improve gait function
5. **General discussion and conclusions**

Key points of this research work

W-EOD : valid et reliable

Quantifies wrist flexor musculoskeletal stiffness in post-stroke spastic individuals



✓

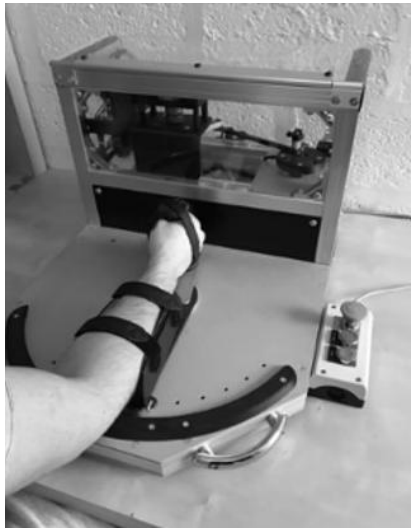
Walking Endurance + Stair Speed

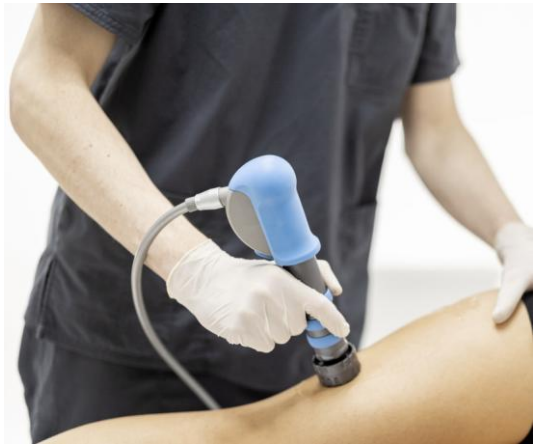
Equinus & SKG → ankle and knee sagittal kinematics

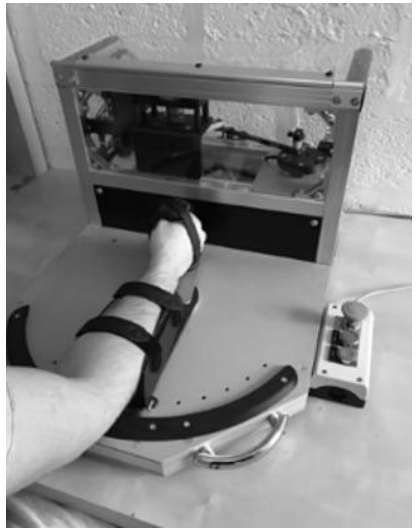
Repeated cycles → time

Higher intensity can be achieved in rehabilitation → good clinical practice

Perspectives







?

Undergoing !

Monitoring the effectiveness of BT-A injections in clinical practice

✓ 6MWT
Timed stairs test

} Walking capacity

Walking capacity: what an individual achieves in a controlled environment

VS

Walking performance : what an individual actually does in their environment

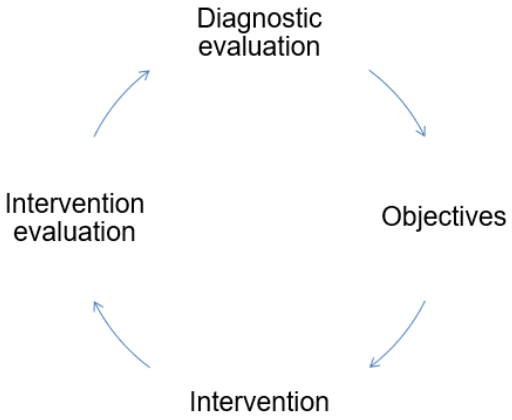
Perspectives

Walking capacity ✓

What about performance?

...

Conclusion



Objective assessment

Tailored therapeutic approach

Optimization of gait improvements

BSNR

Belgian Society for
Neurorehabilitation

THANK YOU FOR YOUR ATTENTION

UCLouvain
Institut de recherche
expérimentale et clinique

Cliniques universitaires
SAINT-LUC
UCLouvain BRUXELLES

Hautes doses vs cycles répétés

1 cycle de hautes doses → ?

Hautes doses vs cycles répétés

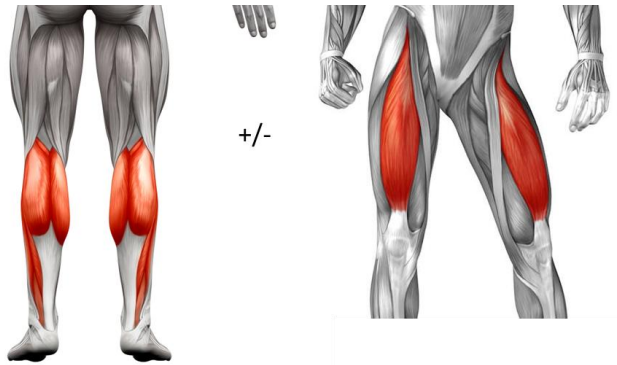


3 cycles de hautes doses → ?

= Distinguer les effets des hautes doses et celui des doses répétées

Augmentation des doses/muscle vs nombre des muscles injectés

Mêmes muscles : doses progressivement croissantes



= Distinguer les effets de l’augmentation du nombre de muscles injectés

Évaluation de la spasticité

Limites MAS et MTS : évaluation passive : pas les co-contractions

Évaluation instrumentée :

- Isocinétisme
- Mesure de la résistance (moment de force)
- Électrophysiologie : EMG de surface, mesure du réflexe H à l'EMG

Évaluation des co-contractions et distinction des composantes neurales (hyperactivité musculaire) et des composantes non neurales (myopathie spastique): blocs moteurs

Li 2025, Deltombe 2004

Évaluation de la spasticité

Disability and Rehabilitation
An international, multidisciplinary journal

http://informahealthcare.com/dre
ISSN 0963-8288 print/ISSN 1464-5165 online

Disabil Rehabil, Early Online: 1–11
© 2015 Informa UK Ltd. DOI: 10.3109/09638288.2015.1014933

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REVIEW PAPER

Assessment of spasticity after stroke using clinical measures: a systematic review

Saleh M. Aloraini[1,2], Johan Gäverth[1,3], Ellen Yeung[1], and Marilyn MacKay-Lyons[1]

[1]School of Physiotherapy, Dalhousie University, Halifax, Nova Scotia, Canada, [2]College of Applied Medical Sciences, Qassim University, Saudi Arabia, and [3]Department of Women's and Children's Health, Karolinska Institutet, Stockholm, Sweden

Abstract

Purpose: To identify and appraise the literature on clinical measures of spasticity that has been investigated in people after stroke. *Methods*: The literature search involved four databases (PubMed, CINAHL, Embase and The Cochrane Library) up to February 2014. The selected studies included those that aimed to measure spasticity using a clinical assessment tool among adult patients post-stroke. Two independent raters reviewed the included articles using a critical appraisal scale and a structured data extraction form. *Results*: A total of 40 studies examining 15 spasticity assessment tools in patients post-stroke were reviewed. None of the reviewed measurement tools demonstrated satisfactory results for all psychometric properties evaluated, and the majority lacked evidence concerning validity and absolute reliability. *Conclusion*: This systematic review found limited evidence to support the use of most of clinical measures of spasticity for people post-stroke. Future research examining the application and psychometric properties of these measures is warranted.

Li 2025, Deltombe 2004

Évaluation de la spasticité

JRM

ORIGINAL REPORT

MJS PUBLISHING

AUTOMATED ASSESSMENT OF UPPER LIMB SPASTICITY IN STROKE PATIENTS WITH FUSION OF MULTICHANNEL SURFACE ELECTROMYOGRAPHY FEATURES

Xin LI[1#], Feiyu NONG[1#], Xu ZHANG[2], Lin CHEN[2], Tian LI[3*], Shengliang SHI[4*] and Yaobin LONG[1*]

From the [1]Department of Rehabilitation, The Second Affiliated Hospital, Guangxi Medical University, Nanning, [2]College of Mechanical Engineering, Guangxi University, Nanning, [3]Tianjin Key Laboratory of Acute Abdomen Disease-Associated Organ Injury and ITCWM Repair, Institute of Integrative Medicine of Acute Abdominal Diseases, Tianjin Nankai Hospital, Tianjin Medical University, Tianjin, and [4]Department of Neurology, The Second Affiliated Hospital, Guangxi Medical University, Nanning, China

[#]Equal contribution

Li 2025, Deltombe 2004

Évaluation de la spasticité

Évaluation ‘idéale’:

- Objectifs du patient
- MTS (Gracies)
- Bloc moteur lorsque possible
- Raideur

Mieux distinguer entre les composantes neurales et non-neurales de l’hyper-résistances ET mieux caractériser l’hyperactivité musculaire (spasticité, co-contractions, etc)

GO-FAST Toxnet

Deltombe 2017, Escaldi 2022

Pourquoi l'EOD?

Syndrome de parésie spastique : myopathie spastique
Raideur : propriétés rhéologiques du muscle

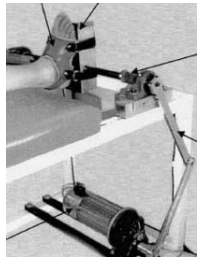
Si on supprime composantes neurales (bloc moteur) : mieux étudier les composantes non-neurales → mieux comprendre la myopathie spastique

Données quantitatives

Deltombe 2017, Escaldi 2022

Pourquoi l'EOD?

Mieux orienter le traitement (thérapies adjuvantes)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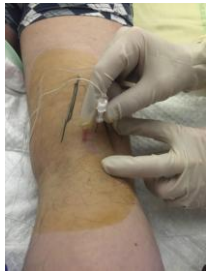
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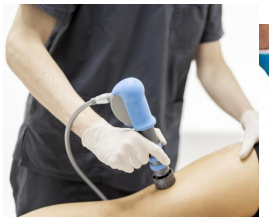
Neural
Non-neural

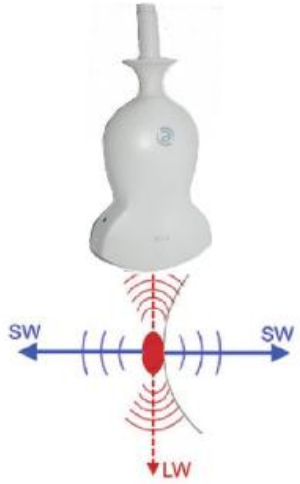

+ Thérapies adjuvantes ?


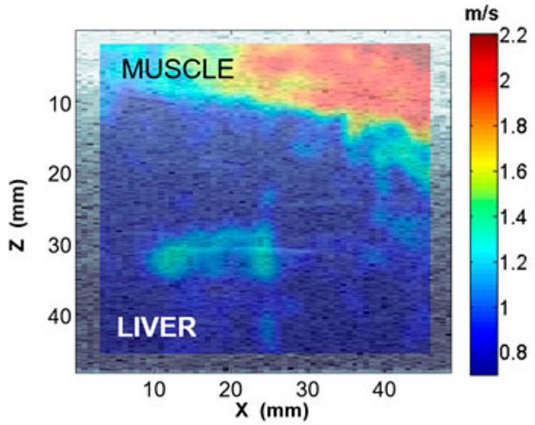
...

Francisco, 2021, Schillebeeckx 2022, Allart 2022

Pourquoi l'EOD?

Valider des outils accessibles tel que le MyotonPro ou l'élastographie pour l'évaluation des composantes non-neurales





Chuang 2012, Lehoux 2020, Nguyen 2022

Pourquoi l'EOD?

Archives of Physical Medicine and Rehabilitation
Volume 93, Issue 3, March 2012, Pages 532-540

Original article

Reliability, Validity, and Responsiveness of Myotonometric Measurement of Muscle Tone, Elasticity, and Stiffness in Patients With Stroke

Li-ling Chuang PhD, PT [a *], Ching-yi Wu ScD, OTR [c *], Keh-chung Lin ScD, OTR [a b]

MyotonPro Is a Valid Device for Assessing Wrist Biomechanical Stiffness in Healthy Young Adults

Anh Phong Nguyen [1], Christine Detrembleur [1], Paul Fisette [2], Clara Selves [1,3] and Philippe Mahaudens [1,3]*

Conclusions

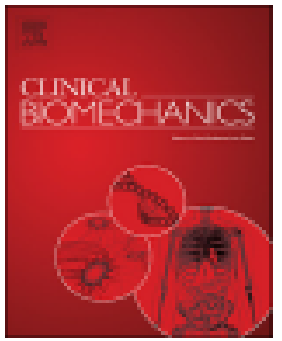
Myotonometry can be a reliable, valid, and responsive outcome measure for assessing muscle properties after stroke rehabilitation.

Pourquoi l'EOD?

Review

Shear wave elastography potential to characterize spastic muscles in stroke survivors: Literature review

Marie-Claude Lehoux[a,b], Stéphane Sobczak[c,d], Frank Cloutier[a,b], Stéphane Charest[a,b,e,f], Antony Bertrand-Grenier[a,b,g,*]



w-EOD

-10° - +10° : pour permettre d'inclure le plus de patients (même ceux avec MAS 4) et donc être reproductibles

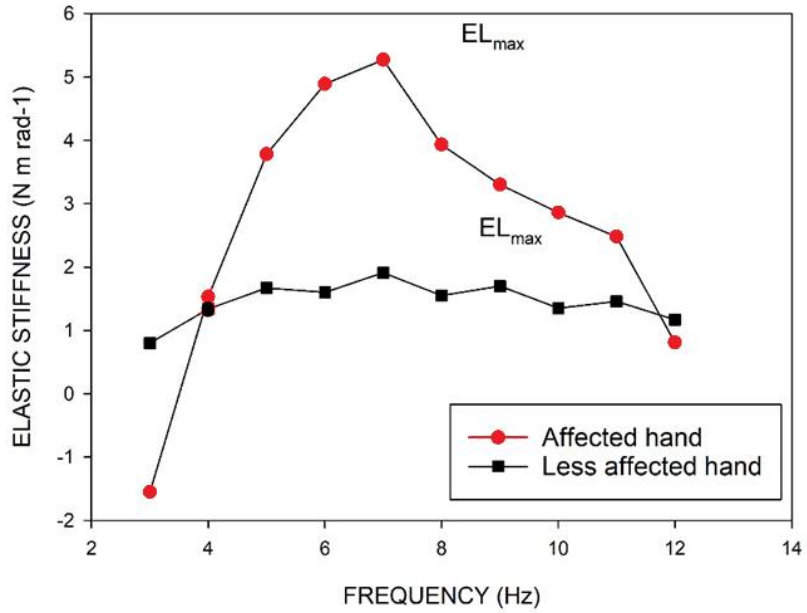
Lors des tests préliminaires : à 5°, les capteurs n'enregistraient plus un signal sinusoïdal (donc équation caduque : transformation de Fourier)
À 15° : moins performant qu'à 10°

Différent par rapport à la cheville car la raideur des fléchisseurs plantaires de la cheville est beaucoup plus grande que des fléchisseurs de poignet (données fiables à 5° même à 2.5° pour la cheville)

L'angle de départ du poignet importe peu : données fiables lors de la validation chez les sujets sains en démarrant à plusieurs angles de flexion du poignet

w-EOD

Raideur élastique : forme de la courbe



À certaines fréquences, la fréquence d'oscillation a pu entrer en résonnance avec le réflexe monosynaptique et susciter potentiellement des réponses musculaires plus importantes, amplifiées par une augmentation de décharge de certains neurones

Hautes doses de BT-A chez l'enfant

15 U/kg → enfant de 30kg : 450 U!
Injections répétées tous les 6-12 mois (effets de la croissance sur l'HM)
Effets des cycles répétés : très peu étudiés (soit 1 cycle, soit études rétrospectives)

Read 2017, Vitrikas 2020, Braendvik 2024

Hautes doses de BT-A chez l'enfant

Longitudinal assessment of gait quality in children with bilateral cerebral palsy following repeated lower limb intramuscular Botulinum toxin-A injections

Felicity A. Read*, Roslyn N. Boyd, Lee A. Barber

Queensland Cerebral Palsy and Rehabilitation Research Centre, The University of Queensland, Brisbane, Australia

Methods and procedures: Seventeen children with BCP and dynamic equinus (8 females and 9 males, age mean (SD), 4.0 (2.2) years, GMFCS I = 2 and II = 15) were included in the study after a retrospective audit of the records of the Queensland Children's Gait Laboratory (QCGL), Children's Health Queensland, Brisbane. The medical records of children who attended the QCGL between January 2001 and January 2016 were searched for eligibility. Children who had un-

Hautes doses de BT-A chez l'enfant

ORIGINAL ARTICLE

Does botulinum neurotoxin A make walking easier in children with cerebral palsy? A randomized clinical trial

Siri Merete Brændvik[1,2,#] | Anne Elisabeth Ross Raftemo[3,4,#] | Karin Roeleveld[1] | Guro Lillemoen Andersen[3,4] | Kjersti Ramstad[5] | Turid Follestad[6,7] | Ånen Aarli[8] | Marcin Bonikowski[9] | Torstein Vik[4,†] | Walking Easier*

Method: This was an industry-independent, randomized, quadruple-blind, placebo-controlled, multicentre trial (ClinicalTrials.gov registration: NCT02546999). Sixty-one children (33 male, median age [range] = 8 years [4–16 years]) with spastic CP and classified in Gross Motor Function Classification System (GMFCS) levels I and II allocated to single injections of either BoNT-A or 0.9% saline into the calf muscles. The main outcome was gross energy cost (J/kg/m); secondary outcomes were walking capacity, habitual physical activity, perceived change in mobility tasks, and calf pain at baseline, 4 weeks (P1), 12 weeks (P2), and 24 weeks (P3) after the injection.

Hautes doses de BT-A chez l'enfant

ORIGINAL ARTICLE

Does botulinum neurotoxin A make walking easier in children with cerebral palsy? A randomized clinical trial

Siri Merete Brændvik[1,2,#] | Anne Elisabeth Ross Raftemo[3,4,#] | Karin Roeleveld[1] | Guro Lillemoen Andersen[3,4] | Kjersti Ramstad[5] | Turid Follestad[6,7] | Ånen Aarli[8] | Marcin Bonikowski[9] | Torstein Vik[4,†] | Walking Easier*

Interpretation: One treatment with BoNT-A was not superior to placebo in making walking easier in children with CP classified in GMFCS levels I and II, at least in the short term. BoNT-A may have a pain-reducing effect.

1 seul cycle, mais plusieurs ?

Questionnaires auto-rapportés activités de marche :

ABILOCO : effet plafond → pas d'amélioration dans notre cohorte, qui était déjà très performante

ABILOCO a un haut effet plafond (vs MIF ou FAC), c'est pour cela que nous l'avions choisi.

Encore l'étudier

Caty 2008

Questionnaires auto-rapportés activités de marche :

ORIGINAL ARTICLE

ABILOCO: A Rasch-Built 13-Item Questionnaire to Assess Locomotion Ability in Stroke Patients

Gilles D. Caty, MD, Carlyne Arnould, PhD, Gaëtan G. Stoquart, MD, Jean-Louis Thonnard, PhD, Thierry M. Lejeune, MD, PhD

ability only at home and in the community. Moreover, 40% of our patients obtained the maximum FWC, FIM walking ability, and FAC scores, indicating a ceiling effect, whereas ABILOCO can discriminate between walking abilities from 3 to 6.17 logits among these patients. The invariance of

Caty 2008

Causes de SKG

- Spasticité RF
- Faiblesse fléchisseurs de hanche et des fléchisseurs dorsaux de la cheville
- Spasticité du vaste intermédiaire

Robertson 2008, Caty 2008

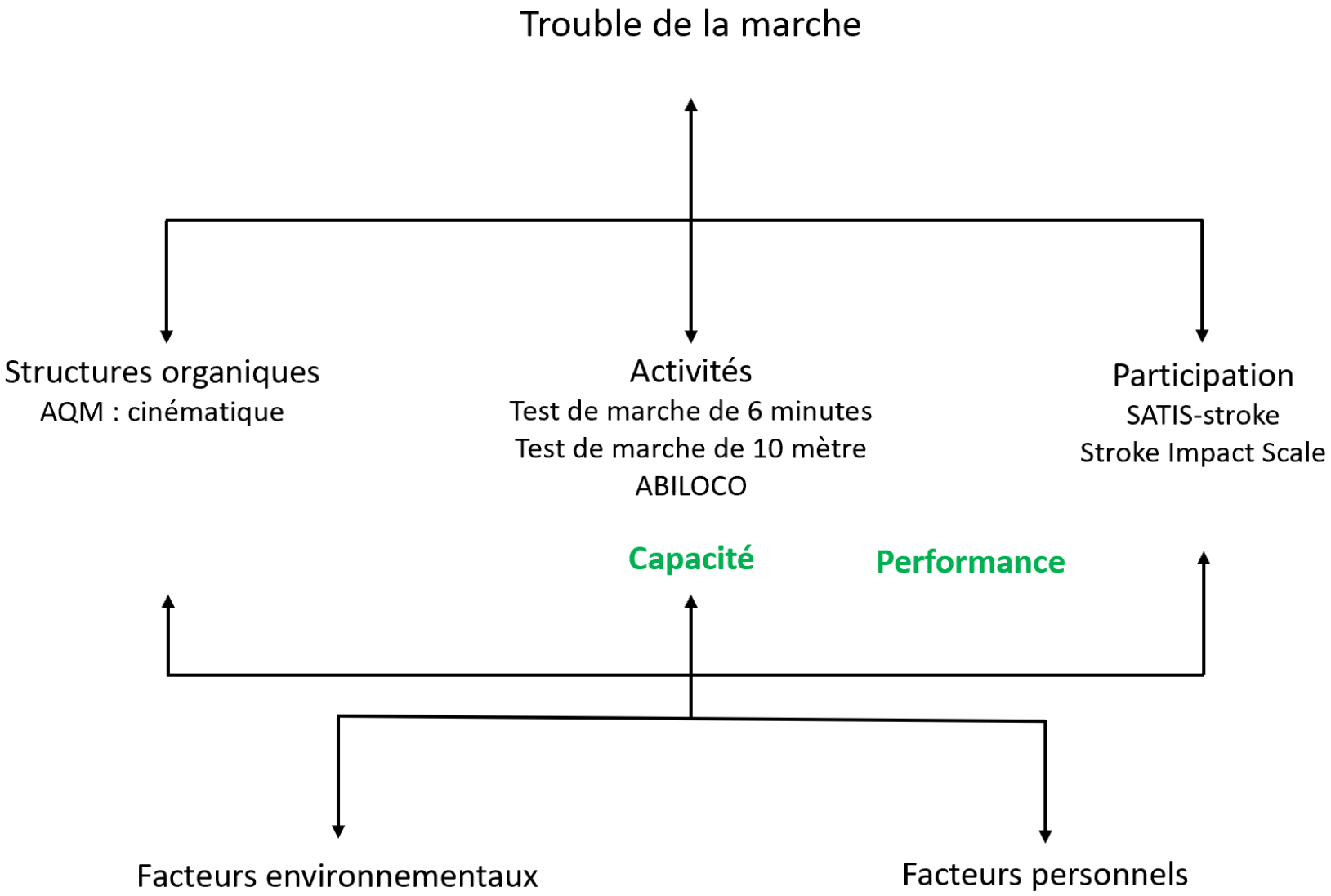
Capacité et Performance

- Capacité de marche : possibilité de marcher d'une certaine manière, que ce soit en termes de vitesse ou de qualité, dans un environnement contrôlé spécifique, généralement dans le cadre d'une évaluation clinique.

- La performance de marche fait référence à ce que la personne fait réellement dans son environnement.

WHO 2008, Holleran 2020, Lang 2023

Capacité et Performance



Capacité et Performance

Improvement in the Capacity for Activity Versus Improvement in Performance of Activity in Daily Life During Outpatient Rehabilitation

Catherine E. Lang, PT, PhD, FAPTA, Carey L. Holleran, PT, DPT, DHS, Michael J Strube, PhD, Terry D. Ellis, PT, PhD, FAPTA, Caitlin A. Newman, OTR/L, Meghan Fahey, PT, DPT, Tamara R. DeAngelis, PT, DPT, Timothy J. Nordahl, PT, DPT, Darcy S. Reisman, PT, PhD, FAPTA, Gammon M. Earhart, PT, PhD, FAPTA, Keith R. Lohse, PhD, and Marghuretta D. Bland, PT, DPT, MSCI

JNPT

Discussion and Conclusions: The discrepancy between improvements in capacity and performance is a problem in routine, outpatient neurorehabilitation. If performance information were available, patients and clinicians could act to address it.

Si j'avais 1 million d'€

- Étude 3 cycles progressivement croissantes de BT-A sur les performances de marche :
  - GO-FAST (établir plan de traitement)
  - Évaluation de la spasticité : échelles cliniques, raideur, blocs moteurs
  - Protocole d'actimétrie validé dans notre laboratoire

- Analyse de marche avec des systèmes de capture de mouvement portables 'markerless'

- Étude de cycles répétés de BT-A sur la capacité et la performance de marche d'enfants atteints de PC

- Motiver l'un ou l'autre doctorant pour m'aider!

Si j'avais 1 million d'€

The Knee 52 (2025) 171–178

Contents lists available at ScienceDirect

The Knee

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

Quantifying performance and joint kinematics in functional tasks crucial for anterior cruciate ligament rehabilitation using smartphone video and pose detection

Nicolas Lambricht [a,*], Alexandre Englebert [b], Laurent Pitance [a,c], Paul Fisette [d], Christine Detrembleur [a]

[a] Institute of Experimental and Clinical Research, UCLouvain, Brussels, Belgium
[b] Institute of Information and Communication Technologies, Electronic and Applied Mathematics, UCLouvain, Louvain-la-Neuve, Belgium
[c] Service de Stomatologie et de Chirurgie Maxillo-faciale, Cliniques Universitaires Saint-Luc, Brussels, Belgium
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Original Article

Validity of the ActiGraph activity monitor for individuals who walk slowly post-stroke

Cynthia Campos, Vincent G. DePaul, Svetlana Knorr, Jennifer S. Wong, Avril Mansfield & Kara K. Patterson

Pages 295-304 | Received 18 Sep 2017, Accepted 25 Feb 2018, Published online: 20 Mar 2018

Si j’avais 1 million d’€

1. Étudier les effets de cycles répétés d’injections de toxine botulique de type A (BT-A) sur la performance de marche en conditions écologiques chez des personnes présentant de l’hyperactivité musculaire post AVC.
2. Évaluer les effets de cycles répétés d’injections de BT-A sur la marche chez des enfants atteints de paralysie cérébrale, à la fois sur les capacités (en laboratoire) et sur la performance (en milieu écologique) de marche.

