How to manage spasticity in disorders of consciousness?

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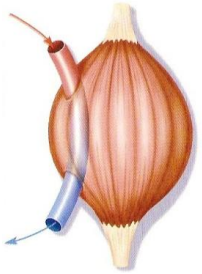
What is spasticity?

« Motor disorder, characterized by a velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from **hyper-excitability** of the stretch reflex as one component of the upper motor neuron (UMN) syndrome » (*Lance, 1980*)

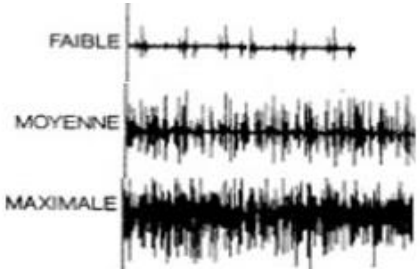
- No consensus on definition
- Commonly accepted notions of **increased tonus** and **velocity-dependent hyperreflexia**

Clinical entities (UMN)

- Spasticity



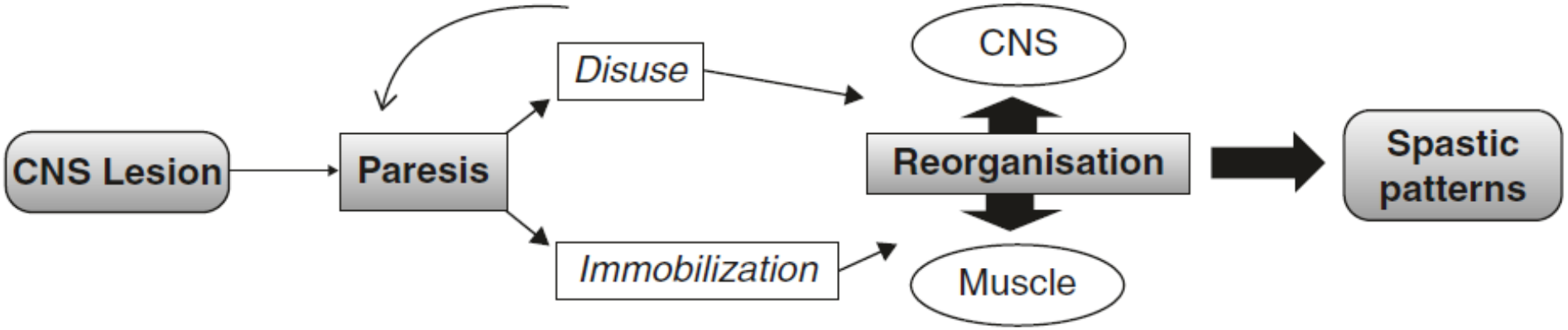
- Spastic Dystonia



- Spastic co-contractions

Physiopathology

A vicious circle



Martens et al., Coma and Disorders of Consciousness, 2018

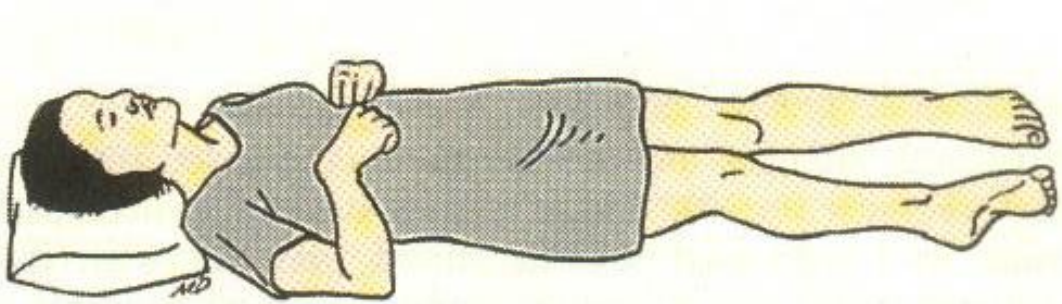
Affected muscles

- **Upper limb:** shoulder internal rotators and adductors, elbow flexors, wrist pronators and flexors, hand intrinsic muscles
- **Lower limb:** hip internal rotators and adductors, knee extensors, ankle flexors (*equinovarus spastic deformity*)