Effets cumulatifs vs récupération neurologique

- Pas de lésion structurelle du nerf
- Récupération motrice vraie : réparation et récupération neurologique → retour fonction motrice pré-AVC
- Récupération motrice selon CIF : récupération de la fonction motrice, même avec des mécanismes de compensation

- Hyperactivité musculaire : gêner la récupération vraie et la récupération fonctionnelle en particulier en aggravant le ‘non use’ dû principalement à la parésie
- Plasticité liée à l’activité peut prévenir cet apprentissage de la non-utilisation
- Tout ce qui améliore la fonction et l’utilisation participe à la récupération

Li 2021, Field-Fote 2015

Effets cumulatifs vs récupération neurologique

Clinical Rehabilitation 2002; **16**: 654–660

Are we underestimating the clinical efficacy of botulinum toxin (type A)? Quantifying changes in spasticity, strength and upper limb function after injections of Botox® to the elbow flexors in a unilateral stroke population

Anand D Pandyan Department of Physiotherapy Studies, Keele University, **Philippe Vuadens** Clinique Romande de Réadaptation, Sion, Switzerland, **Frederike MJ van Wijck** Centre for Rehabilitation and Engineering Studies (CREST), University of Newcastle, **Sandra Stark** Hunters Moor Regional Neurological Rehabilitation Centre, Newcastle upon Tyne, **Garth R Johnson** and **Michael P Barnes** Centre for Rehabilitation and Engineering Studies (CREST), University of Newcastle, Newcastle upon Tyne, UK

Received 22nd March 2001; returned for revisions 15th May 2001; revised manuscript accepted 21st June 2001.

Conclusion: Treatment with Botox® reduces spasticity but does not necessarily cause a reduction in the force generating capabilities at the joint. The improvement in strength may have contributed to the improvements in upper limb function. The MAS is an inappropriate measure of spasticity.

Effets cumulatifs vs récupération neurologique

European Journal of Physical and Rehabilitation Medicine 2024 August;60(4):581-90
DOI: 10.23736/S1973-9087.24.08429-6

ORIGINAL ARTICLE

Post-stroke spasticity: follow-up and functional implications of chronic long-term treatment with botulinum toxin

Marco BATTAGLIA [1, 2] *, Margherita B. BORG [1, 2], Alberto LORO [1, 2], Lucia COSENZA [2], Lorenza SCOTTI [3], Alessandro PICELLI [4], Mirko FILIPPETTI [4], Michele BERTONI [5], Stefania SPINA [6], Andrea SANTAMATO [6], Stefano CARDA [7], Alessio BARICICH [1, 2]

Botulinum toxin is reconfirmed as an effective tool in reducing spasticity in plant flexor muscles, even after multiple treatment cycles.

The integrated post-injection treatment is a key element for therapeutic efficacy and for the maintenance of a more stable functional level over time.

The clinical significance of the agility and balance improvement and fall risk reduction (TUG) remains constant throughout repeated cycles. In contrast, the proportion of patients with improvement in endurance (6MWT) and walking speed (10mWT) after treatment tends to decline over time.

Effets cumulatifs vs récupération neurologique

DEVELOPMENTAL MEDICINE & CHILD NEUROLOGY ORIGINAL ARTICLE

Muscle volume alterations after first botulinum neurotoxin A treatment in children with cerebral palsy: a 6-month prospective cohort study

CAROLINE ALEXANDER[1] | CATHERINE ELLIOTT[2,3] | JANE VALENTINE[2,4] | KATHERINE STANNAGE[5] | NATASHA BEAR[6] | CYRIL J DONNELLY[1] | PETER SHIPMAN[7] | SIOBHAN REID[1]

INTERPRETATION Absolute and normalized muscle volume of the injected muscle reduces after first BoNT-A exposure, and does not return to baseline volume by 25 weeks. Hypertrophy is seen in the soleus up to 25 weeks; the volume of the plantar flexor compartment is stable.

Effets cumulatifs vs récupération neurologique

Journal of Biomechanics 44 (2011) 39–44

Contents lists available at ScienceDirect

Journal of Biomechanics

journal homepage: www.elsevier.com/locate/jbiomech
www.JBiomech.com

Changes in contractile properties of muscles receiving repeat injections of botulinum toxin (Botox)

Rafael Fortuna [a], Marco Aurélio Vaz [b], Aliaa Rehan Youssef [a], David Longino [a], Walter

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A B S T R A C T

Botulinum toxin type A (BTX-A) is a frequently used therapeutic tool to denervate muscles in the treatment of neuromuscular disorders. Although considered safe by the US Food and Drug Administration, BTX-A can produce adverse effects in target and non-target muscles. With an increased use of BTX-A for neuromuscular disorders, the effects of repeat injections of BTX-A on strength, muscle mass and structure need to be known. Therefore, the purpose of this study was to investigate the changes in strength, muscle mass and contractile material in New Zealand White (NZW) rabbits. Twenty NZW rabbits were divided into 4 groups: control and 1, 3 and 6 months of unilateral, repeat injections of BTX-A into the quadriceps femoris. Outcome measures included knee extensor torque, muscle mass and the percentage of contractile material in the quadriceps muscles of the target and non-injected contralateral hindlimbs. Strength in the injected muscles was reduced by 88%, 89% and 95% in the 1, 3 and 6 months BTX-A injected hindlimbs compared to controls. Muscle mass was reduced by 50%, 42% and 31% for the vastus lateralis (VL), rectus femoris (RF) and vastus medialis (VM), respectively, at 1 month, by 68%, 51% and 50% at 3 months and by 76%, 44% and 13% at 6 months. The percentage of contractile material was reduced for the 3 and 6 months animals to 80–64%, respectively, and was replaced primarily by fat. Similar, but less pronounced results were also observed for the quadriceps muscles of the contralateral hindlimbs, suggesting that repeat BTX-A injections cause muscle atrophy and loss of contractile tissue in target muscles and also in non-target muscles that are far removed from the injection site.

Effets cumulatifs vs récupération neurologique

toxins

MDPI

Article

Long-Term Management of Post-Stroke Spasticity with Botulinum Toxin: A Retrospective Study

Nicoletta Falcone [1,*], Fabrizio Leo [2], Carmelo Chisari [1] and

Abstract: Stroke-induced spasticity is a prevalent condition affecting stroke survivors, significantly impacting their quality of life. Botulinum Toxin A injections are widely used for its management, yet the long-term effects and optimal management strategies remain uncertain. This retrospective study analyzed medical records of 95 chronic stroke patients undergoing long-term BoNT-A treatment for spasticity. Demographic data, treatment duration, dosage variability, and dropout rates were assessed over a period ranging from 2 to 14 years. The study revealed a notable extension of the interval between BoNT-A injections throughout the treatment duration. Dropout rates peaked during the initial 5 years of treatment, perhaps due to perceived treatment ineffectiveness. Additionally, a trend of escalating dosage was observed across all groups, indicating a potential rise in the severity of spasticity or changes in treatment response over time. BoNT-A injections emerged as the predominant treatment choice for managing post-stroke spasticity. The delayed initiation of BoNT-A treatment underscores the need for heightened awareness among healthcare providers to recognize and manage spasticity promptly post-stroke. Patients' expectations and treatment goals should be clearly defined to optimize treatment adherence, while the observed escalation in dosage and treatment intervals emphasizes the dynamic nature of spasticity and underscores the importance of monitoring long-term treatment outcomes.

Effets cumulatifs vs récupération neurologique

Étudier l'impact au plan morphologique du muscle :

- Étude par IRM après plusieurs cycles d'injection de BT-A : volume? Involution graisseuse?
- Étudier la force musculaire après de nombreux cycles
- Évaluation exhaustive avant chaque ré-injection
- Registre de la spasticité

Co-contractions

Co-contractions

- EMG de surface lors de l'activation volontaire (marche)
- Bloc moteur lorsque possible
- AQM (EMG)
- Gracies (5 étapes avec MTS)

Lamora 2023, Wissel 2018, Chalard 2019

Co-contractions

JRM Journal of Rehabilitation Medicine

J Rehabil Med 2023; 55: jrm4850

ORIGINAL REPORT

EFFECTS OF DIAGNOSTIC TIBIAL NERVE BLOCK AND SELECTIVE TIBIAL NERVE NEUROTOMY ON SPASTICITY AND SPASTIC CO-CONTRACTIONS: A RETROSPECTIVE OBSERVATIONAL STUDY

Jean-Philippe LAMORA, PT, MSc[1,2], Thierry DELTOMBE, MD[3] and Thierry GUSTIN, MD[4]

From the [1]UCLouvain Faculty of Motor Sciences, Place Pierre de Coubertin, BE-1348 Louvain-la-Neuve, Belgium, [2]La Musse School of Physiotherapy, La Renaissance Sanitaire - Hopital La Musse, CS 20119, 27180 Saint-Sebastien de Morsent, France, [3]Physical Medicine and Rehabilitation Department, Université catholique de Louvain, CHU UCL Namur site Godinne, BE-5530 Yvoir, Belgium and [4]Neurosurgery Department, Université catholique de Louvain, CHU UCL Namur site Godinne, BE-5530 Yvoir, Belgium

Conclusion: **Tibial nerve block and neurotomy improve active ankle dorsiflexion, probably by reducing spastic co-contractions. The results also confirmed a long-lasting decrease in spasticity after neurotomy and the predictive value of nerve blocks.**

Co-contractions

all forms of spastic muscle overactivity, Gracies et al. also proposed a 5-step clinical assessment (9). This algorithm consists of both passive (steps 1 and 2) and active (steps 3–5) assessments, including measurement of the active range of motion (XVA) and the MTS scores. The MTS provides a spasticity grade and quantitative measures of the passive maximal range of motion at low speed (XV1), which enables detection of muscle contracture, and the passive angle of catch at the fastest speed (XV3). Using these data, 2 other angles are calculated. The difference XV1–XV3 is called the spasticity angle X and reflects the amount of stretch hyperreflexia. The difference XV1–XVA is the paresis angle Z, which represents the amount of paresis and spastic co-contractions. This last angle is of great interest, as it provides information about the ability to perform a selected movement more precisely than a simple active angle.

Co-contractions

Journal of Electromyography and Kinesiology 25 (2015) 347–354

Contents lists available at ScienceDirect

Journal of Electromyography and Kinesiology

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

Assessment of the ankle muscle co-contraction during normal gait: A surface electromyography study

Francesco Di Nardo [a,*], Alessandro Mengarelli [a], Elvira Maranesi [a,b], Laura Burattini [a], Sandro Fioretti [a]

[a] Department of Information Engineering, Università Politecnica delle Marche, 60131 Ancona, Italy
[b] Posture and Movement Analysis Laboratory, Italian National Institute of Health and Science on Aging (INRCA), 60131 Ancona, Italy

Evaluation of gender-related differences in co-contraction activity of shank muscles during gait

A. Mengarelli, *Student Member, IEEE*, E. Maranesi, V. Barone, L. Burattini, S. Fioretti, *Member, IEEE*, and F. Di Nardo

Réadaptation de la marche après AVC

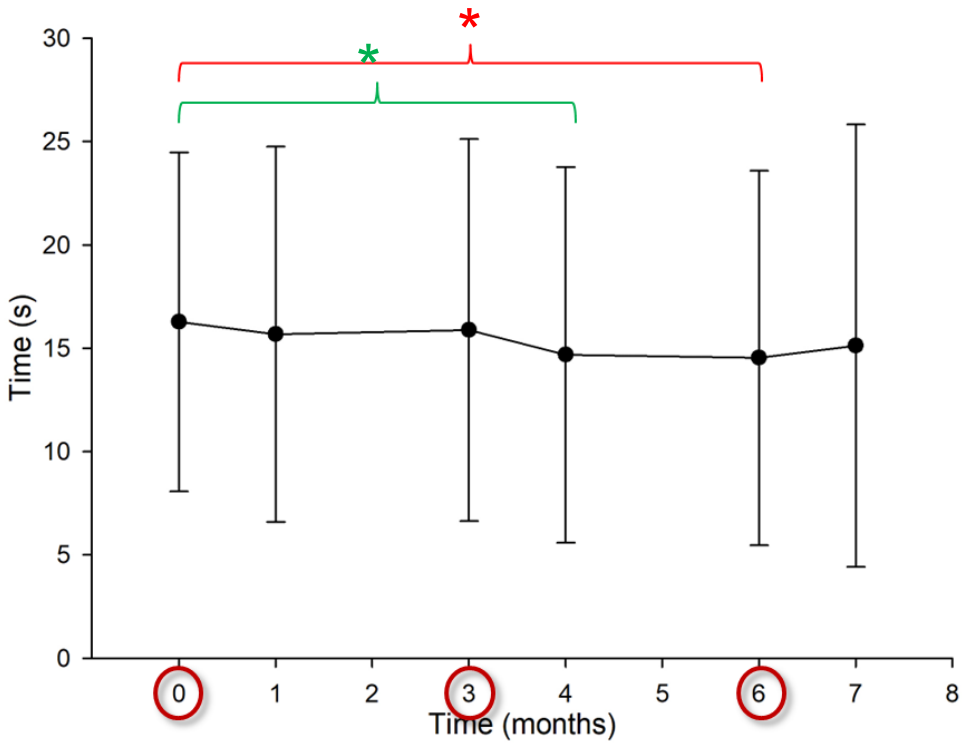
	Fonctions organiques et structures anatomiques
Prédiction de la récupération de la marche	TCT (TWIST) HE-MRC (TWIST)
	Age Description de la lésion Hémianopsie Incontinence urinaire

Évaluation endéans les 2 semaines après AVC → prédiction sur base de la FAC

Verbeek 2014, Winstein 2016, Smith 2017

2. Functional parameters of gait (activities and participation – ICF)

- **10mWT:** time required to walk 10m



- Δ2 = 0.08 m/s
- Δ3 = 0.09 m/s

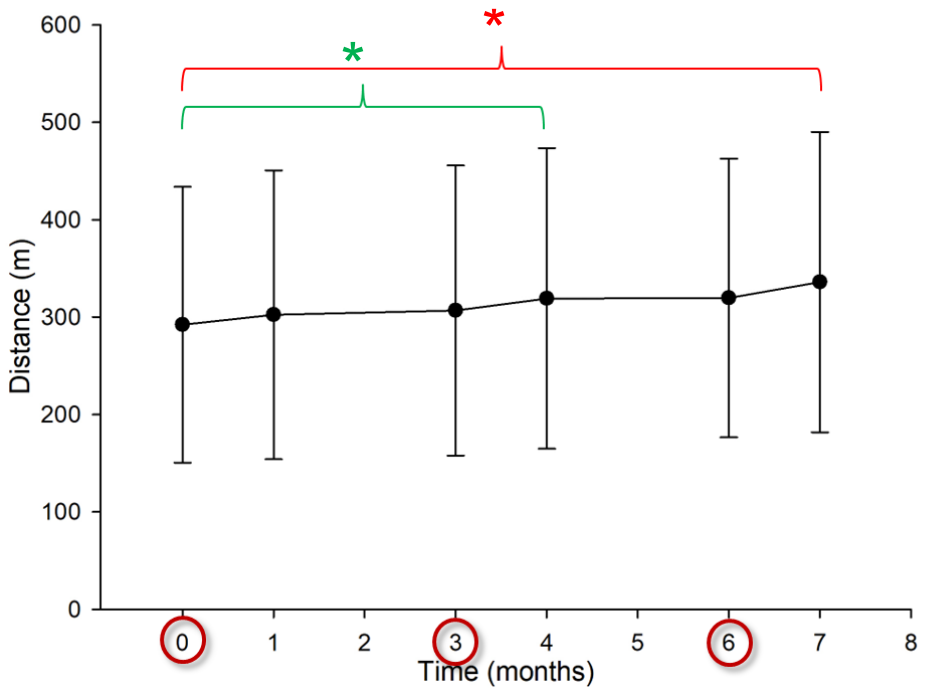
- MCID 10mWT : 0.16 m/s[1]

1. www.srlab.org

* $p < 0.05$

2. Functional parameters of gait

- **6MWT:** distance walked in 6 minutes



- Δ2 = 27 m
- Δ3 = 43,8 m

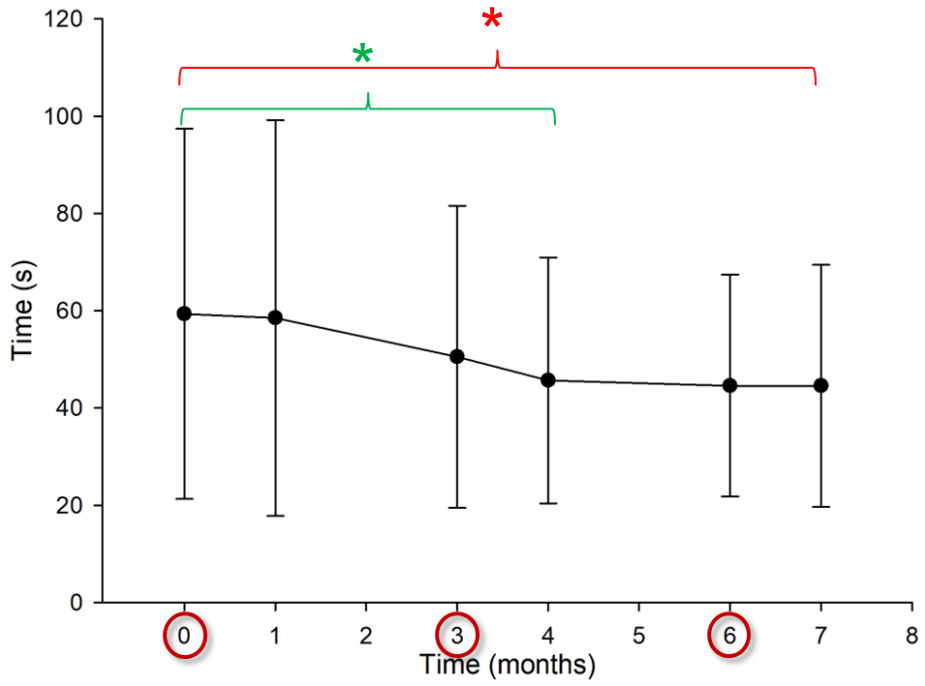
- MCID 6MWT :14-30 m[1]

1. Bohannon et al. 2017

* $p < 0.05$

2. Functional parameters of gait

- **Stairs:** time taken to climb 20 steps (20 cm), up & down



- $\Delta 2$ = 13,7 s
- $\Delta 3$ = 14,8 s

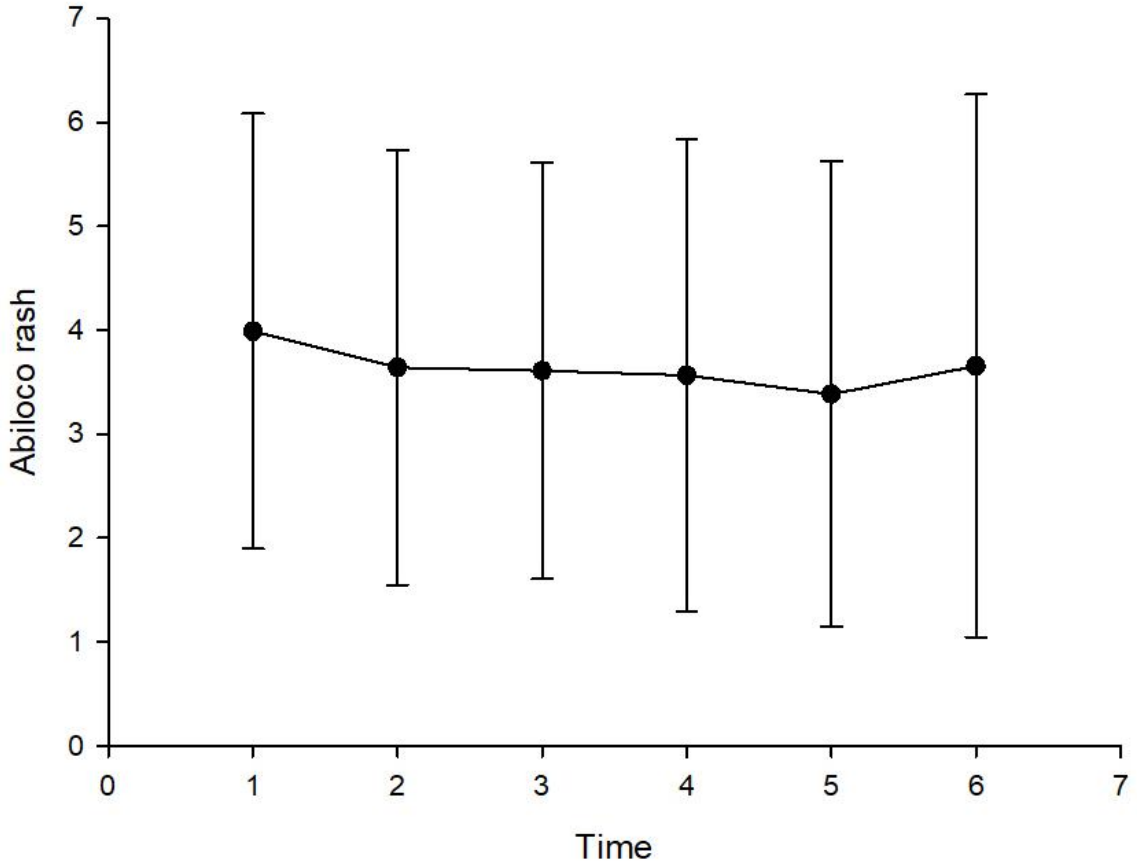
- MDC = 12,5 s[1]

1. Martin et al. 2017

* $p < 0.05$

2. Activities & participation :

- **Abiloco-rash :** Questionnaire for locomotion abilities



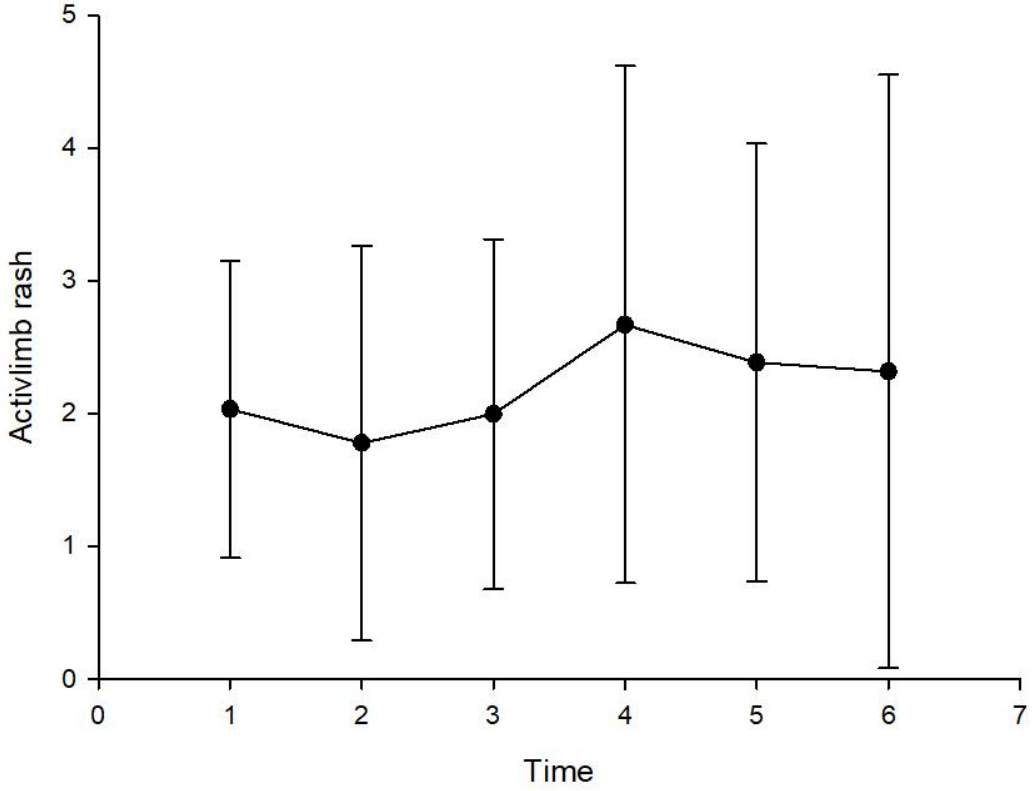
- $\Delta 2 = 0.6$
- MDC = 1,52[1]

1. de Menezes et al. 2019, PM&R

p = 0.61

2. Activities & participation :

- **Activlim-rash:** questionnaire on limitation in activities

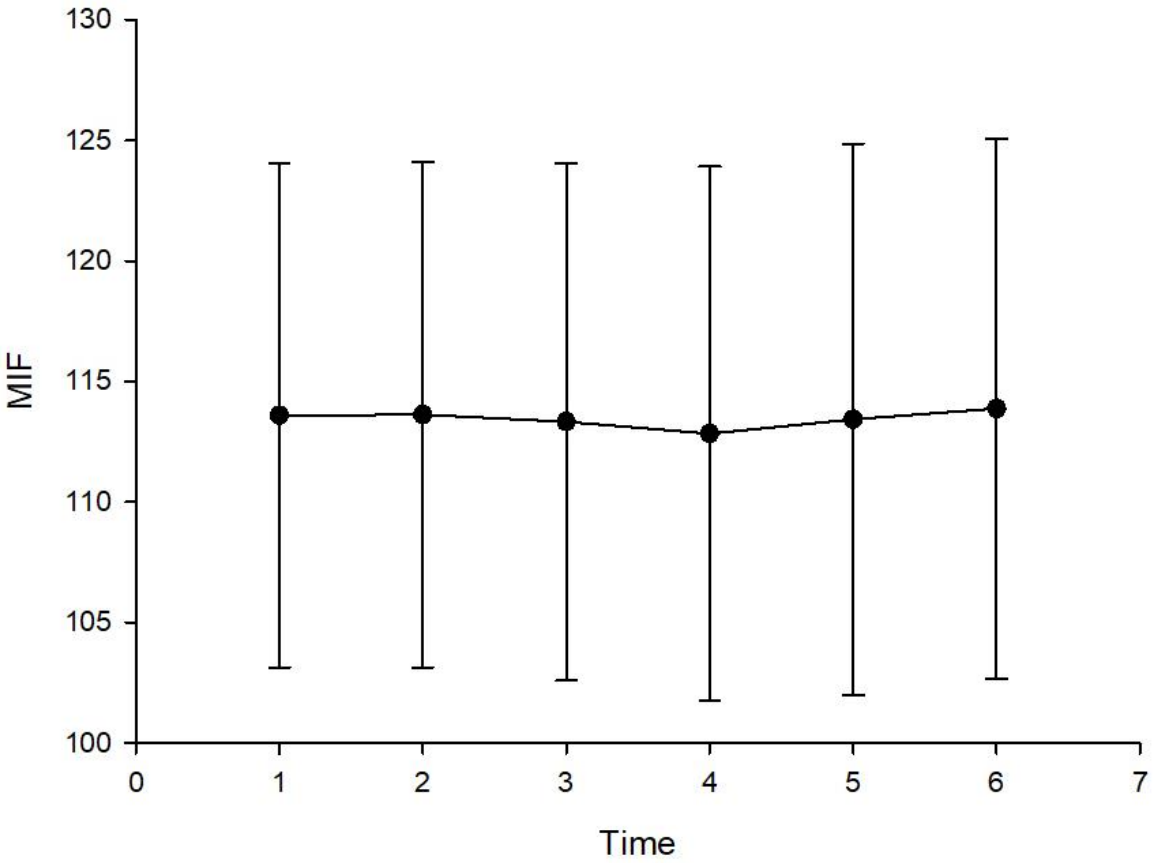


- $\Delta 2 = 0.61$
- MDC = ?

p =0.069

2. Activities & participation :

- **FIM:** functional independence measure



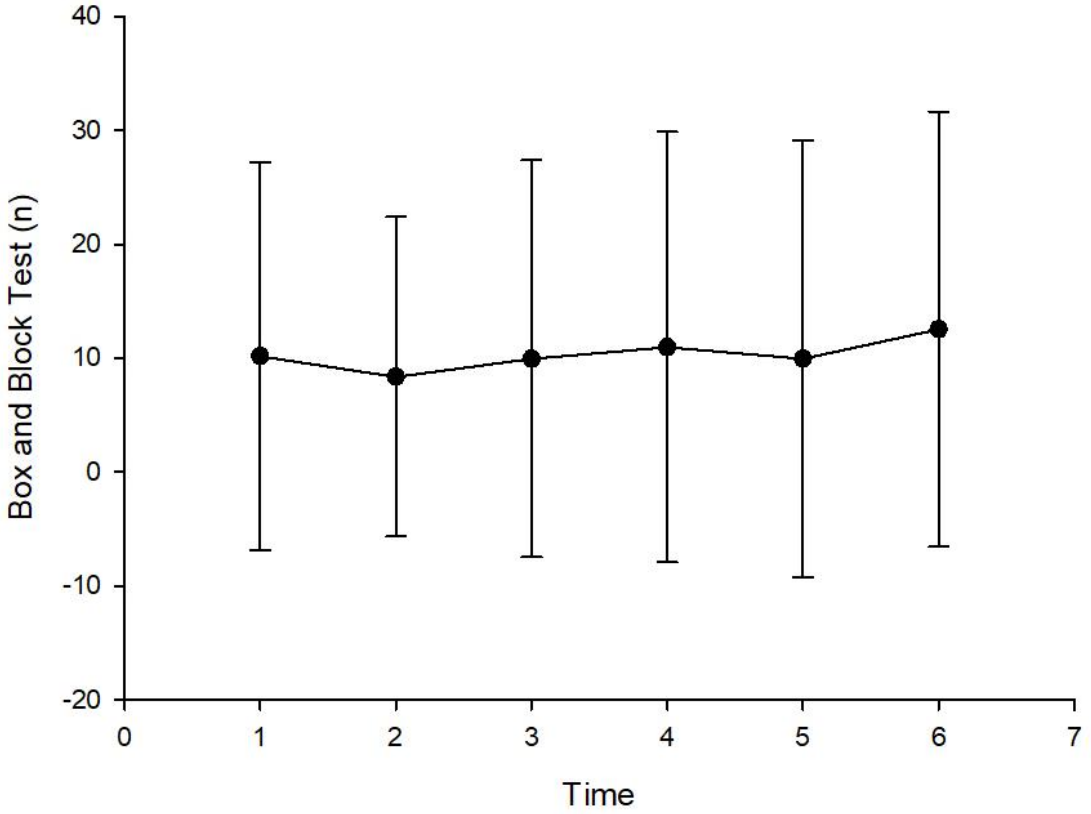
- Δ T1-T6 = 0.3 points
- MDC = 22 points[1]

1. Beninato et al. 2016

* $p < 0.05$

2. Activities & participation : upper-limb activities (ICF):

- **Box & bloc test :** number of blocs displaced in 60 sec



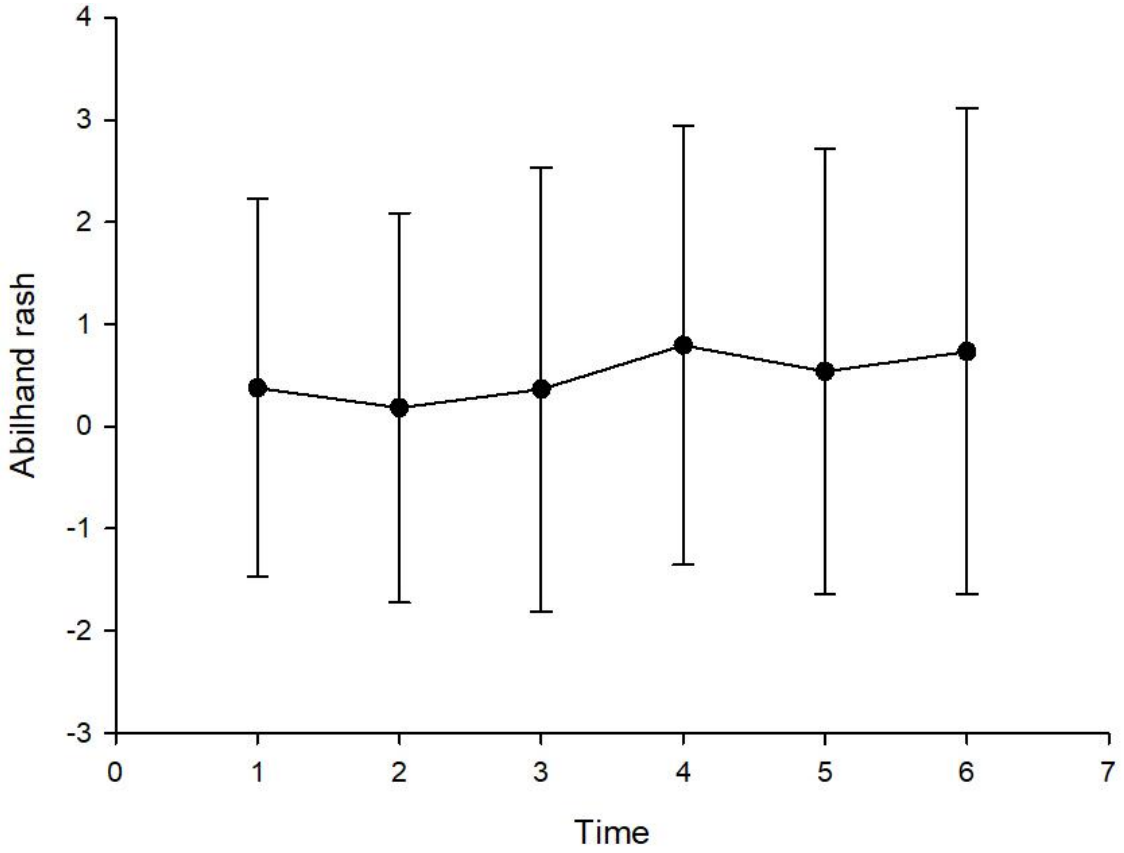
- Δ T1-T6 = 2.4 blocs
- MDC = 5.5 blocs[1]

1. www.srlab.org

p = 0.34

2. Activities & participation : upper-limb function (ICF):

- **Abilhand – rash :** questionnaire to assess bimanual ability

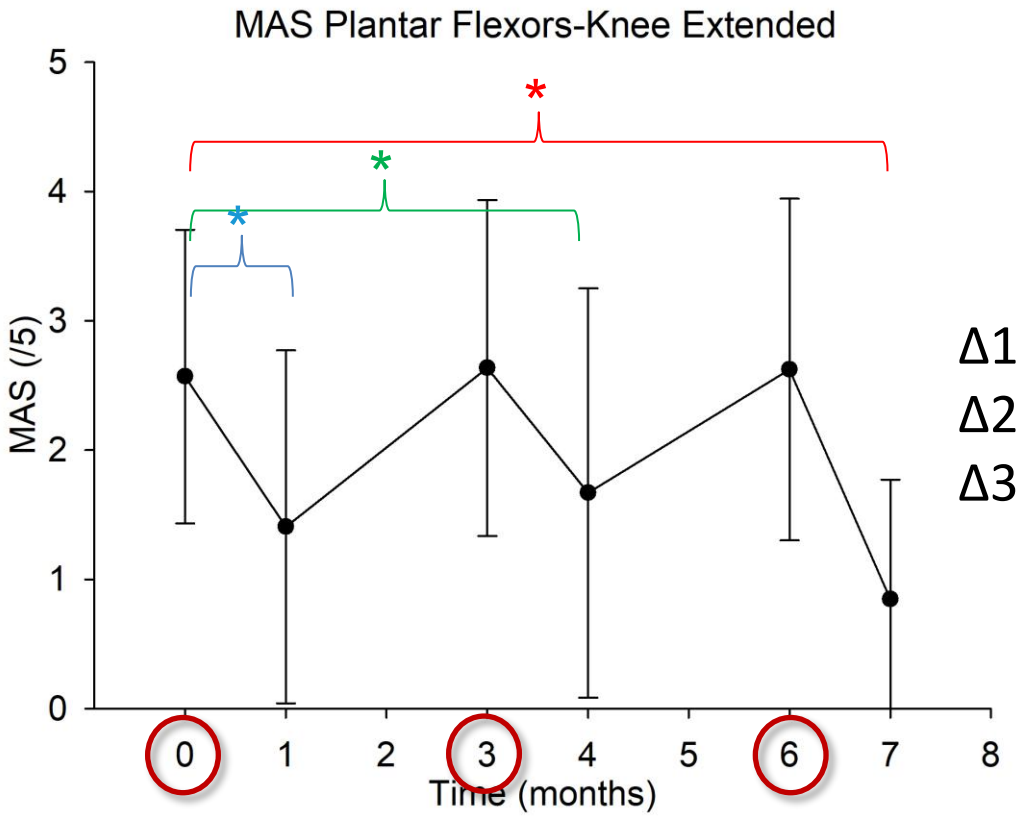


- Δ T1-T6 = 0.36
- MDC = 6.7 [1]

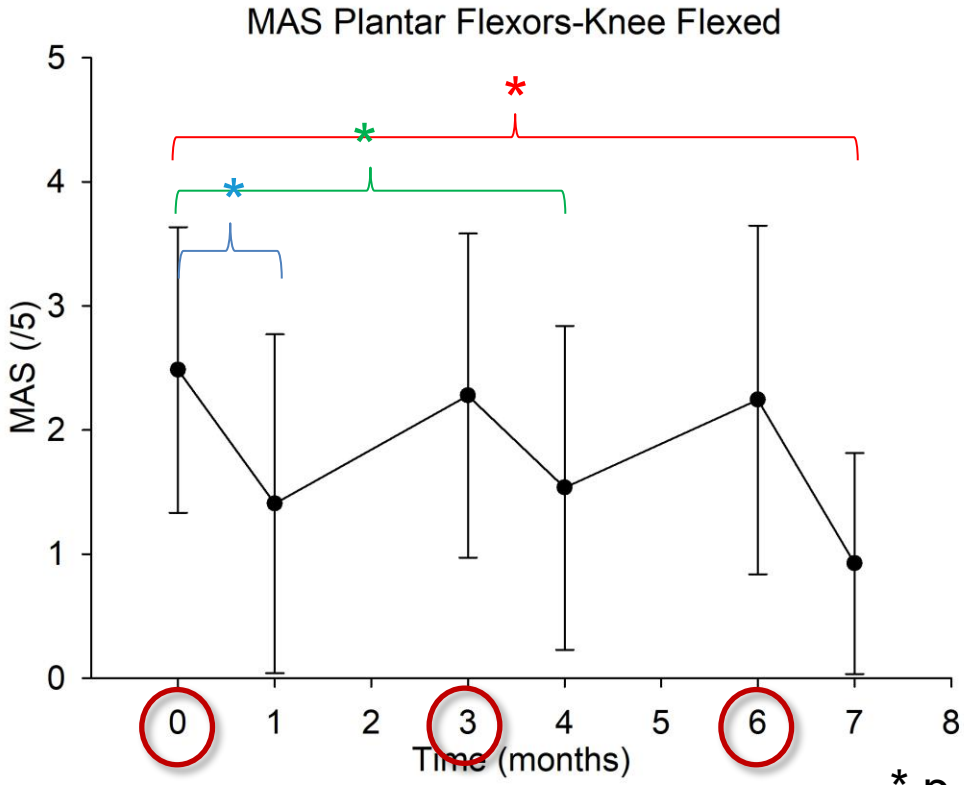
1. www.srlab.org

p = 0.39

3. Impairments : body functions and body structures (ICF):



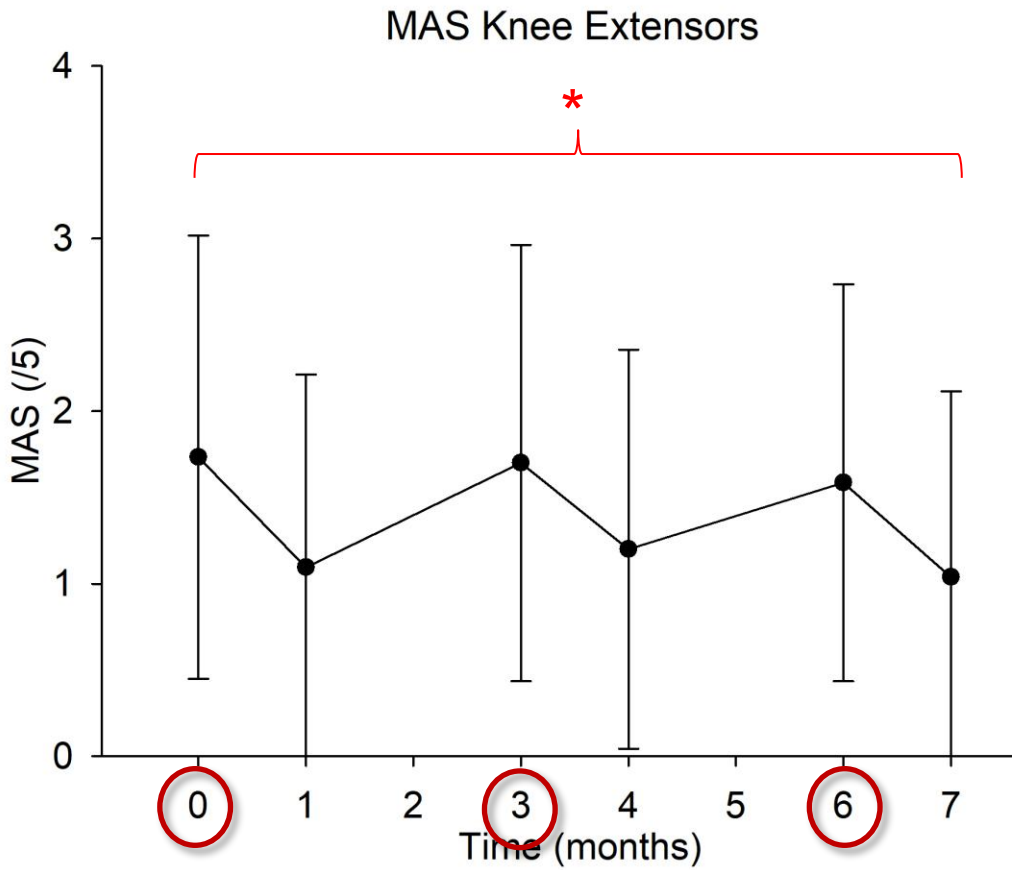
Δ1 = 1,2
Δ2 = 0,9
Δ3 = 1,8



Δ1 = 1,1
Δ2 = 1,0
Δ3 = 1,6

* p < 0.05

3. Impairments : body functions and body structures (ICF):



Δ3 = -0,66

* p < 0.05

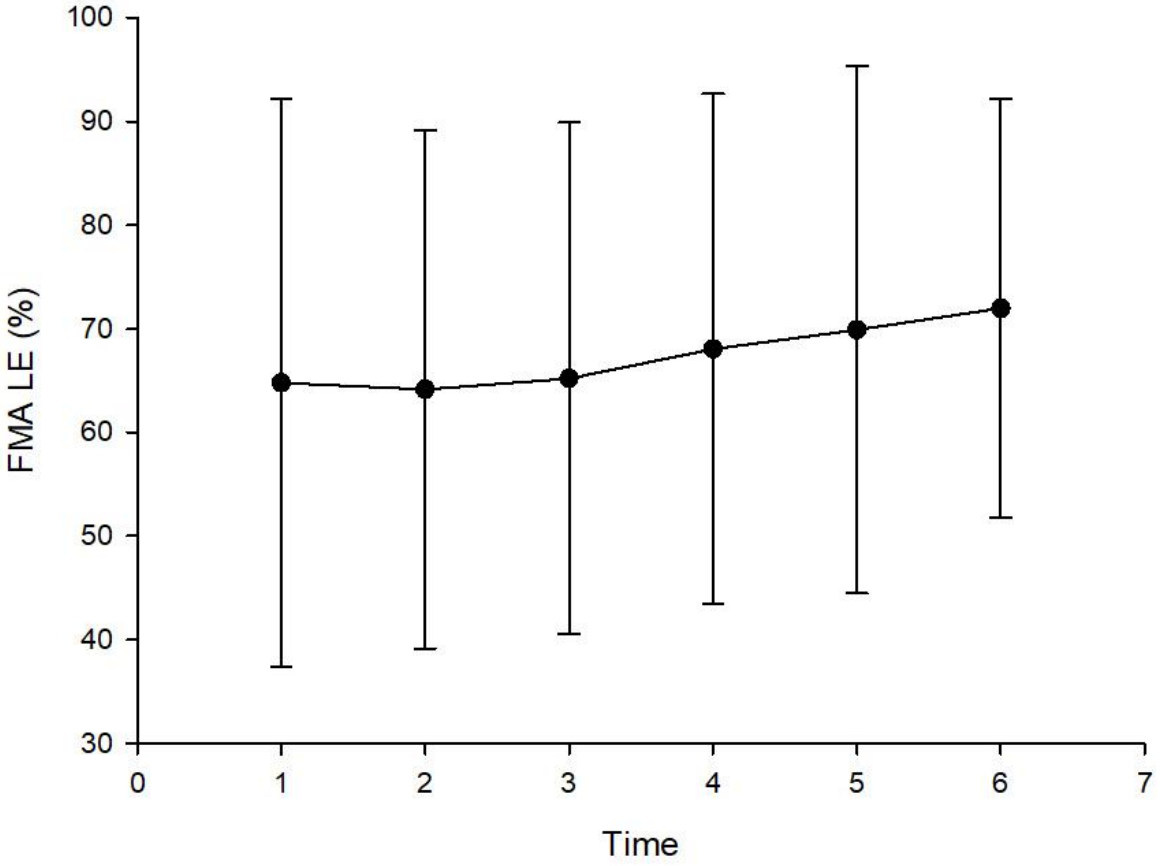
3. Impairments : body functions and body structures (ICF):

- Significant improvement ($p<0.05$) of MAS & MTS V2 & V3 values after 2nd and 3rd injection cycles for upper limb muscle groups :

- Shoulder abductors
- Elbow flexors
- Pronators
- Wrist flexors
- Finger flexors

3. Impairments : body functions and body structures (ICF):

- **FMA-LE:** Functional assessment of the lower limb



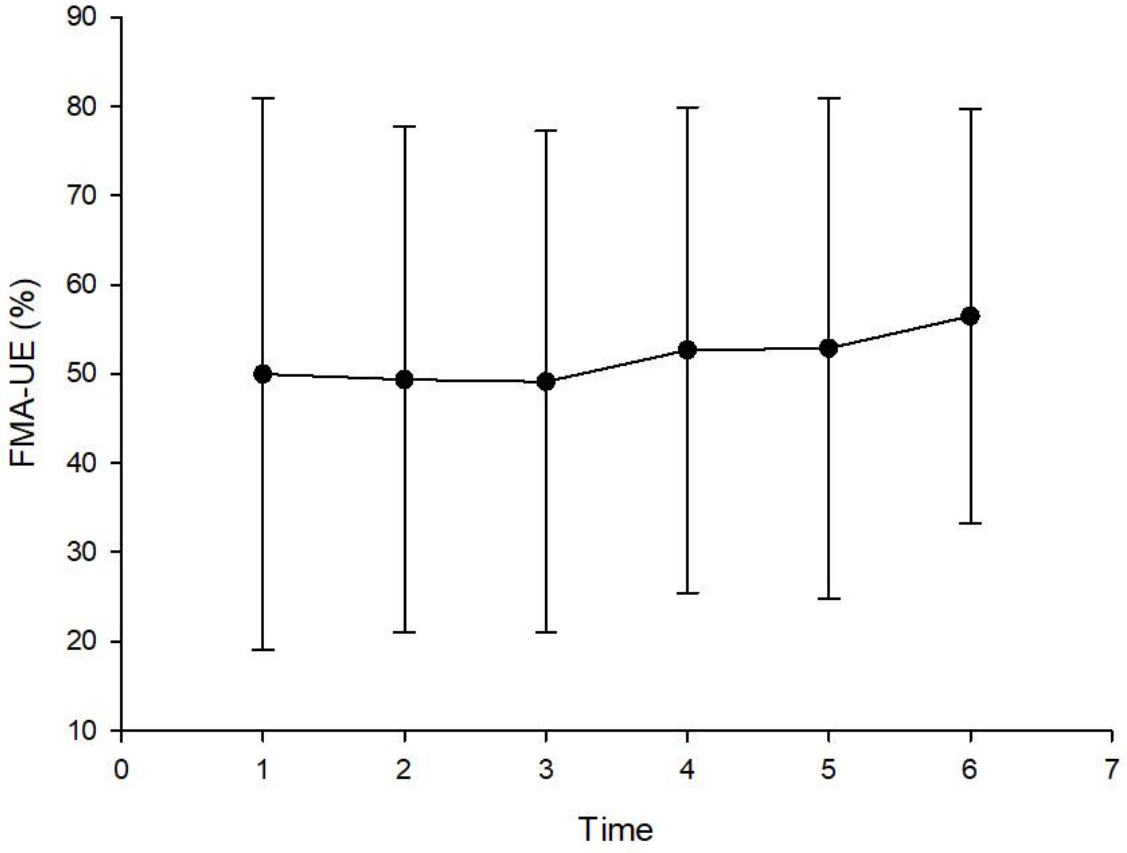
- Δ T1-T6 = 7.19
- MCID = 1.9

1. www.srlab.org

p = 0.21

3. Impairments : body functions and body structures (ICF):

- **FMA-UE:** Functional assessment of the upper limb



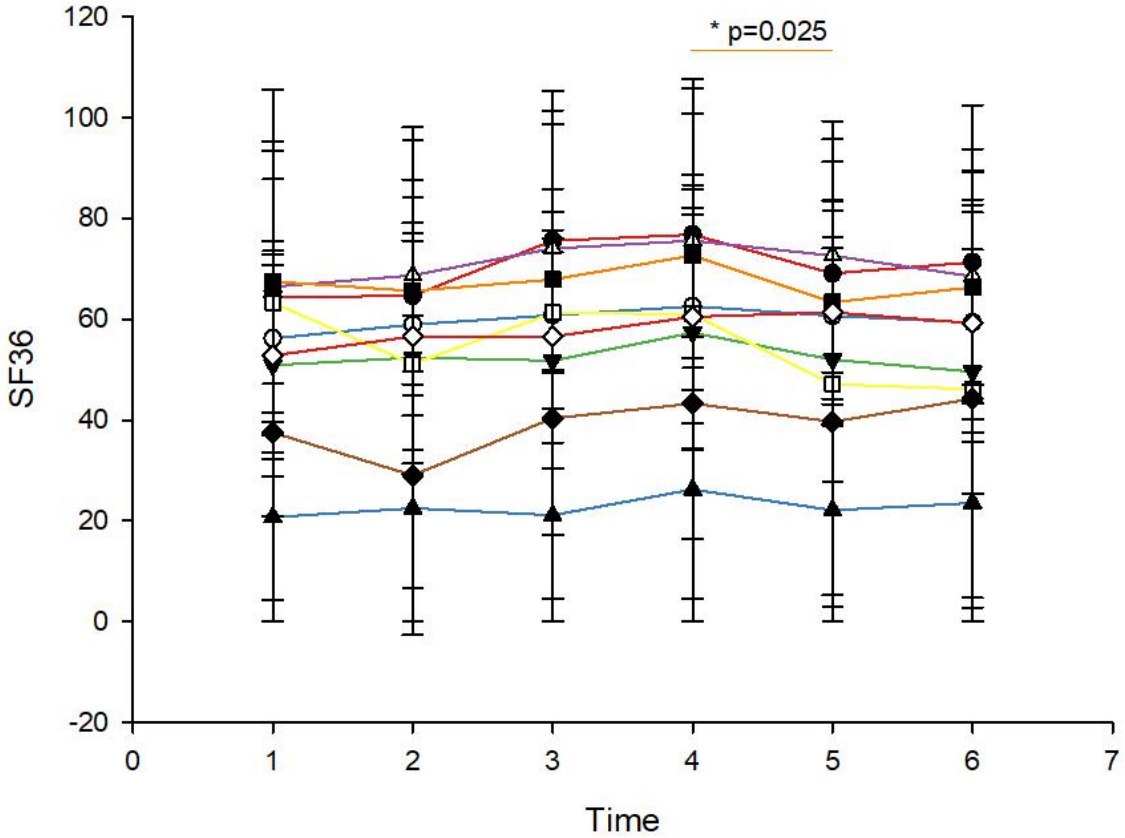
- ∆ T1-T6 = 6.51
- MCID = 1.5

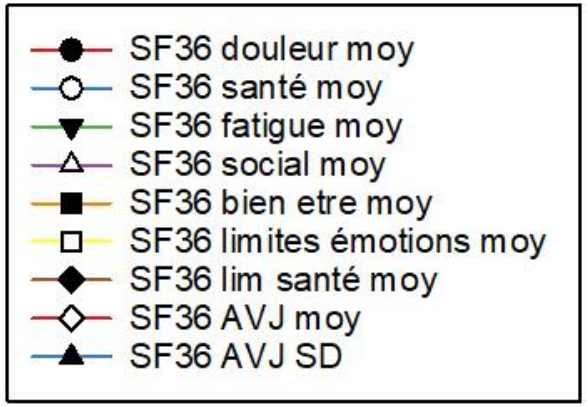
1. www.srlab.org

p = 0.21

4. Quality of life: participation domain (ICF):

- **SF-36:** quality of life questionnaire





- ΔT4-T5 = -9.3
- MDC = (19-45)

1. www.srlab.org

* p < 0.05

Primary outcomes:

- Improvement of functional parameters of gait (**6MWT** and **timed up the stairs test**) after 2nd and 3rd cycle, not after 1st cycle
- **10 m WT** : improvement after 2nd cycle and before 3rd, but not significant after 3rd

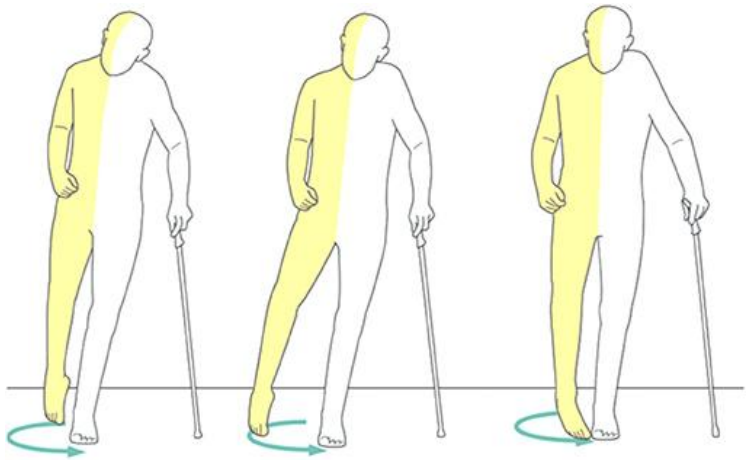
Acta Neurologica Belgica
https://doi.org/10.1007/s13760-020-01320-7

REVIEW ARTICLE

Gait rehabilitation after stroke: review of the evidence of predictors, clinical outcomes and timing for interventions

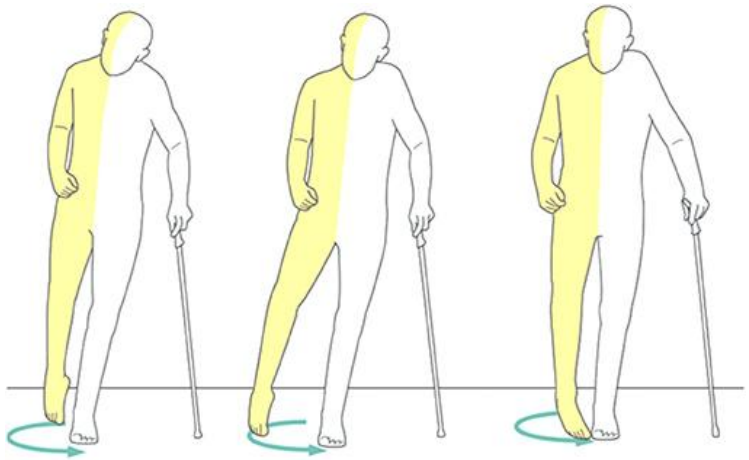
Clara Selves[1,2] · Gaëtan Stoquart[1,2] · Thierry Lejeune[1,2]

Received: 22 November 2019 / Accepted: 27 February 2020



- 30-50% stroke victims → community ambulation
- Indicator of activities and participation domains of the ICF
- Walking performance influenced by **speed** and **endurance** (distance)
- Determinant of level of independence in daily living & general health

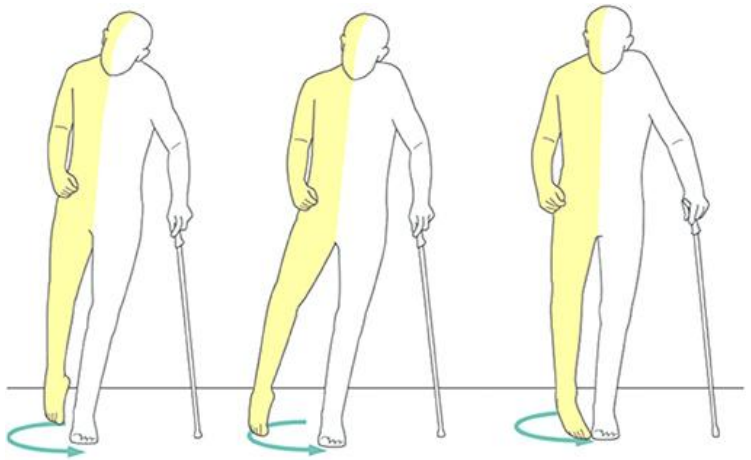
Selves et al., 2020, Acta Neurologica Belgica ; Lord et al., 2008 Clinical Rehabilitation



Predicting **when** and **if** a stroke victim will walk is of great interest :

- Managing patient and family's expectations
- Planning rehabilitation program and duration
- In patient rehabilitation duration and discharge destination

Selves, Stoquart, Lejeune, Acta Neurologica Belgica, 2020



KNGF guidelines: recovering gait 6 months post-stroke : predicted by evaluating **sitting balance** and **leg function** within 1–2 weeks post stroke :

- sitting balance item of the trunk control test (TCT) = 25 points
- motricity index ≥ 25 points or lower limb Fugl-Meyer (FM) ≥ 19

(Level 1)

Selves, Stoquart, Lejeune, Acta Neurologica Belgica, 2020

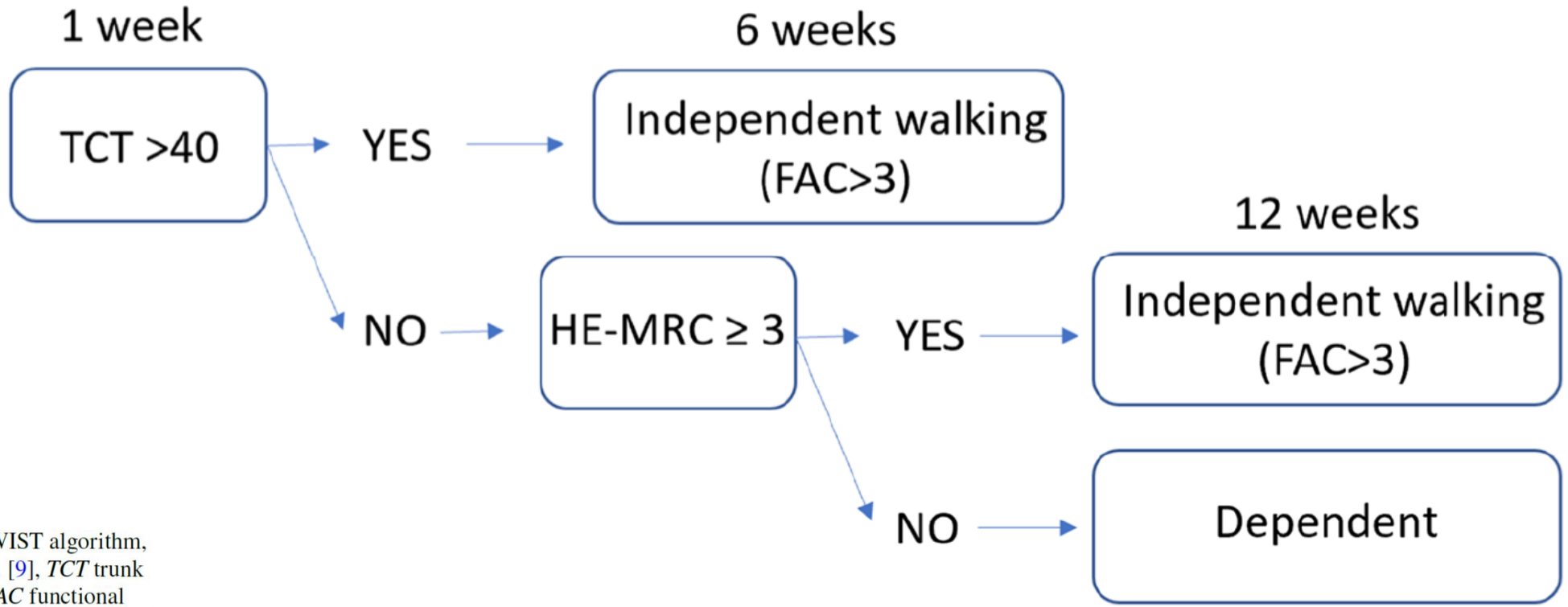


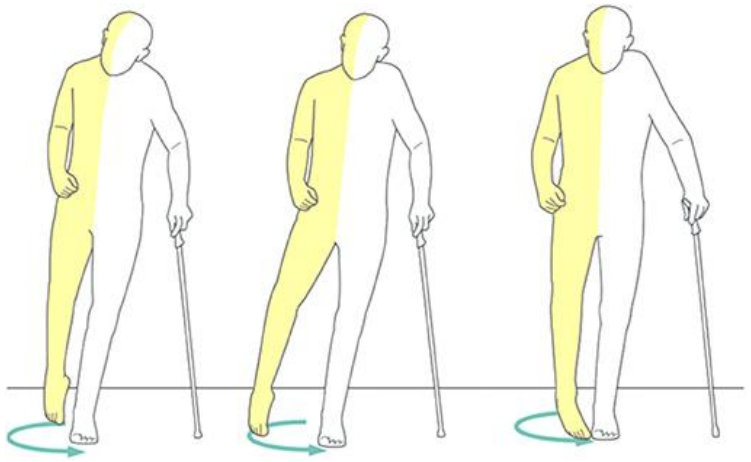
Fig. 1 The TWIST algorithm, by Smith et al. [9], *TCT* trunk control test, *FAC* functional ambulation category, *HE-MRC* hip-extension-Medical Research Council

Selves, Stoquart, Lejeune, Acta Neurologica Belgica, 2020

KEY DESCRIPTIONS

- 4 items:
  1) Rolling to weak side
  2) Rolling to strong side
  3) Balance in sitting position
  4) Sit up from lying down
- Total score range: 0 (minimum) to 100 (maximum, indicating better performance).
- Score of each item: (0, 12 or 25)
  0 = unable to perform movement without assistance.
  12 = able to perform movement, but in an abnormal style, for example, pulls on bed clothes, rope or monkey pole, or uses arms to steady self when sitting.
  25 = able to complete movement normally.
- For the sitting balance item, a patient scores 12 if they need to touch anything with their hands to stay upright, and 0 if they are unable to stay up (by any means) for 30 seconds.
- Total score of TCT = Sum points (rolling to weak side + rolling to strong side + balance in sitting + sit up from lying down) (Collin & Wade,1990)

Classification	Definition
0	Absolute inability to walk even with external help.
1	Requires external help to be able to walk.
2	Only able to walk on flat surfaces and known spaces like home.
3	Able to walk inside and outside of home but limited distances.
4	Able to walk anywhere but with obvious limp or need of technical assistance.
5	Normal deambulation.



Within the first 2 weeks of stroke :

- Young age
- Lesser lower-limb motor impairment
- Less sensory loss
- Absence of hemianopia
- Better sitting balance and trunk control

Selves, Stoquart, Lejeune, Acta Neurologica Belgica, 2020

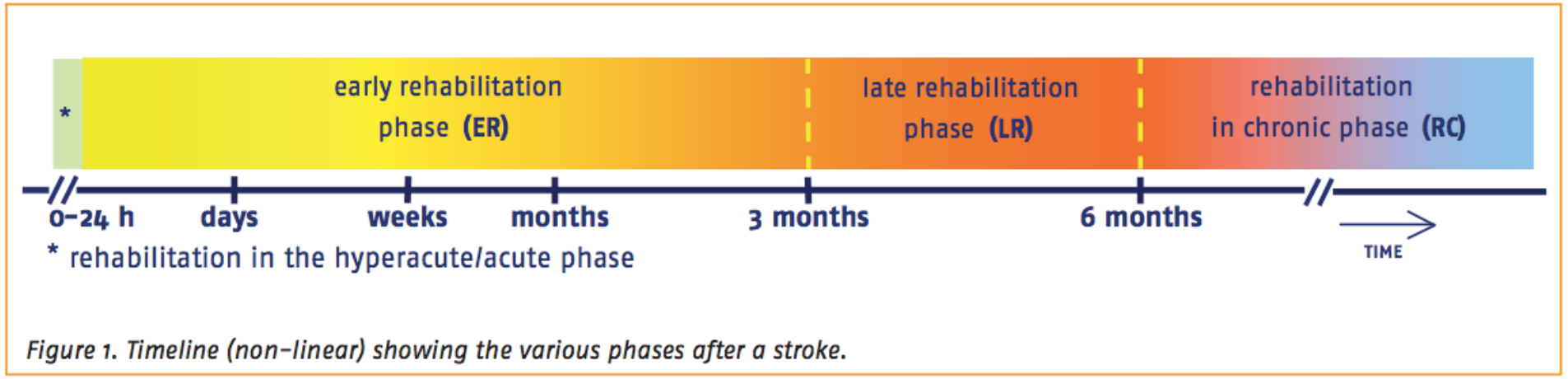


Figure 1. Timeline (non-linear) showing the various phases after a stroke.

Verbeek et al. 2014

Rééducation à la marche :

- Intensive
- Répétitive
- Spécifique à la tâche et au contexte

Recommendations: Mobility	Class	Level of Evidence
Intensive, repetitive, mobility- task training is recommended for all individuals with gait limitations after stroke.	I	A

Verbeek et al. 2014, Winstein et al. 2016

Techniques spécifiques :

Phase hyper-aigue (0-48h) :

- Mobilisations activo-passives dans le lit et si envisageable en dehors
- Exercices assis, de mise en station debout et de marche

- 2-3x/jour

Verbeek et al. 2014, Winstein et al. 2016

Techniques spécifiques :

Phase de rééducation précoce (48h - 3 mois) :

- Marche sur tapis roulant avec ou sans soutien : 20-60 min, 2-3x/sem
- Marche assisté par robotique : 30-60 min, 3-5x/sem, 4-8 sem
- Réalité virtuelle : en plus d'autres techniques
- Circuit-training : 30-90 min, 3-5 x/sem
- Auto-rééducation

Verbeek et al. 2014, Winstein et al. 2016

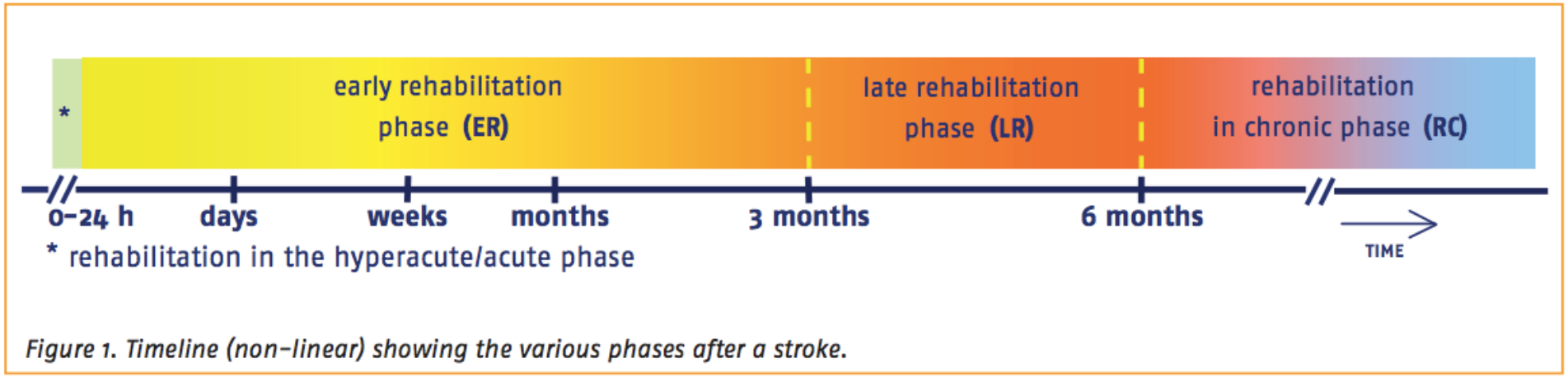


Figure 1. Timeline (non-linear) showing the various phases after a stroke.

Verbeek 2014, Winstein 2016

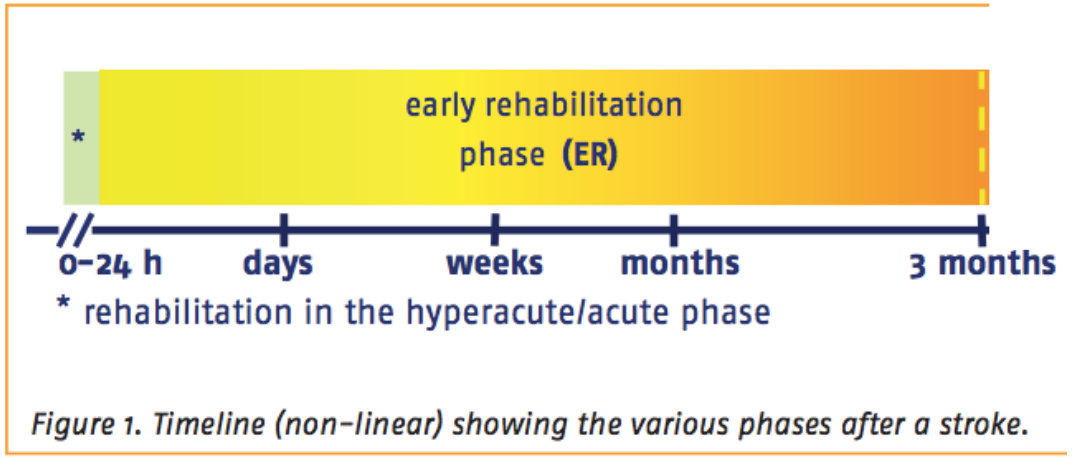
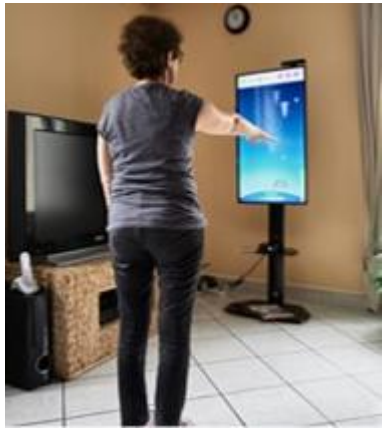
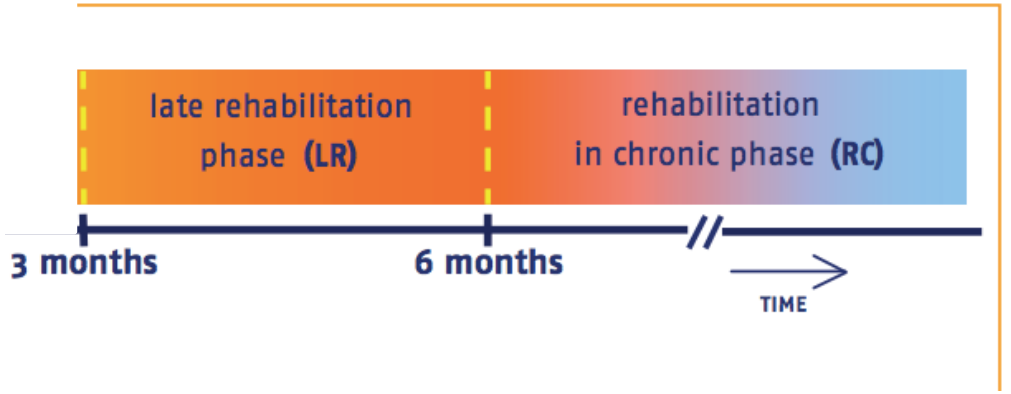
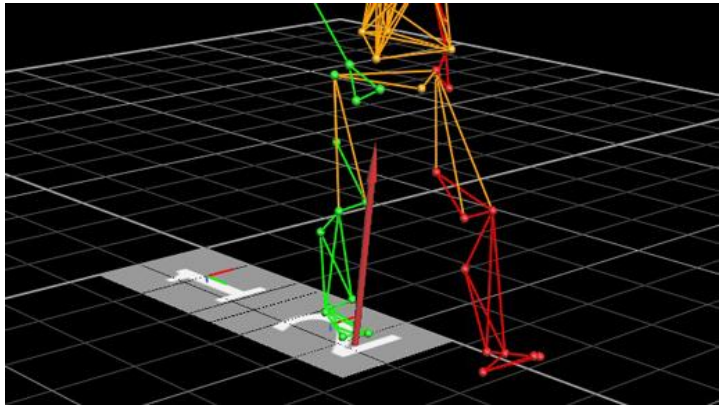


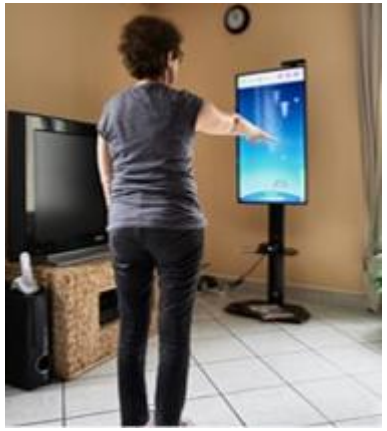
Figure 1. Timeline (non-linear) showing the various phases after a stroke.



Verbeek 2014, Winstein 2016, Selves 2019







Verbeek 2014, Winstein 2016, Selves 2019

Évaluation

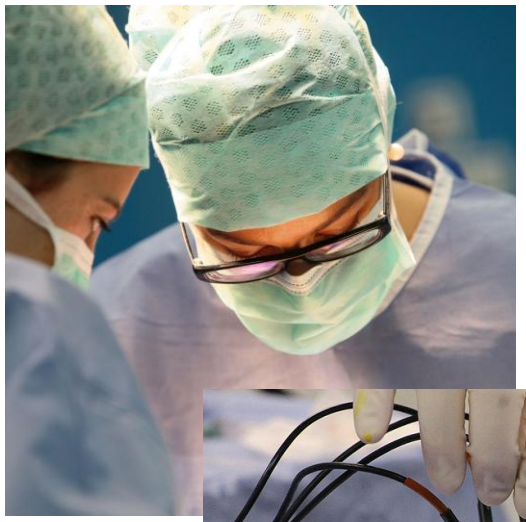
Bloc nerveux :

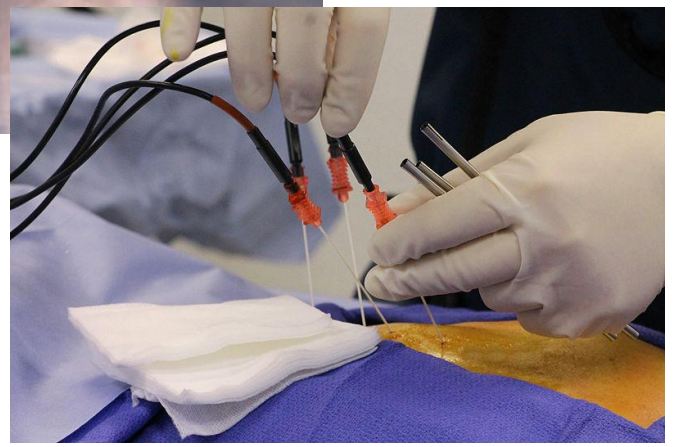
DNB : composantes neurales

1. Deltombe et al. 2017, JRM 2. Filippetti et al. 2022, JRM

Composantes neurales

Composantes neurales et non neurales





Composantes neurales et non neurales

Pourquoi cette thèse?

Gaps cliniques :

- Évaluation de la spasticité
- Distinction entre les composantes neurales et non-neurales

Gaps dans la littérature scientifique :

- Traiter la spasticité, améliore-t-il réellement la marche?

Objectifs et hypothèses

1) Améliorer notre compréhension sur l'évaluation de la spasticité et de la raideur musculosquelettique
2) Améliorer notre compréhension sur les effets de la réduction de la spasticité sur les capacités de marche
3) Valider un outil objectif pour mesurer la raideur musculosquelettique des fléchisseurs du poignet et de la main chez des sujets spastiques post-AVC
4) Évaluer les effets de hautes doses de toxine botulique sur la marche spastique post-AVC

Validité et reproductibilité du w-EOD (outil d'oscillation électromécanique du poignet) dans l'évaluation de la raideur des fléchisseurs de la main

Validity and reliability of the assessment of hand flexors stiffness using a new electromechanical oscillatory device in people with stroke

Clara Selves[a,b], Thierry Lejeune[a,b], Christine Detrembleur[b], Marie-Adeline Haustrate[c] and Gaëtant Stoquart[a,b]

International Journal of Rehabilitation Research 2023, 46:170–177 Received 21 November 2022 Accepted 24 February 2023.

- **Objectif primaire :**

➢ Validation du w-EOD comme outil d'évaluation de l'HR (MAS, Tardieu)

➢ Reproductibilité du w-EOD

W-EOD

Moment de force poignet

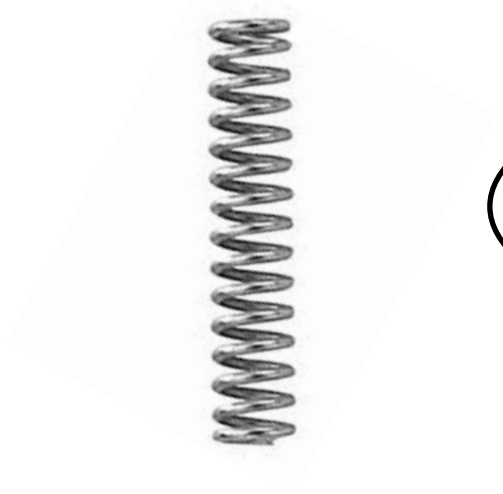
Décomposé

Raideur visqueuse

Raideur élastique

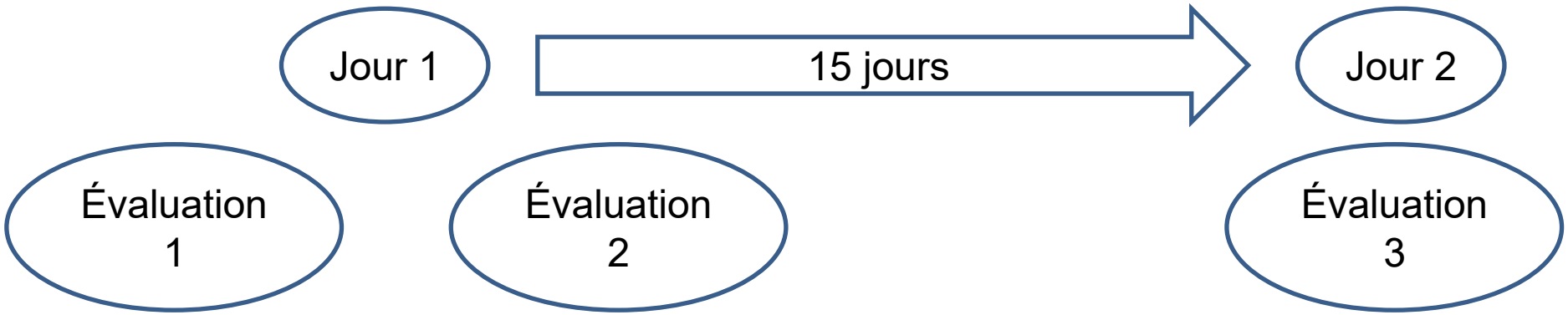
Diagramme de phase

L-path (vecteur de raideur viscoélastique)



*Lobet et al. 2018, Haemophilia, Nguyen et al, 2020, Frontiers in Sports and active living

24 personnes avec HR au MS après AVC



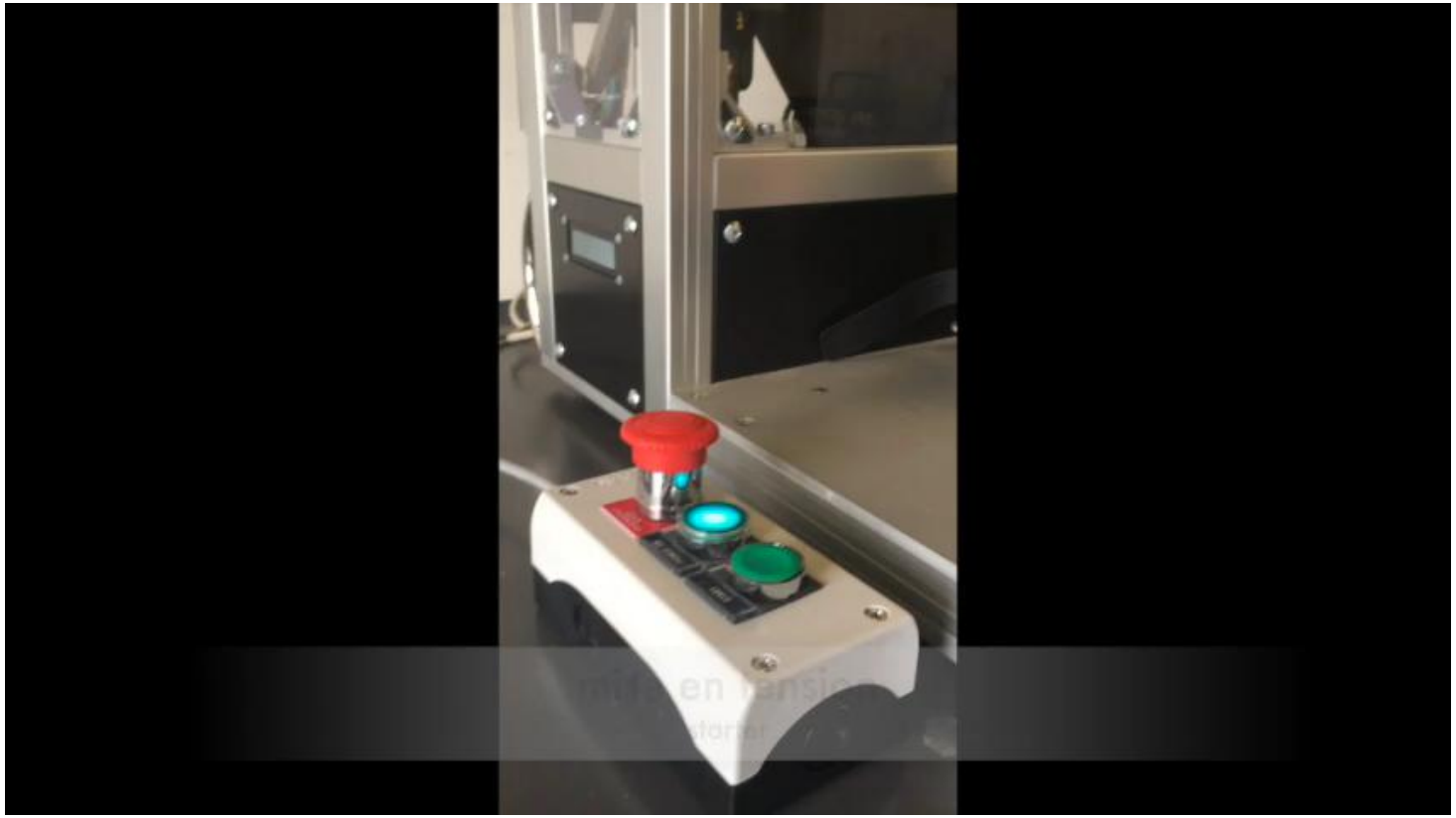
Évaluations :

- ELmax, VI et L-path (w-EOD)
- HR (MAS, MTS)

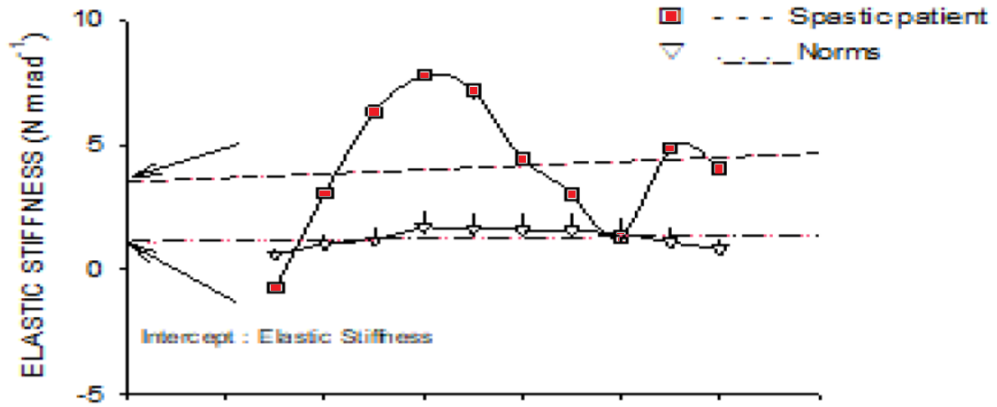
- Côté atteint et moins atteint

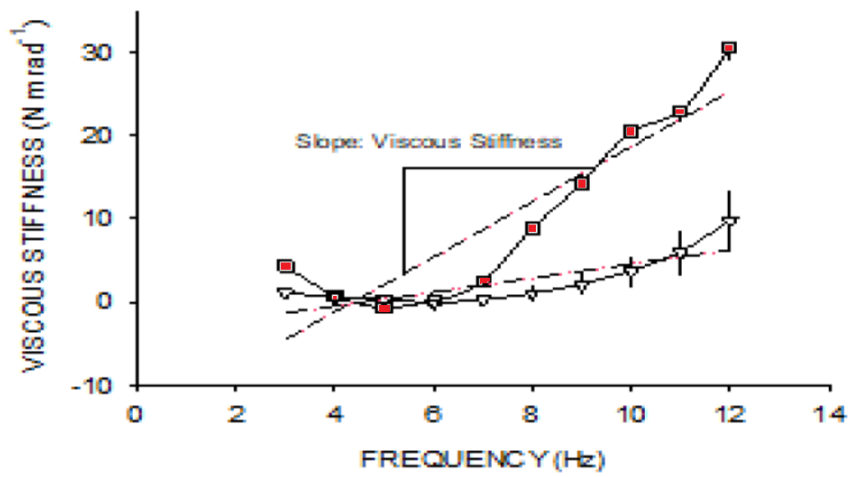
Statistiques:

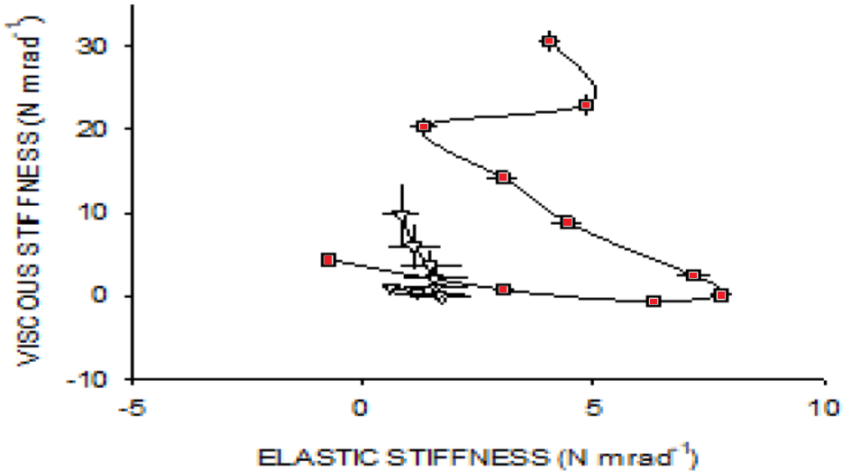
- Validité de construit : corrélation (r) MAS & MTS
- Reproductibilité court et long terme (ICC)



- ROM : -10° to +10°
- 10 oscillations/fréquence, sur 10 fréquences différentes de 3-12 Hz, ordre aléatoire

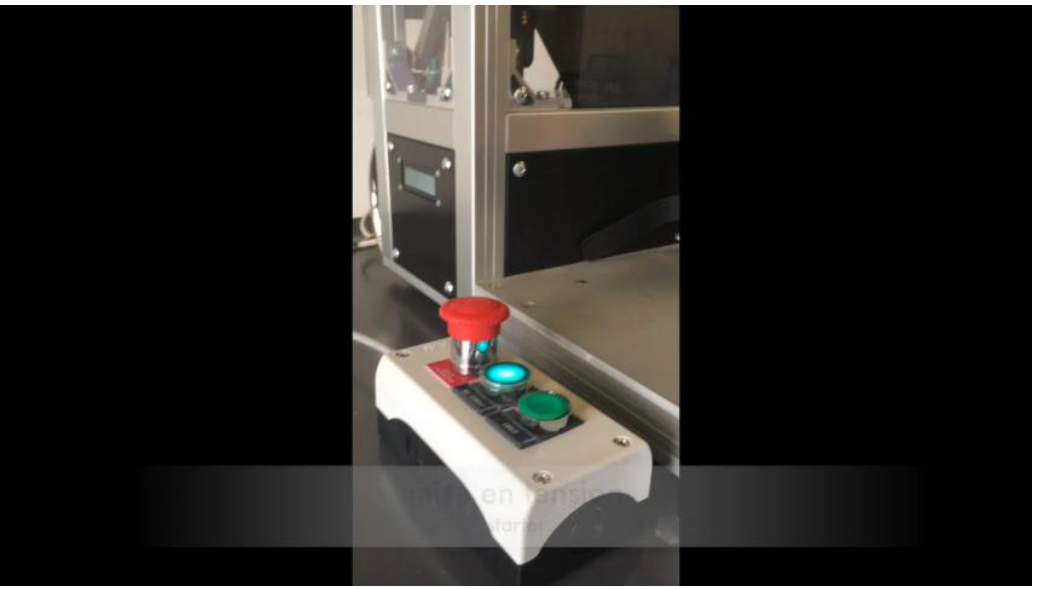






- **ELmax**
- **VI**
- **L-path**

} Influencés par la spasticité



- ROM : -10° to +10°
- 10 oscillations/fréquence, sur 10 fréquences différentes de 3-12 Hz, ordre aléatoire

- **ELmax:** indépendante de la fréquence d'oscillation → ressaut élastique → impactée par l'étirement d'une articulation
- **VI**: dépendante de la fréquence d'oscillation → amortisseur
- **L-path** → Raideur totale → EL vs VI (courbe)

Résultats:

Table 1 Participants characteristics and descriptive statistics

Number of patients (female)	24 (10)
Age, years, mean (min–max)	53.2 (20–76)
Time post-stroke, months, mean (min–max)	32 (1–271.7)
Affected side R/L (*n*)	11/13
Hyper-resistance finger flexors, *n* (MAS, 0/1/2/3/4)	6/1/7/3/6
Hyper-resistance wrist flexors, *n* (MAS, 0/1/2/3/4)	6/1/13/3/1

MAS, Modified Ashworth scale; R/L, right/left.

Résultats: Validité de construit:

- ELmax, VI et L-path : ↑ du côté spastique

Table 2 Mean stiffness values at the three evaluation times

	Hand flexor muscles (affected arm)				Hand flexor muscles (less-affected arm)
	T1	T2	T3	Mean value three assessments	T1
EL_{max} (N m/rad)	3.2 (0.6–7.1) ± 1.6	3.0 (1.0–7.2) ± 1.6	3.1 (1.2–7.8) ± 1.5	3.1 (1.3–6.9) ± 1.4	2.2 (1.0–3.8) ± 0.9*
VI (N m s/rad)	2.1 (3.6–0.7) ± 0.7	1.9 (3.1–0.7) ± 0.5	2.0 (3.2–0.3) ± 0.8	2.0 (3.1–0.7) ± 0.6	1.8 (3.3–0.6) ± 0.7*
L-path (N m/rad)	24.3 (12.0–48.5) ± 7.6	23.1 (10.0–35.4) ± 6.5	23.6 (6.8–43.5) ± 8.3	23.7 (11.0–37.6) ± 6.8	19.9 (9.3–32.5) ± 6.7*

Results are presented in mean (minimal and maximal values) ± SD.
EL_{max}, maximal elastic stiffness; L-path, path length; VI, viscous stiffness.
*$P < 0.001$.

- ELmax, VI et L-path notre population > normes sujets sains (Nguyen et al. 2020)

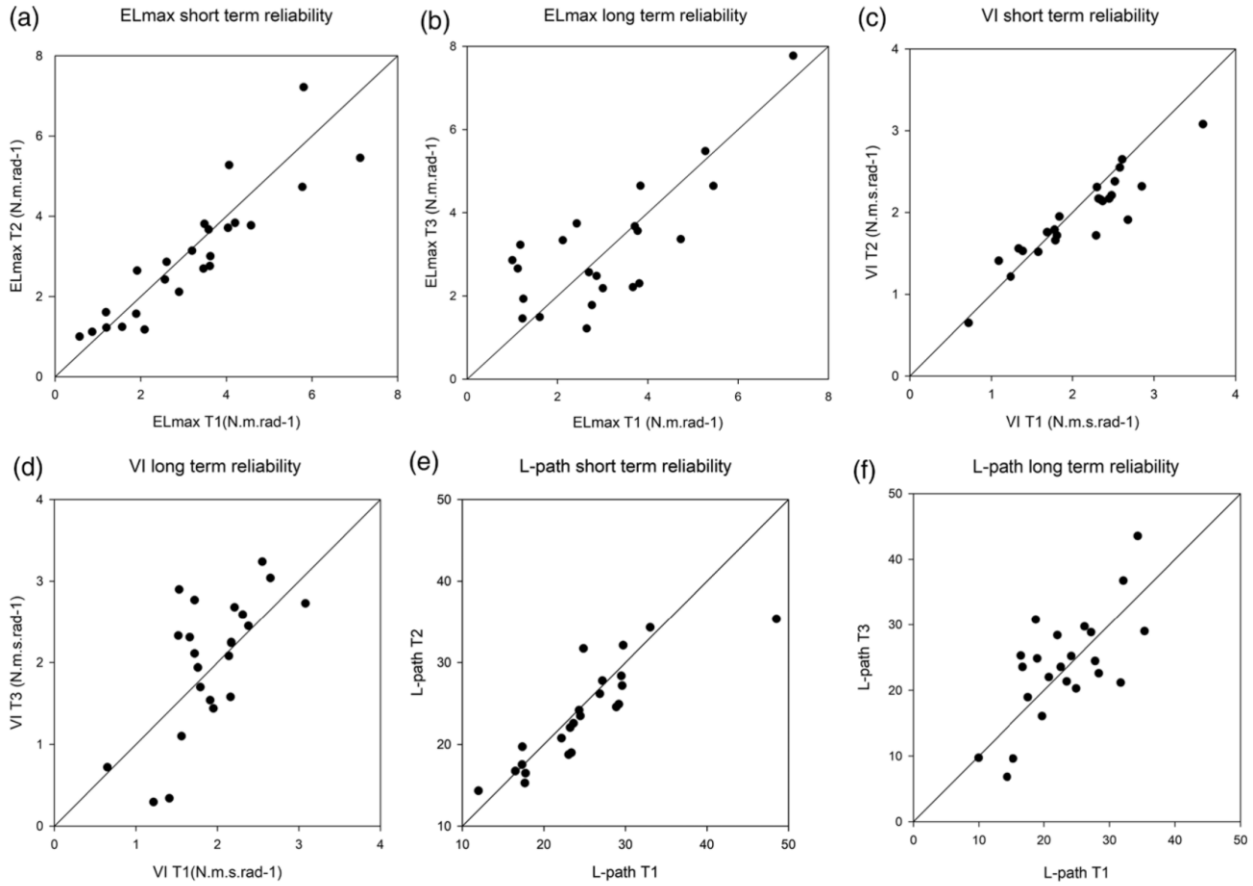
Résultats: Validité de construit :

- Fléchisseurs des doigts:
  - **ELmax** – **MAS** (ρ=0.60, $p<0.05$)
    – **MTS-V2** (ρ=0.56, $p<0.05$)
    – **MTS-V3** (ρ=0.55, $p<0.05$)

- Fléchisseurs du poignet:
  - **ELmax** – **MAS** (ρ=0.49, $p<0.05$)
    – **MTS-V2** (ρ=0.43, $p<0.05$)
    – **MTS-V3** (ρ=0.49, $p<0.05$)

- Pas de corrélation entre VI et L-Path et les échelles cliniques

Résultats: Reproductibilité (ICC):



Discussion: Comparaison à d'autres outils d'évaluation

- **Neuroflexor®** : comp. neurales r = 0.6 avec MAS et 0.36 avec MTD, comp. non-neurales r = 0.5 avec MAS
- **EMG-equipped electronical goniometer** : r = 0.03-0.38 avec MTS
- **Isokinetic dynamometers** : r = 0.45-0.95 avec MAS
- **USE (ultrasound elastography)** : r = 0.55-0.85 avec MAS

Discussion: comparaison à la MAS et MTS

- Corrélation absente ou faible entre les divers outils objectifs d'évaluation de la raideur et les échelles cliniques (MAS et MTS)
- Limites des échelles cliniques : Gold-standard de la mesure de la spasticité ?
- Pas de consensus concernant la méthode d'évaluation

- Raideur plus importante dans le membre affecté (**ELmax** : 31.3%, **VI** : 14.3%, **L-Path** : 18.1%, p<0.01).
- Corrélation modérée à bonne avec les échelles cliniques

Outil valide

- **Outil reproductible**
- Détections de variations de raideur de l'ordre de 20-50% à court et long terme

Effects of 3 cycles of Increasing Botulinum Toxin Doses on Functional Parameters of Post-Stroke Spastic Gait: A Prospective Cohort Study

Original Research Article

NeuroRehabilitation
1–11

DOI: 10.1177/10538135241303343
journals.sagepub.com/home/nre

Effects of 3 Cycles of Increasing Botulinum Toxin Doses on Functional Parameters of Post-stroke Spastic Gait: A Prospective Cohort Study

Clara Selves[1,2], Stéphanie Dehem[1,2], Thierry Lejeune[1,2], Thierry Deltombe[3] and Gaëtan Stoquart[1,2]




- Clinical practice : injection cycles repeated / 3-6 months
- Many studies on **1 injection cycle** on spasticity[1]
- Less clear on function[1]
- Promising results on **several cycles** but very few studies[2]

1. Caty et al. 2008, Bollens et al. 2013, Pittock, et al. 2003, Robertson, et al. 2009, Hutin et al. 2010
2. Bensmail et al. 2010, Gracies et al. 2017, Wissel et al. 2017

Effects of 3 cycles of Increasing Botulinum Toxin Doses on Functional Parameters of Post-Stroke Spastic Gait: A Prospective Cohort Study

Hypothesis:

↑ gait-related activities

↓ HR lower-limb muscle groups

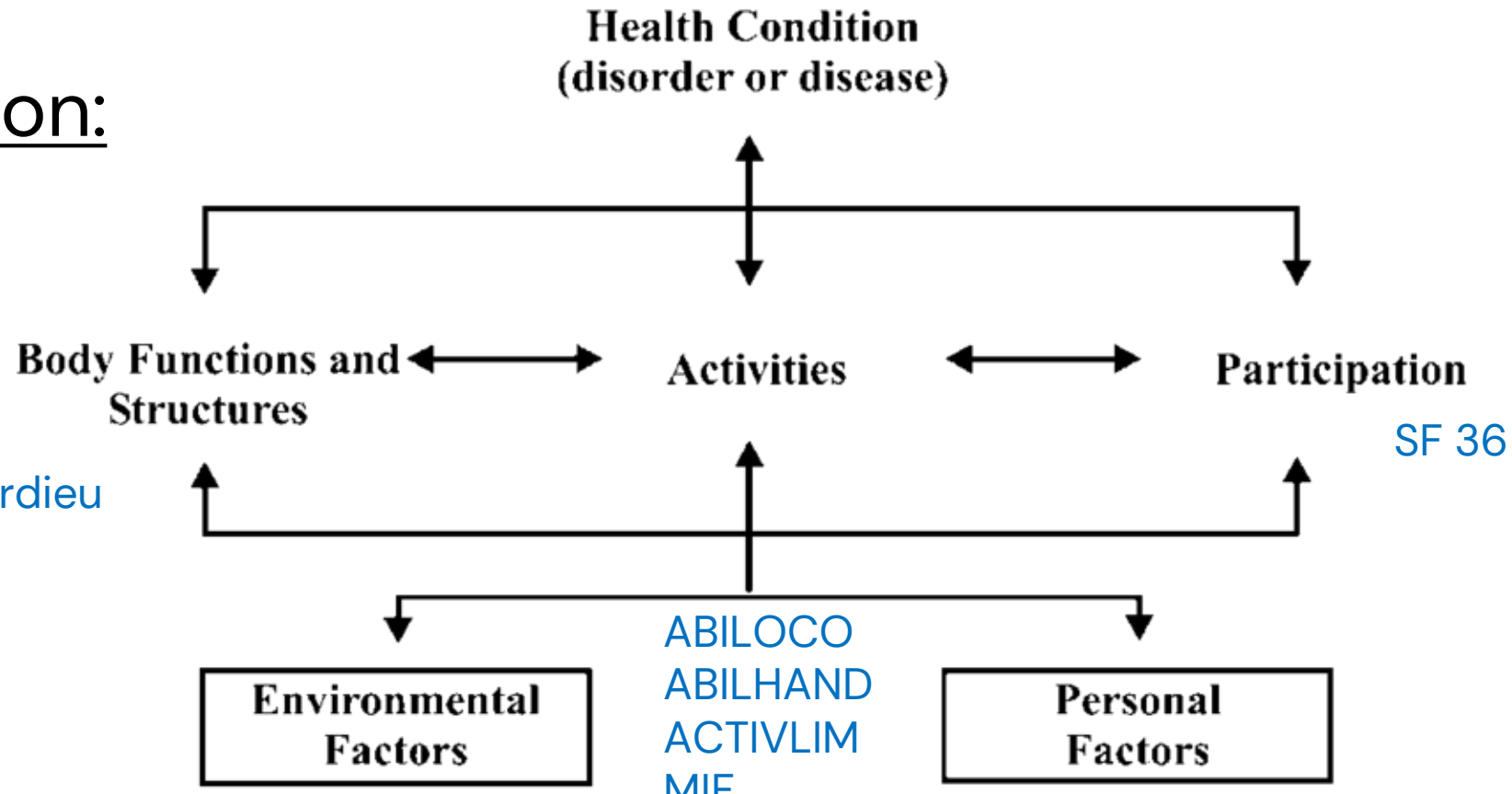
Inclusion Criteria:

- Adults >18 yo
- Hemiparesis (stroke) >3 months
- Lower-limb HR (**plantar flexors** (and) knee extensors) → gait impairment
- Focal chemical denervation indication

Exclusion Criteria:

- Neuromuscular disease
- BoNT injections in the last 3 months

Evaluation:

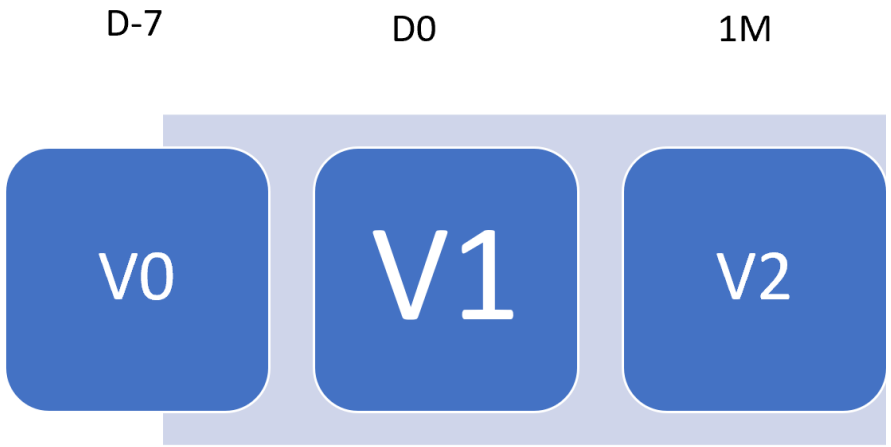


ROM,
MAS, Tardieu
FMA
QGA

(MRI)

ABILOCO
ABILHAND
ACTIVLIM
MIF
10 m walk test
6 min walk test
Stairs
Timed up & go
Box & Block

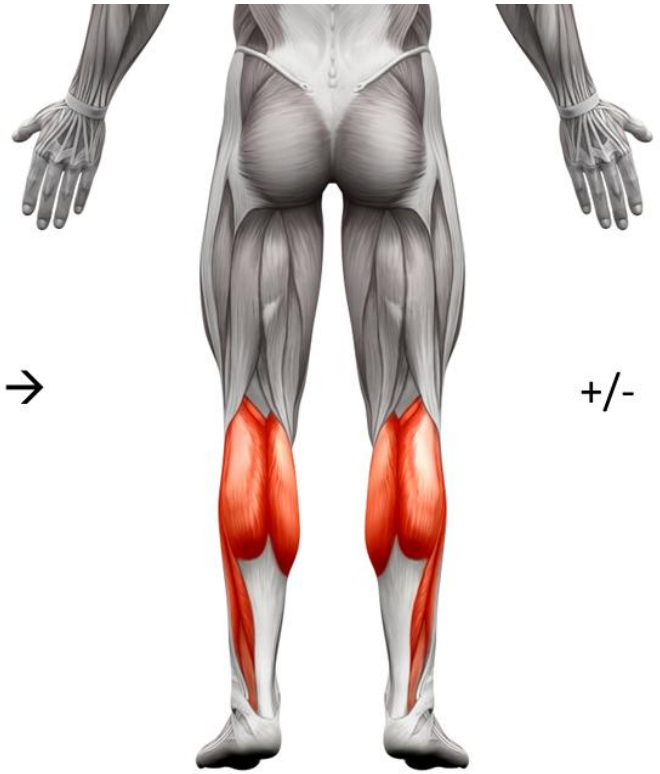
SF 36



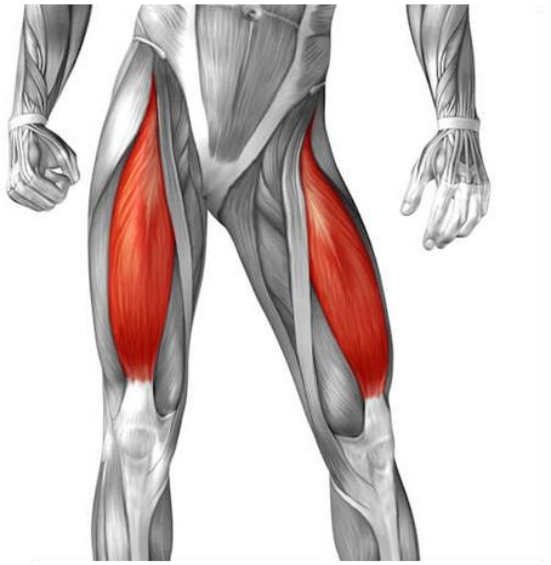
D: day, M: months, V: visit

D: day, M: months, V: visit

→



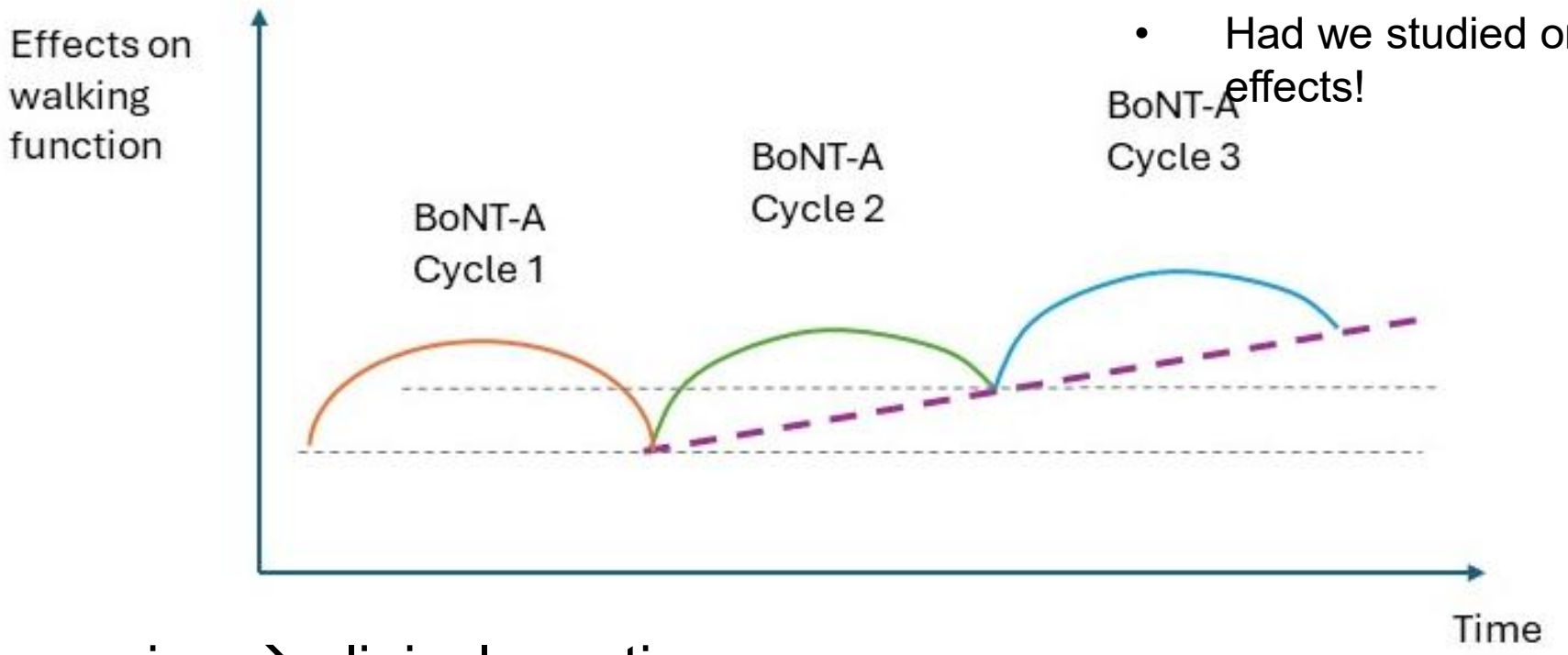
+/-



+/-

Primary outcomes:

- Suggest cumulative and dose-related effects



- Encouraging → clinical practice

- 1st pragmatic cohort study to treat both U & LL with progressively higher doses of Inco BT-A
- Had we studied only 1 cycle = no effects!

Primary outcomes:

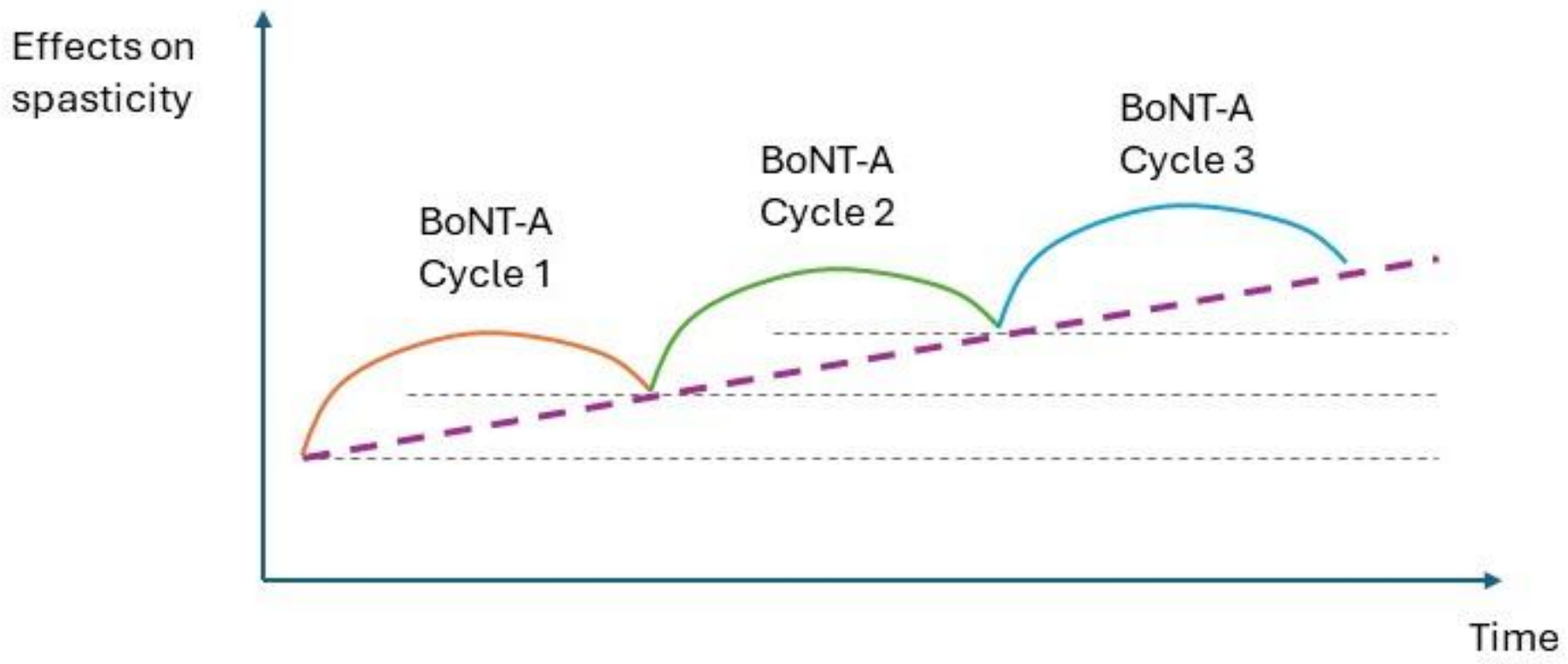
- Limited community ambulators → >225 m (6MWT)
- Unlimited community ambulators → >312 m (6MWT)

	Baseline (V1)	Post cycle 1 (V2)	Post cycle 2 (V4)	Post cycle 3 (V6)
6MWT (m, mean (SD))	292 (141)	302 (148)	319 (154)	336 (154)
Unlimited	41%	44%	47%	63%

* Bohannon et al. 2017

Secondary outcomes:

- Cumulative and dose-related effects

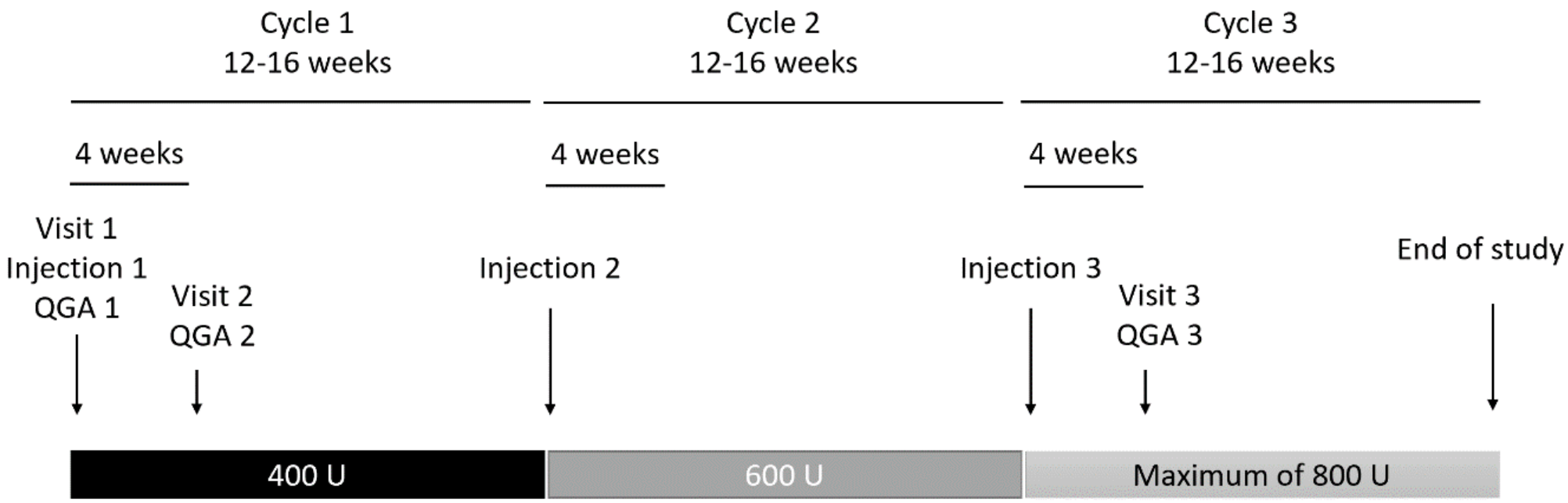


Impact sur les paramètres fonctionnels et biomécaniques de marche

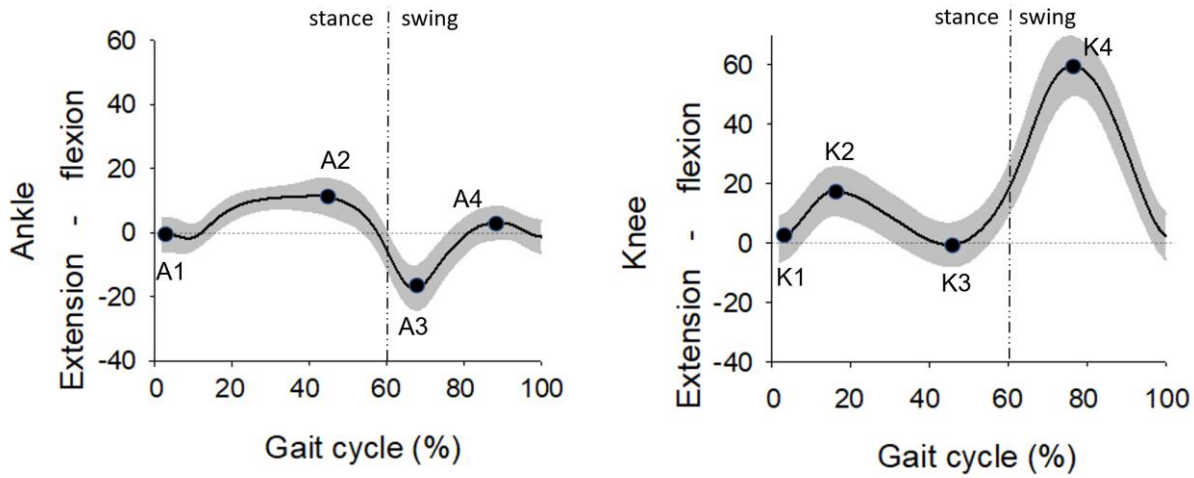
AQM :

- Examen de référence
- Variables cinématiques, cinétiques, électromyographiques, mécaniques et énergétiques
- Évaluer l'efficacité des injections de toxine botulique sur la cheville et le genou

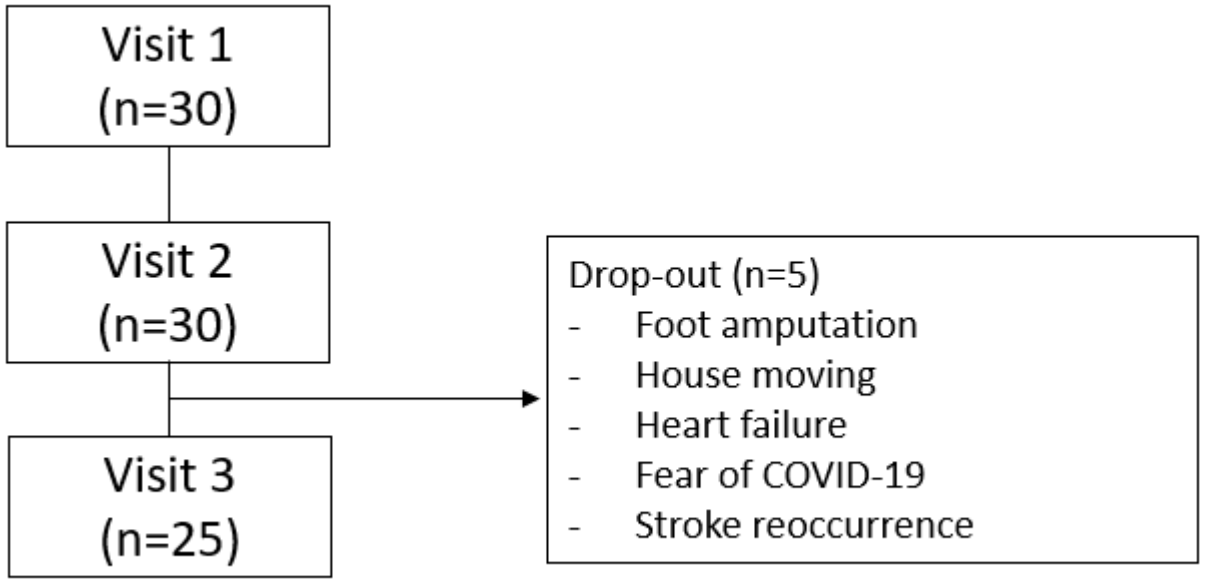
Méthode


Cycle 1
12-16 weeks
Cycle 2
12-16 weeks
Cycle 3
12-16 weeks
4 weeks
4 weeks
4 weeks
Visit 1
Injection 1
QGA 1
Visit 2
QGA 2
Injection 2
Injection 3
Visit 3
QGA 3
End of study
400 U
600 U
Maximum of 800 U

Méthode


stance
swing
Ankle
Extension - flexion
60
40
20
0
-20
-40
A1
A2
A3
A4
0
20
40
60
80
100
Gait cycle (%)
stance
swing
Knee
Extension - flexion
K1
K2
K3
K4
Gait cycle (%)

Results – study flow chart



Résultas

n = 25	Primary (n)	Secondary (n)	Tertiary (n)
Pes equinus	12	7	3
Equinus during swing	3	4	10
Stiff knee	9	9	6
Genu recurvatum	0	2	3
Excessive knee flexion	1	3	3

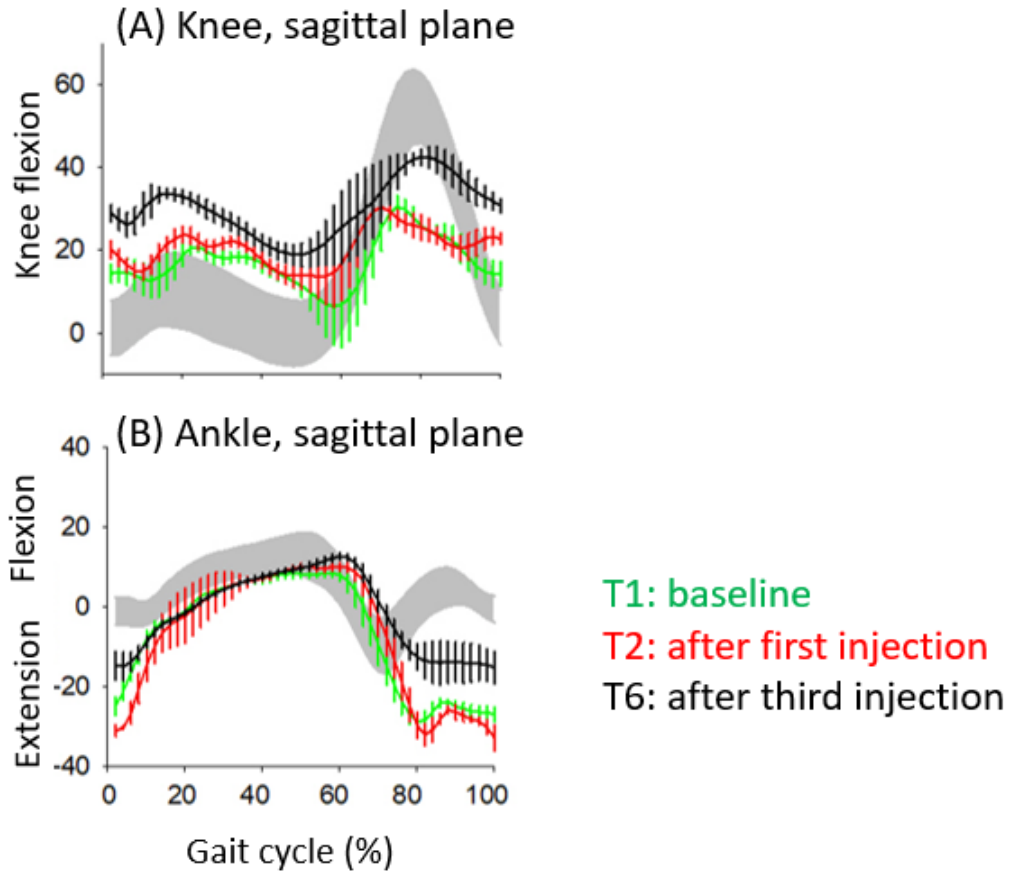
Résultats

Postural gait pattern	n	Visit 1 (baseline)	Visit 2 (after 1st injection)	Visit 6 (after 3rd injection)	RM-ANOVA, time (p-value)
Pes equinus	22	7.5 (13.0)	8.2 (15.2)	10.2 (11.0)[a,b]	0.008
A1 (°)	3	-16.4 (8.1)	-18.4 (11.2)	-6.4 (9.9)[a,b]	0.018
A2 (°)	8	3.3 (5.3)	3.2 (5.5)	5.8 (6.0)	0.1
A2-A1 (°)	11	17.0 (6.1)	17.7 (7.3)	17.9 (6.9)	0.5
Equinus during swing	17	6.6(8.5)	5.6 (10.0)	6.5 (12.4)	0.78
A4 (°)	11	4.0 (8.4)	1.9 (9.8)	6.7 (9.1)[b]	0.048
A4-A3 (°)	6	11.1 [6.6;16.2]	11.3 [5.6;16.1]	11.7 [-2.1;14.6]	0.9
Stiff knee	24	24.6 (15.5)	23.3 (12.7)	31.3 (15.8)[a,b]	<0.001
K4 (°)	19	23.2 (15.1)	23.0 (14.0)	30.3 (15.8)[a,b]	<0.001
K4-K3 (°)	5	30.0 (17.3)	24.8 (4.2)	35.2 (16.8)	0.09
Genu recurvatum, angle (K3, °)	7	-6.7 (4.5)	-4.9 (6.0)	-1.8 (6.8)	0.06
Excessive knee flexion, angle (K1, °)	5	23.8 (4.8)	19.5 (6.9)	20.0 (8.1)	0.20

Results – descriptive statistics

	Participants (n=30), mean (SD)
Gender, male/female (n)	20/10
Age (yr)	54.3 (12.7)
BMI (kg/m^2)	24.9 (4.1)
Affected side, left/right (n)	18/12
Type of stroke, haemorrhagic/ischemic (n)	10/20
Time since stroke (months)	26.1 (33.8)
FMA-UE (%)	51.2 (30.7)
FMA-LE (%)	65.7 (27.5)
FIM (/126)	114.4 (10.3)

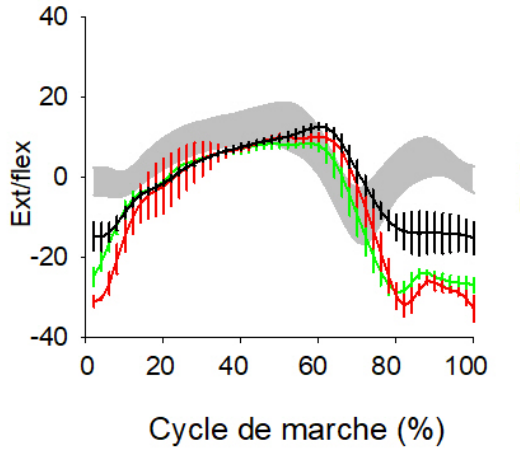
Résultats – typical trace knee and ankle sagittal

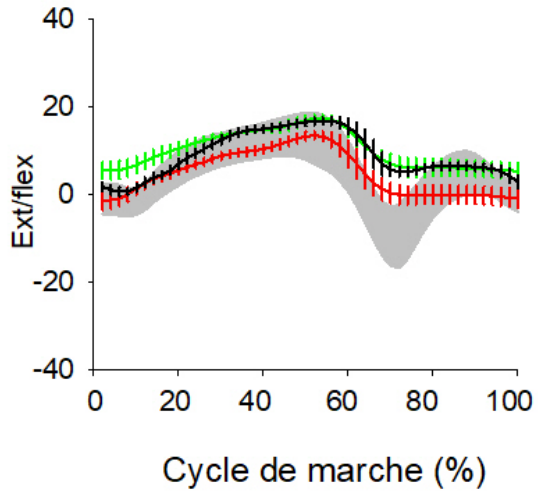


T1: baseline
T2: after first injection
T6: after third injection

Results – classic kinematics – typical trace ankle sagittal

T1
T2
T3



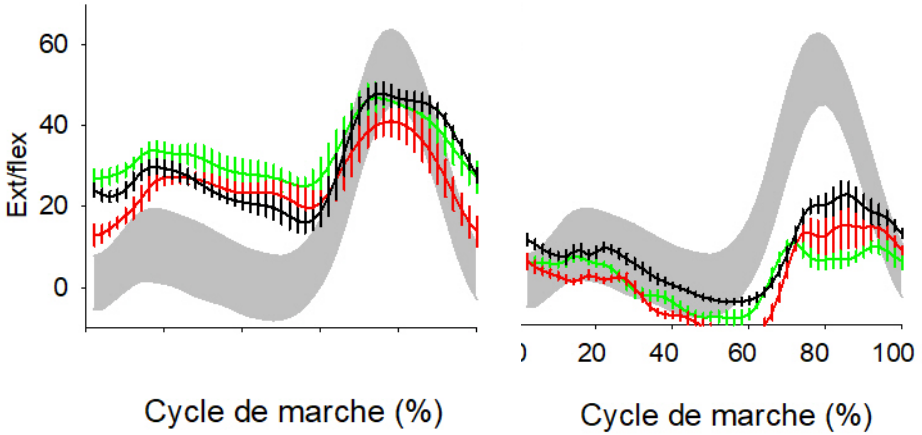


Pic normal au départ
Amplitude

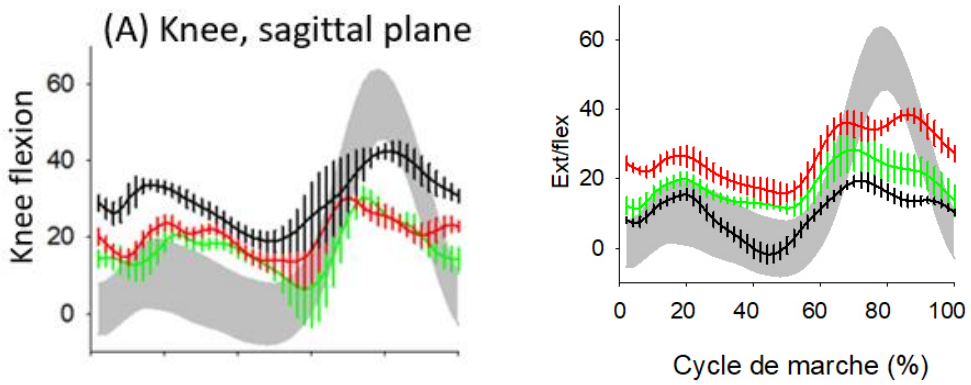
Amplitude normale au départ
Pic

Results – classic kinematics – typical trace knee sagittal

T1
T2
T3

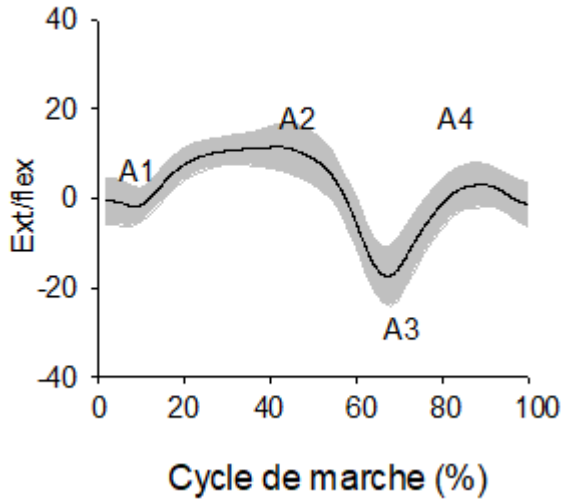


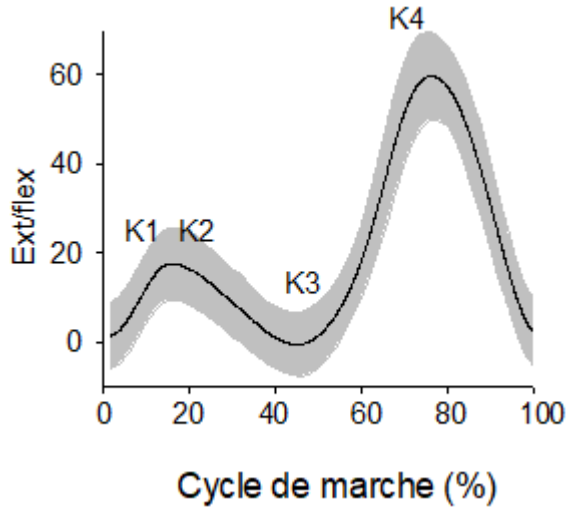
Pic normal au départ
Amplitude



Amplitude normale
Pic

Methods


40
20
0
-20
-40
Ext/flex
A1
A2
A3
A4
0
20
40
60
80
100
Cycle de marche (%)


60
40
20
0
Ext/flex
K1
K2
K3
K4
0
20
40
60
80
100
Cycle de marche (%)

Results – participants objectives

n = 25	Visit 1	Visit 2	Visit 3	p-value
Primary objectives (°)	10.8 (14.7)	10.2 (14.9)	15.4 (16.7)[a,b]	**<0.001**
Secondary objectives (°)	9.9 (21.5)	11.7 (19.5)	13.1 (21.9) [a]	**0.02**
Tertiary objectives (°)	5.3 (18.6)	6.0 (18.8)	9.8 (18.9) [a,b]	**<0.001**

a = significant difference between V1 and V6
b = significant difference between V2 and V6

Résultats

n = 25	Primary (n)	Secondary (n)	Tertiary (n)
Pes equinus	12	7	3
Equinus during swing	3	4	10
Stiff knee	9	9	6
Genu recurvatum	0	2	3
Excessive knee flexion	1	3	3

75 objectives : at V3

→ 12 (16%) **improved** >10°
→ 12 (16%) **improved** >5° <10°
→ 37 (49.3%) **improved** >0° <5°

→ 12 (16%) **degraded** <5°
→2 (2.7%) **degraded** >5° <10°

- Amélioration des objectifs (1, 2 et 3) à l'échelle du groupe après 3ème injection mais pas après 1ère

- Amélioration de l'équin et du SKG (selon notre algorithme) après 3ème injection, mais pas après 1ère

- Amélioration de K2 (flexion max genou phase d'appui) et de K4 (flexion max genou phase oscillante) à l'échelle du groupe après 3ème injection, mais pas après 1ère

- Pas de modification pour les autres perturbations de la marche (steppage, recurvatum, flessum de genou)

- La spasticité après AVC est très fréquente
- Son évaluation est cruciale afin d'optimaliser le traitement
- Grâce à l'EOD qui mesure la raideur, on espère mieux distinguer les composantes neurales et non neurales

- La toxine botulinique à haute doses et lors de cycles répétés, permet de mieux traiter la spasticité et d'améliorer les paramètres fonctionnels de marche chez des personnes victimes d'AVC présentant de la spasticité étendue

- Ces bénéfices sont également quantifiables lors d'analyses quantifiées de la marche

- Les ODC sont un traitement souvent utilisé avec peu d'ES. Actuellement nous n'observons pas d'effet sur la raideur (recrutement jusqu'à fin décembre)

MERCI POUR VOTRE ATTENTION

Traitement

Toxine botulinique de type A

Neurotoxine (inhibition libération acétylcholine plaque motrice) → dénervation chimique → composantes neurales (hyperactivité musculaire)

Effets: 3-4 mois

✓

1ère ligne
Spasticité focale et multifocale
Segmentaire et multi-segmentaire

Spasticité invalidante, multifocale et/ou multi-segmentaire
Doses maximales autorisées → limite au traitement optimal

Wissel 2009, Suputtitada 2024, Wissel 2017, Foley 2010

Traitement

?

✓

Wissel 2009, Suputtitada 2024, Wissel 2017, Foley 2010

Validité et reproductibilité du wrist-EOD (outil d'oscillation électromécanique du poignet) dans l'évaluation de la raideur des fléchisseurs de la main

Résultats: Validité de construit (n=24):

ELmax, VI et L-path : ↑ du côté spastique

Table 2 Mean stiffness values at the three evaluation times

	Hand flexor muscles (affected arm)				Hand flexor muscles (less-affected arm)
	T1	T2	T3	Mean value three assessments	T1
EL_{max} (N m/rad)	3.2 (0.6–7.1) ± 1.6	3.0 (1.0–7.2) ± 1.6	3.1 (1.2–7.8) ± 1.5	3.1 (1.3–6.9) ± 1.4	2.2 (1.0–3.8) ± 0.9*
VI (N m s/rad)	2.1 (3.6–0.7) ± 0.7	1.9 (3.1–0.7) ± 0.5	2.0 (3.2–0.3) ± 0.8	2.0 (3.1–0.7) ± 0.6	1.8 (3.3–0.6) ± 0.7*
L-path (N m/rad)	24.3 (12.0–48.5) ± 7.6	23.1 (10.0–35.4) ± 6.5	23.6 (6.8–43.5) ± 8.3	23.7 (11.0–37.6) ± 6.8	19.9 (9.3–32.5) ± 6.7*

Results are presented in mean (minimal and maximal values) ± SD.
EL_{max}, maximal elastic stiffness; L-path, path length; VI, viscous stiffness.
*$P < 0.001$.

ELmax, VI et L-path notre population > normes sujets sains (Nguyen et al. 2020)

n = 25	Primaire (n)	Secondaire (n)	Tertiaire (n)
Équin durant appui	12	7	3
Équin durant oscillante	3	4	10
Stiff knee	9	9	6
Genu recurvatum	0	2	3
Flexion du genou excessive	1	3	3

n = 25	Primaire (n)	Secondaire (n)	Tertiaire (n)
Équin durant appui	12	7	3
Équin durant oscillante	3	4	10
Stiff knee	9	9	6
Genu recurvatum	0	2	3
Flexion du genou excessive	1	3	3

Discussion Générale

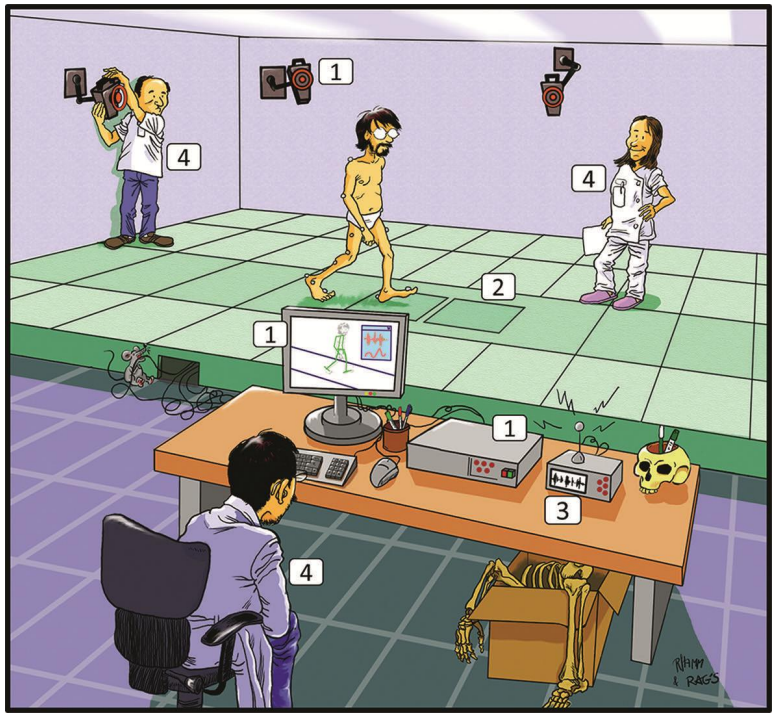
Évaluation de la marche

✓ AQM : examen de référence pour évaluer la marche :
Variables cinématiques

✗ **Cinématique :** difficile d'analyser des groupes présentant des patterns posturaux différents (ex. recurvatum et flexum)

Revue récente : 91 variables identifiées !

Tentatives pour palier à cela : GDI, Gillette gait Index, Gait Profile Score, …



Li 2025, Baker 2009, Rozumalski 2011, Correa 2017

Plan de thèse

1. **Chapitre 1 :** Introduction générale
2. **Chapitre 2 :** Validité et reproductibilité du w-EOD (outil d'oscillation électromécanique du poignet) dans l'évaluation de la raideur des fléchisseurs de la main
3. **Chapitre 3** : Facteurs prédictifs de la récupération de marche après AVC
4. **Chapitre 4 :** Traitement de la spasticité pour améliorer la fonction de marche
5. **Chapitre 5 :** Discussion générale
6. **Conclusions générales**

Intervention

Réadaptation de la marche après AVC : revue des facteurs prédictifs de récupération et des techniques rééducatives

REVIEW ARTICLE

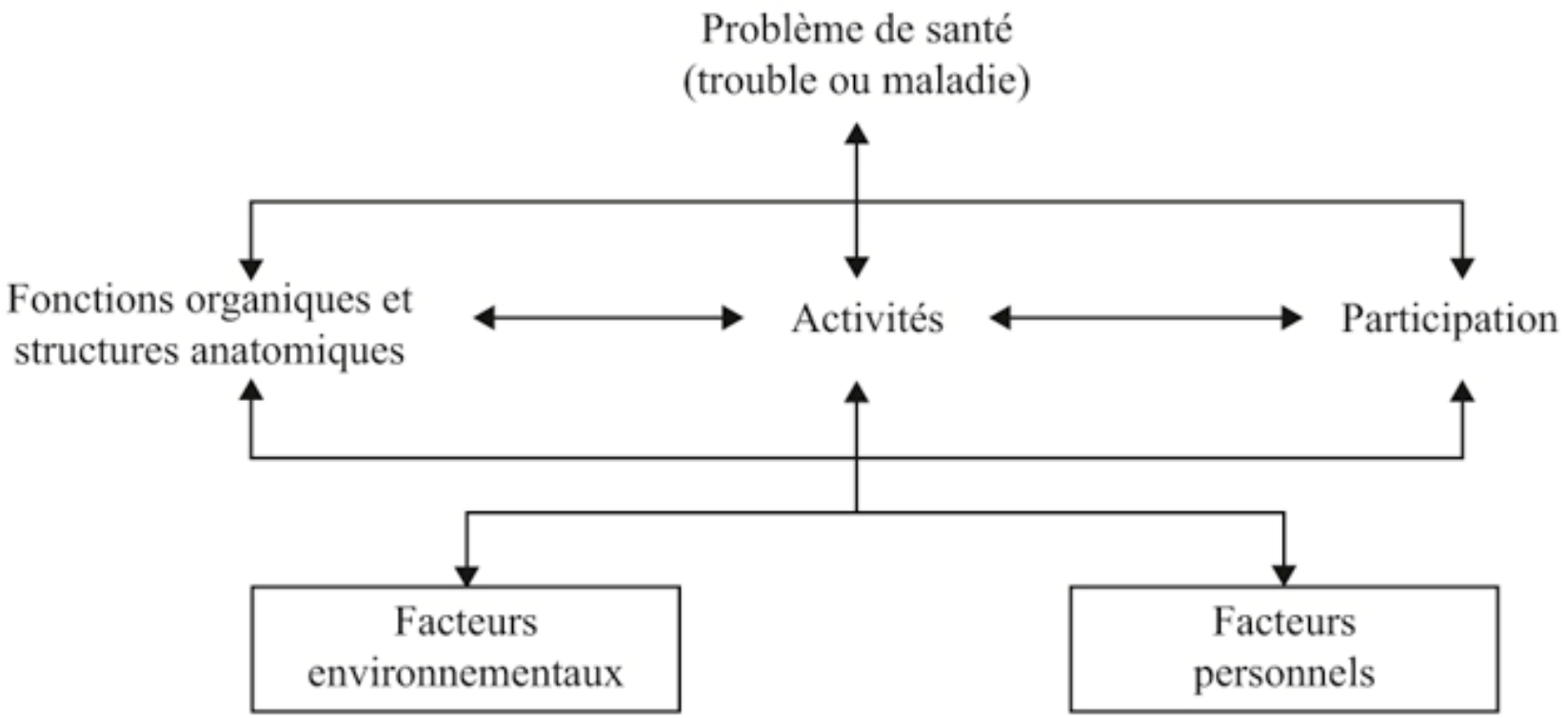
Gait rehabilitation after stroke: review of the evidence of predictors, clinical outcomes and timing for interventions

Clara Selves[1,2] · Gaëtan Stoquart[1,2] · Thierry Lejeune[1,2]

Received: 22 November 2019 / Accepted: 27 February 2020

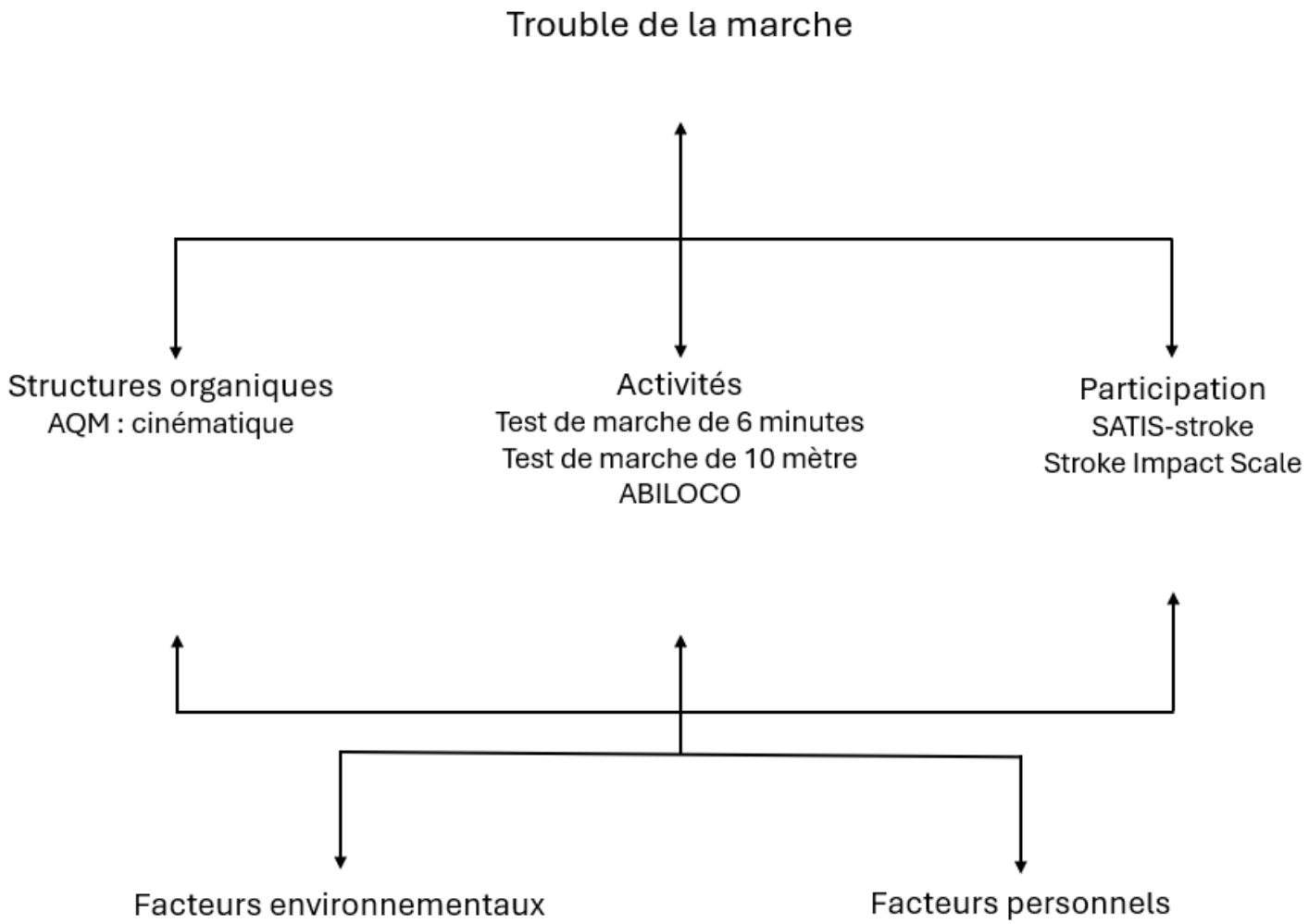
Acta Neurologica Belgica

Évaluation



OMS 2007

Évaluation de la marche



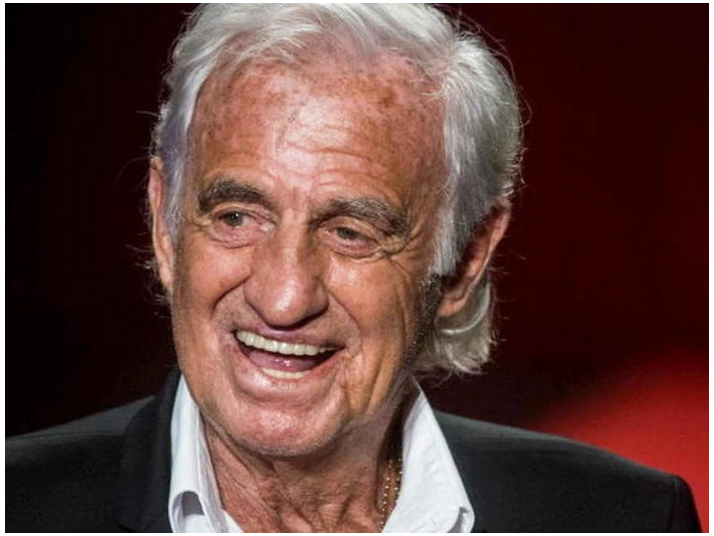
AVC : accident vasculaire cérébral

Fréquent : Europe : 1 million de personnes/an

Sharon Stone : 41 ans

Catherine Deneuve: 76 ans

Jean-Paul Belmondo : 68 ans



Wafa 2020, Feigin 2022, Preston 2021, Van de Port 2006

Comment la BT-A soutient la réadaptation à la marche

✓ Endurance de marche (6MWT)
Vitesse dans les escaliers
} Capacité de marche

Pas nécessairement la vitesse de marche

✓ Équin et SKG → Cinématique sagittale cheville et genou

Effets nécessitent des cycles répétés, à doses suffisamment élevées → prennent du temps

Ces améliorations permettent d'atteindre une plus haute intensité lors de la réadaptation

Évaluation : limites

Échelle d'Ashworth (MAS)

Échelle de Tardieu (MTS)

(Hyper) Résistance >> hyperactivité musculaire

Résistance ≠ activité musculaire réflexe

Échelles ordinales, subjectives

Incohérence entre examinateurs

Fleuren 2011, Mehrholz 2005

Traitement

	Transitoire	Permanent
Focal	BT-A Attelles et plâtres Ondes de choc TENS Blocs nerveux Chémoneurolyse/ cyroneurolyse	Neurotomie sélective Allongements et transferts tendineux Ténotomie percutanée à l'aiguille
Généralisé	Médication orale Kinésithérapie Auto-rééducation (TMS)	Pompe à Baclofène intrathécale Rhizotomie dorsale sélective

Traitement

Toxine botulinique de type A

Spasticité invalidante, multifocale et/ou multi-segmentaire

Doses maximales autorisées → limite au traitement optimal

(Inco-BT-A : 500 U, usuel : 400 U)

Nombreuses études sur les effets de 1 cycle sur l'hyper-résistance (MAS, MTS), moins clair sur les activités de marche (CIF)

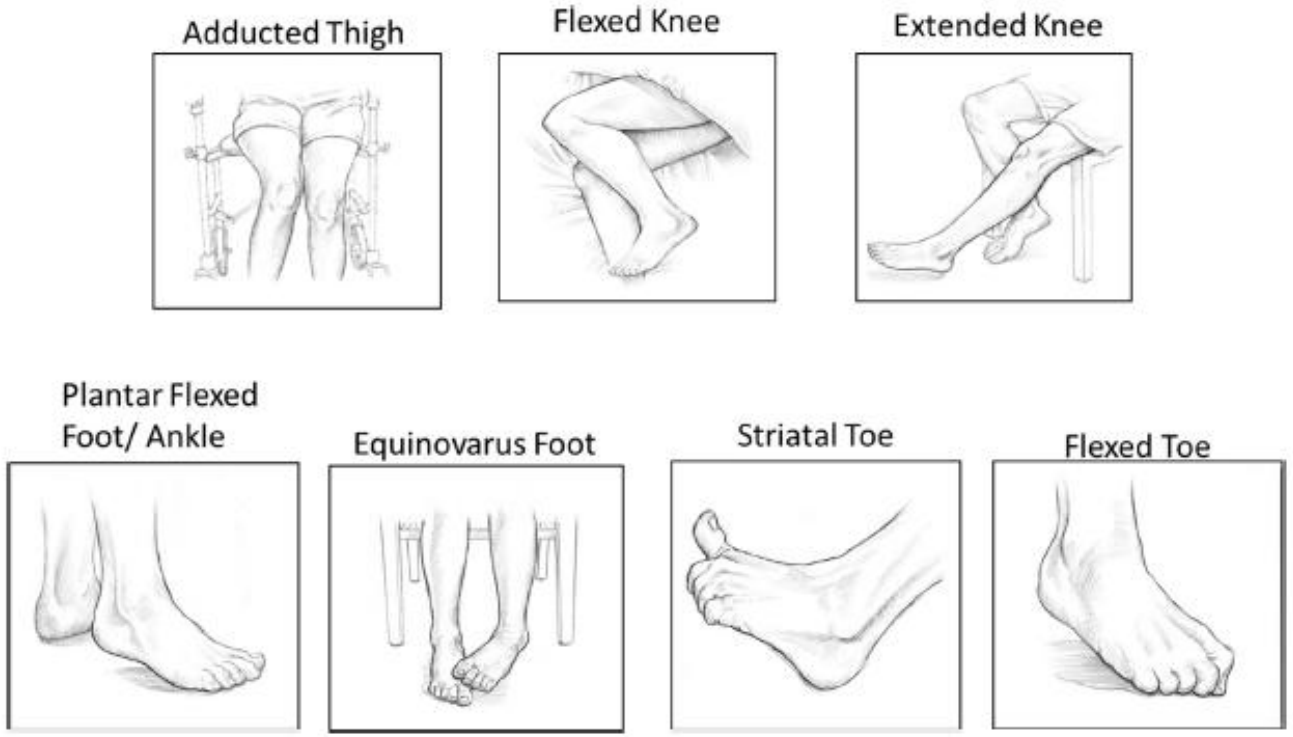
Résultats prometteurs sur plusieurs cycles, peu d'études

Étude sur la sécurité de doses progressivement croissantes (jusqu'à 800 U d'Inco-BT-A)

Pittock 2003, Caty 2008, Stoquart 2008, Wissel 2009, Gracies 2017, Wissel 2017, Esquenazi 2021, Bensmail 2021, Suputtitada 2024

Traitement de la spasticité pour améliorer la fonction de marche

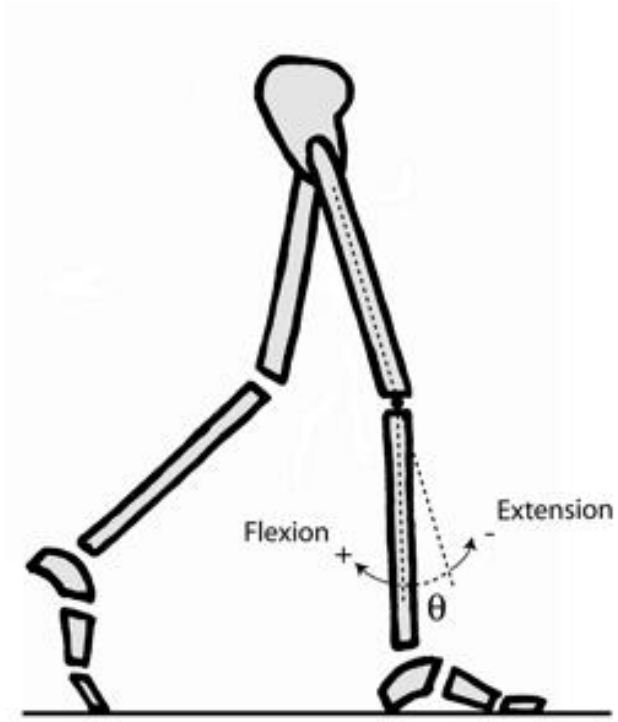
Patterns posturaux des membres inférieurs

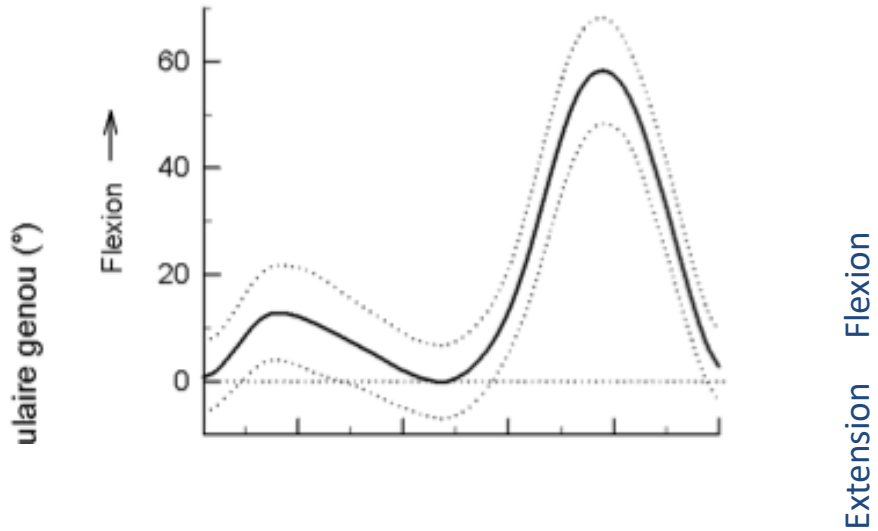


Esquenazi 2017

Traitement de la spasticité pour améliorer la fonction de marche

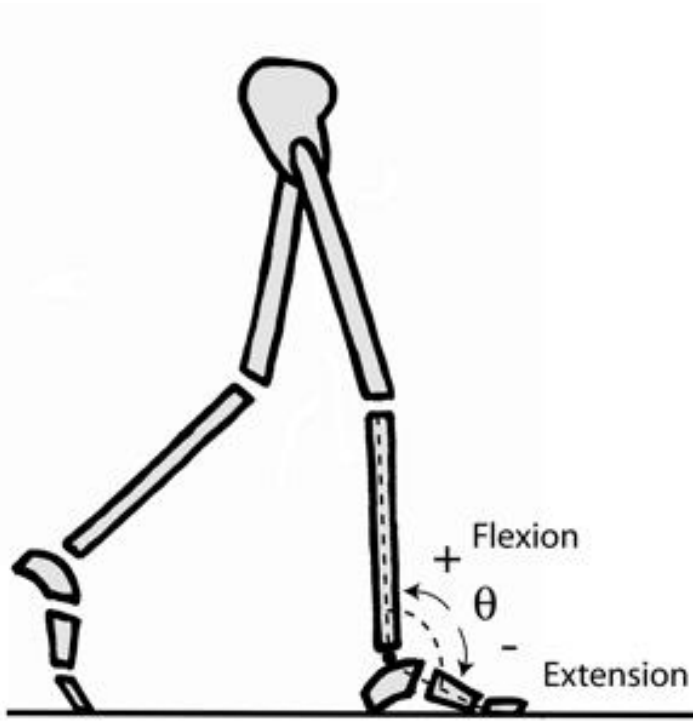
Résultats – typical trace genou sagittal

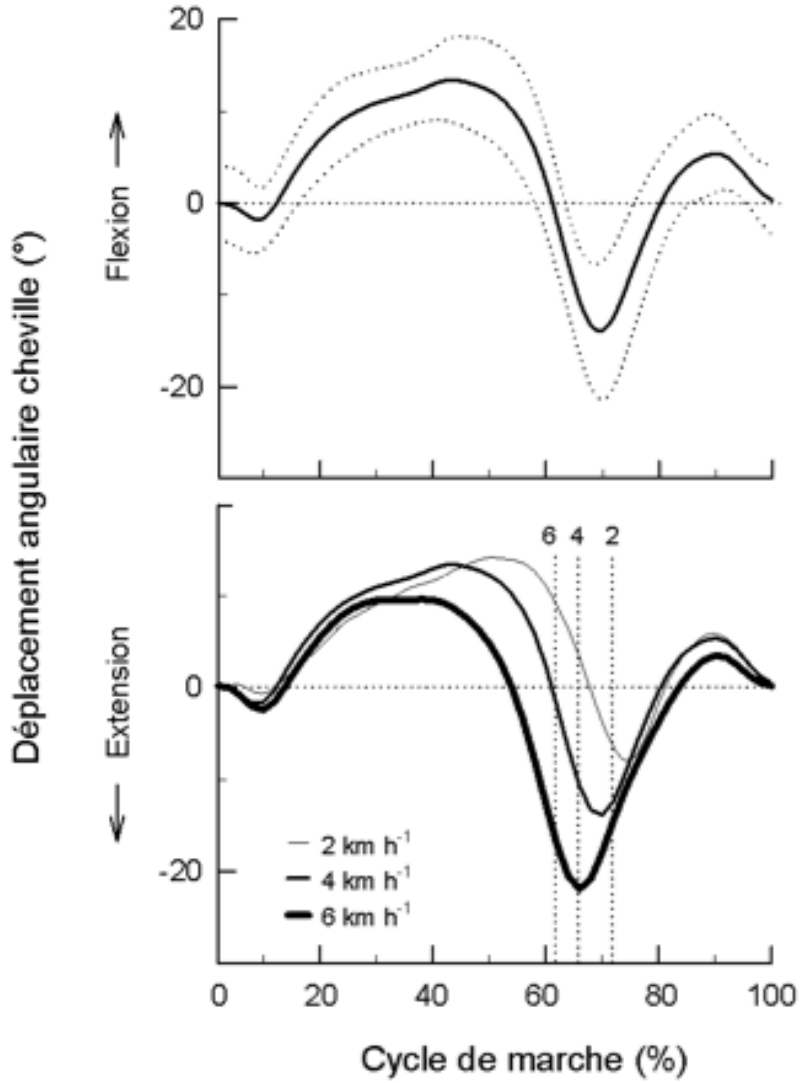




Traitement de la spasticité pour améliorer la fonction de marche

Résultats – typical trace cheville sagittal



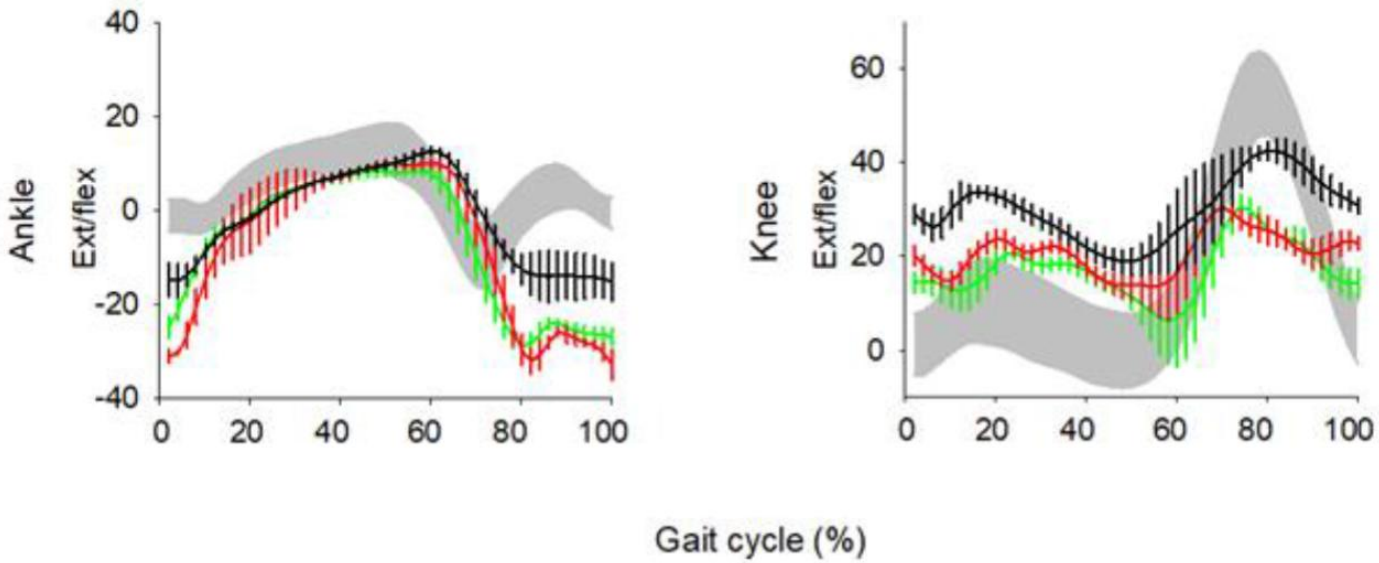


Flexion dorsale

Flexion plantaire

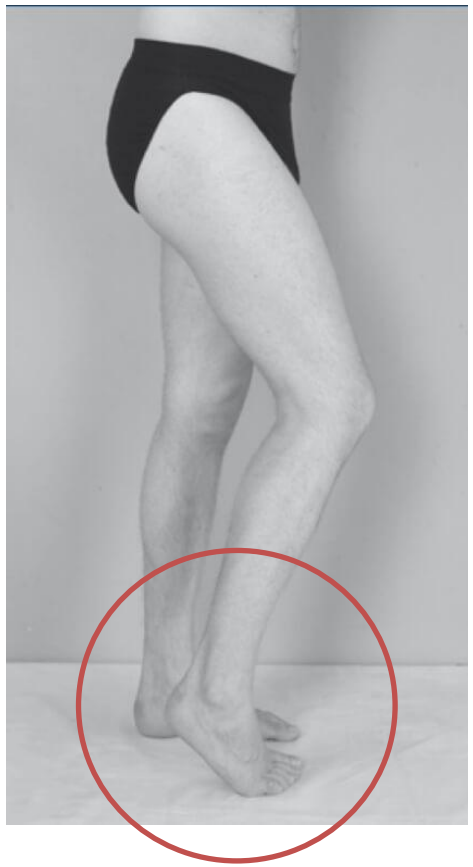
Traitement de la spasticité pour améliorer la fonction de marche

Résultats – typical trace genou et cheville sagittal



T1: baseline
T2: after first injection
T6: after third injection

Traitement de la spasticité pour améliorer la fonction de marche

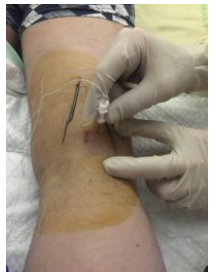


Après 3 cycles

Perspectives

Évaluation

+



=

Neural

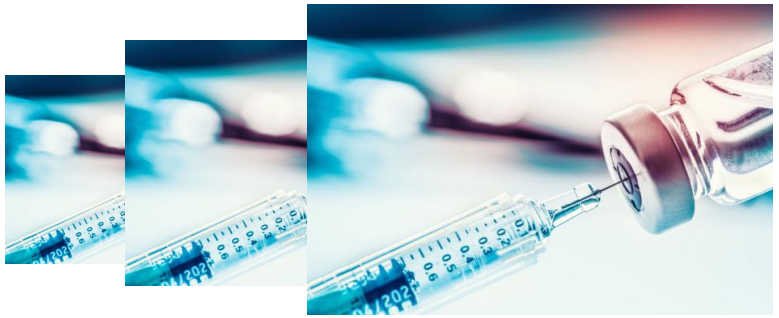
Non-neural

En cours !

?

Comment la BT-A soutient la réadaptation à la marche

✓ Endurance de marche (6MWT)
Vitesse dans les escaliers

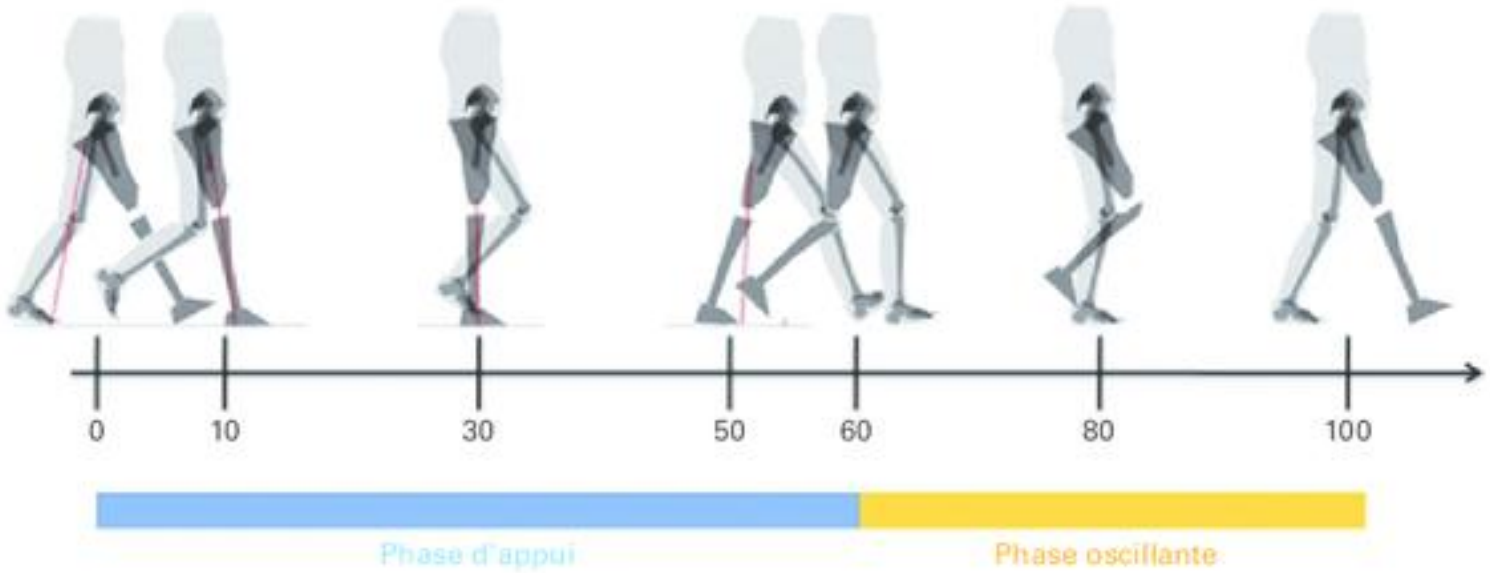


Effets nécessitent des cycles répétés, à doses suffisamment élevées → prennent du temps

Ces améliorations permettent d'atteindre une plus haute intensité lors de la réadaptation

→ Recommandations de bonne pratique ✓

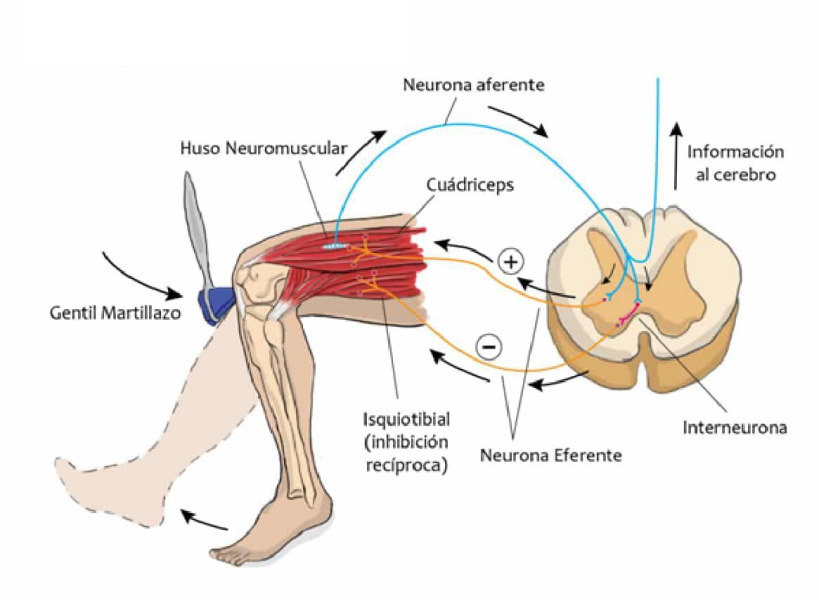
Troubles de la marche



Wafa 2020, Feigin 2022, Preston 2021, Van de Port 2006

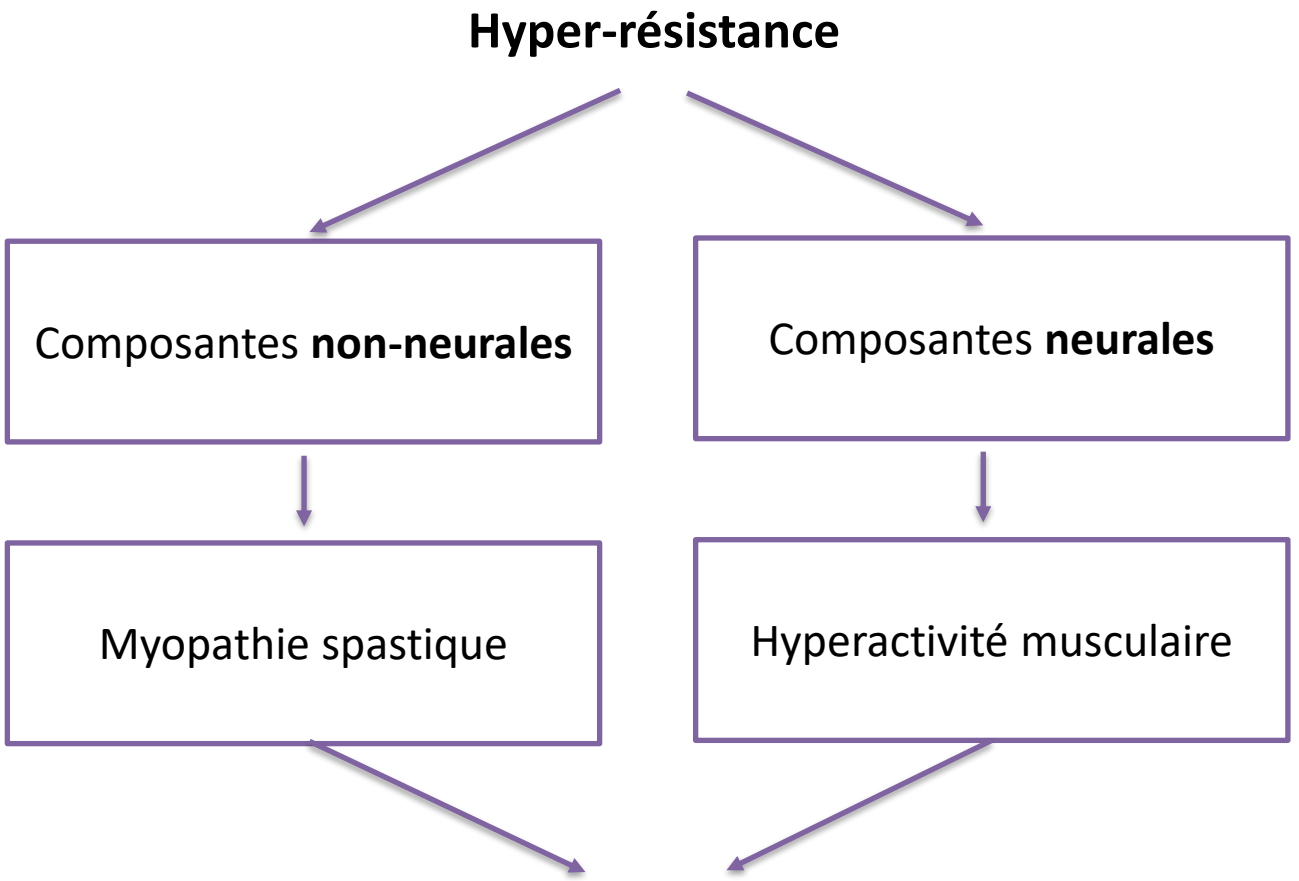
Spasticité

Pandyan 2005: désordre sensori-moteur



Pandyan 2005

Évaluation

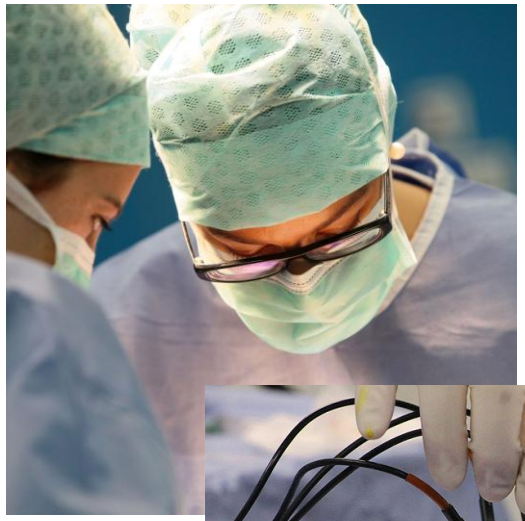


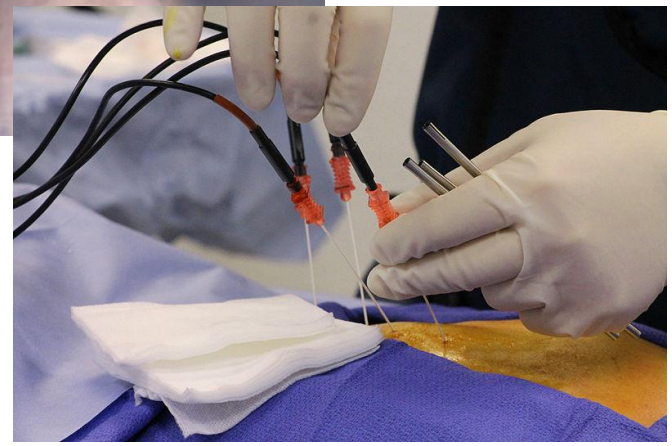
Baude 2018, Van den Noort 2017

Traitement

Composantes neurales

Composantes neurales
et non-neurales



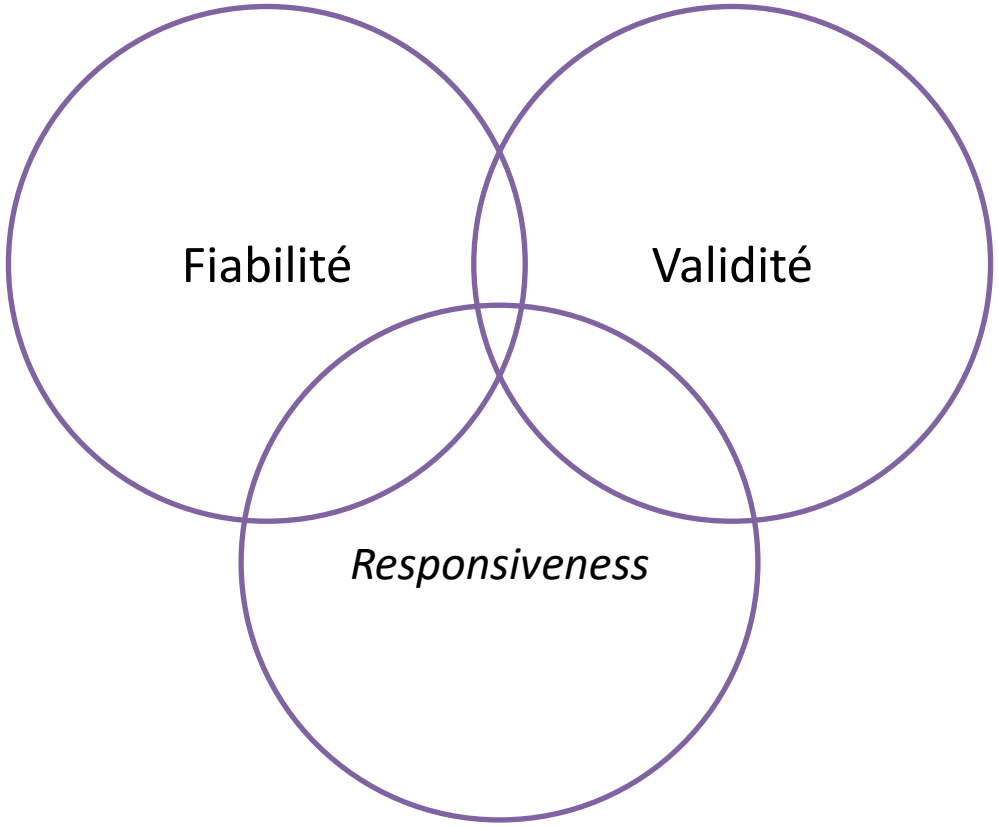


Composantes neurales
et non-neurales

Évaluation de la spasticité

9 propriétés à respecter pour valider un outil de mesure

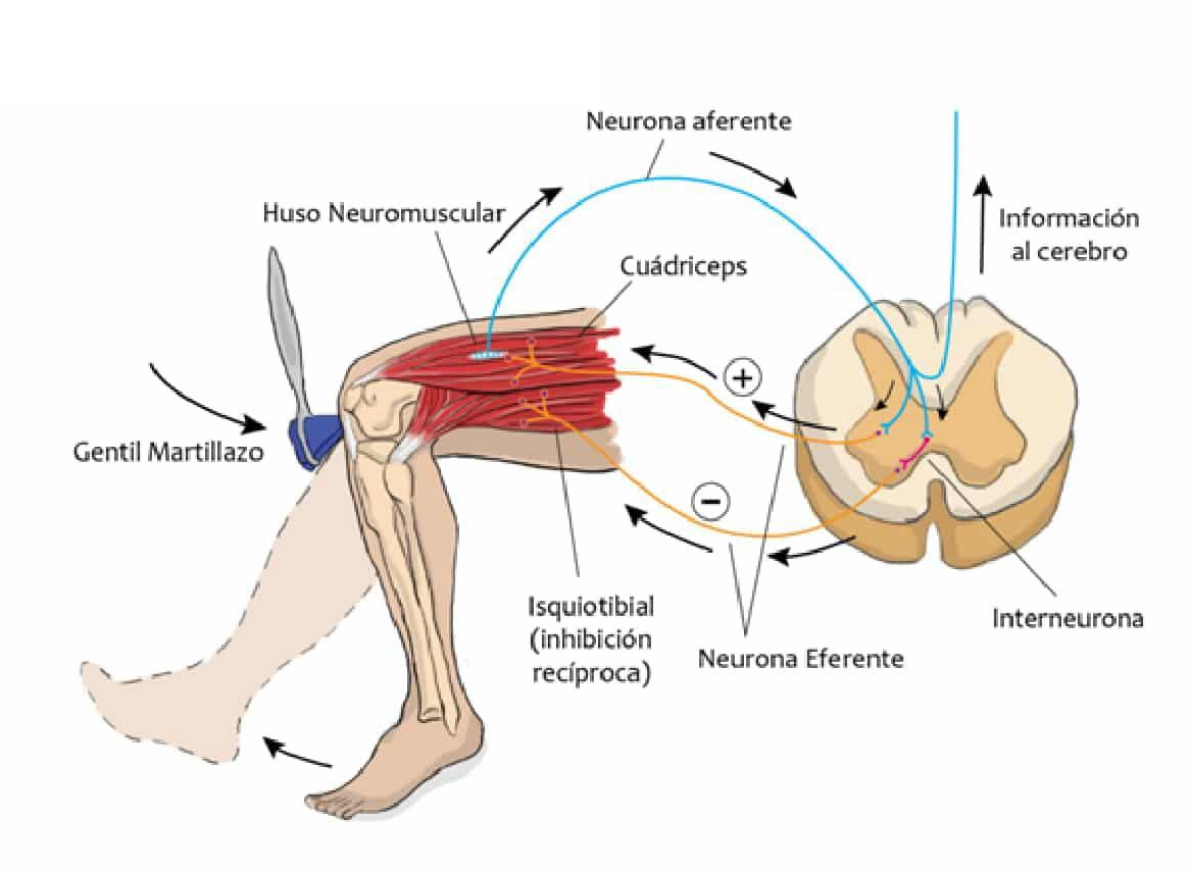
- Fiabilité :
  - Reproductibilité intra et inter examinateur
  - Consistance interne
  - Erreur de mesure
- Validité :
  - Validité de contenu
  - Validité de critère
  - Validité de construit :
    - Validité structurelle
    - Test d'hypothèse
    - Validité inter-culturelle
- Réactivité (*responsiveness*)



www.cosmin.nl, Mokkink 2010

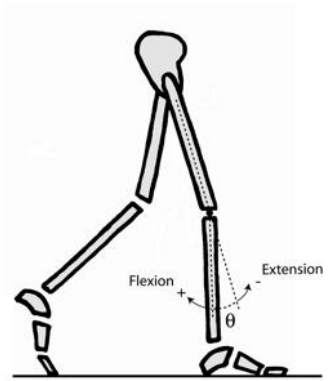
Spasticité

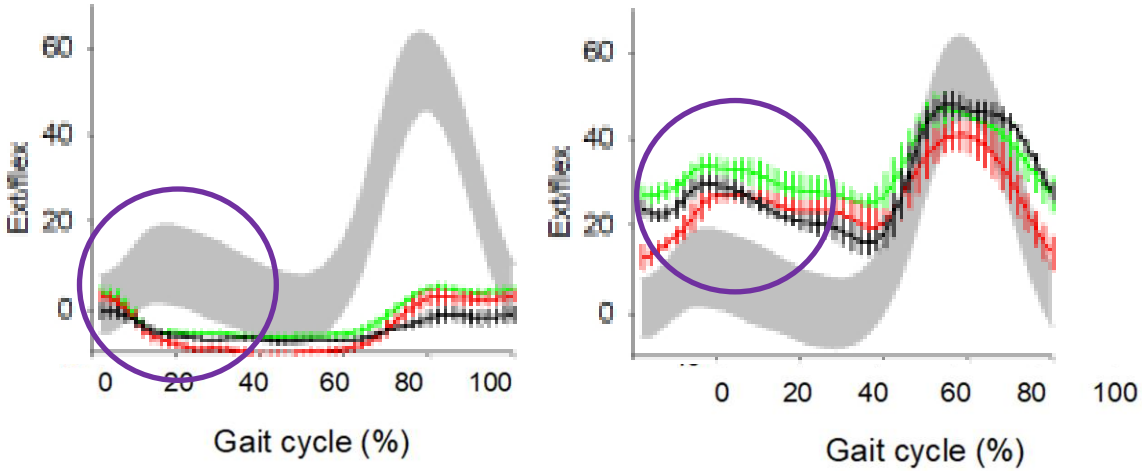
Lance 1980 : 'Augmentation vitesse-dépendante du réflexe d'étirement'



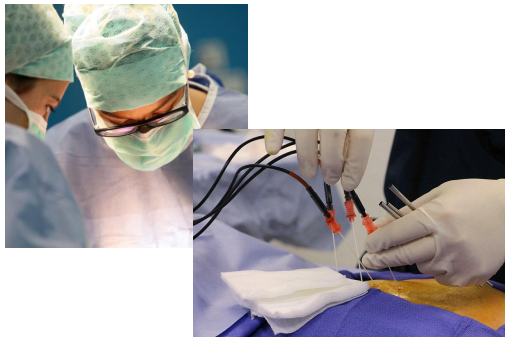
Lance 1981

Traitement de la spasticité pour améliorer la fonction de marche





Traitement

	Transitoire	Permanent
Focal		
Généralisé		

Inspired by Deltombe