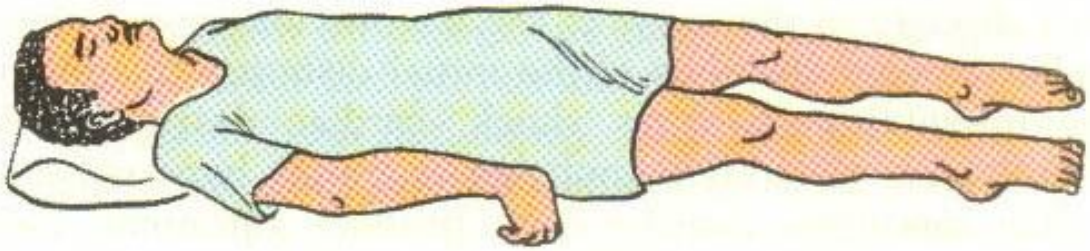
Thibaut et al., Brain Injury, 2013

2 schemas

- Decortication



- Decerebration



Complications after brain injury

Table 2 Medical complexity of DOCs cohort and etiology subgroups

Procedure	Overall Sample (N=122)	Blast Trauma (n=29)	Penetrating Trauma (n=10)	Other Trauma (n=67)	Nontrauma (n=16)
Procedures					
Spasticity	70 (62–78)	70 (52–86)	90 (71–100)	76 (66–86)	88 (71–100)
Dysautonomia	34 (25–42)	48 (30–66)	40 (10–70)	27 (16–37)	38 (14–61)
Seizure	30 (22–38)	45 (27–63)	70 (42–98)	21 (11–31)	19 (0–38)
Shunt placement	25 (18–33)	31 (14–48)	10 (0–29)	28 (18–39)	12 (0–28)
Intracranial infection	22 (15–30)	48 (30–66)	40 (10–70)	12 (4–20)	0 (–)
Heterotopic ossification	16 (10–23)	31 (14–48)	20 (0–45)	10 (3–18)	13 (0–29)
PE/DVT	14 (8–20)	21 (6–35)	20 (0–45)	13 (5–22)	0 (–)
Filter placement	41 (33–49)	55 (37–72)	60 (30–90)	40 (29–52)	6 (0–18)
Anticoagulation	84 (77–90)	90 (79–100)	100 (NA)	82 (73–91)	75 (54–96)
PE/DVT with prophylaxis	11 (4–14)	17 (3–31)	10 (0–29)	10 (3–18)	6 (0–18)
RA ventilator-dependent	11 (4–14)	17 (3–31)	0 (NA)	10 (3–18)	6 (0–18)
Frequent consultants during rehabilitation					
No. of consultants seen during rehabilitation (quartiles)	14/18/23	16/20/24	18/24/27	14/17/21	10/17/21
Neuropsychology	73 (65–81)	76 (60–91)	50 (19–81)	73 (63–84)	81 (62–100)
Ophthalmology	66 (58–75)	66 (48–83)	80 (55–100)	67 (56–78)	56 (32–81)
Otolaryngology	65 (57–74)	76 (60–91)	90 (71–100)	63 (51–74)	38 (14–61)
Infectious disease	61 (52–69)	90 (79–100)	90 (71–100)	48 (36–60)	44 (19–68)
Neurology	61 (52–69)	62 (44–78)	90 (71–100)	60 (48–71)	50 (26–75)
Neurosurgery	60 (51–69)	66 (48–83)	100 (NA)	58 (46–69)	31 (9–54)
Gastroenterology	62 (54–71)	76 (60–91)	70 (42–98)	51 (39–63)	25 (4–46)

NOTE. Values are percentage (95% confidence interval) or quartiles (25th/50th/75th percentile).
Abbreviations: DVT, deep vein thrombosis; NA, not applicable; PE, pulmonary embolism; RA, rehabilitation admission status.

Nakase-Richardson et al., APM&R, 2013

Prevalence in DOC

Authors	Study Type	n	Intervention	Results
		Occurrence of Spasticity in DOC Patients		
Thibaut et al., 2014 [3]	Prospective	65	/	89% showed spasticity (MAS ≥ 1)
Nakase-Richardson, 2013 [17]	Prospective	122	/	70% showed spasticity (requiring oral medications, injections or surgical procedure)
Ganesh et al., 2013 [18]	Prospective	68	/	57% showed spasticity

N=255

- Between **57 and 89%**
- Study 1: 61.5% suffer from severe spasticity (MAS ≥3)
  – negative correlation with frequency of PT
  – positive correlation with chronicity and pain

Martens et al., Brain Sciences, 2017

How to evaluate?

- Most commonly: Modified Ashworth Scale

Modified Ashworth Scale	
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch or by minimal resistance at the end of the range of motion (ROM)when the affected part(s) is (are) moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected part(s) is (are) easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part(s) is (are) rigid in flexion or extension

Bohannon & Smith, Physical Therapy, 1987

How to evaluate?

- Most commonly: Modified Tardieu Scale

Modified Tardieu Scale	
X: Quality of movement mobilization	
0	No resistance throughout the course of the passive movement
1	Slight resistance throughout the course of passive movement, no clear catch at a precise angle
2	Clear catch at a precise angle, interrupting the passive movement, followed by release
3	Fatigable clonus with less than 10 s when maintaining the pressure and appearing at the precise angle
4	Unfatigable clonus with more than 10 s when maintaining the pressure and appearing at a precise angle
5	Joint is fixed
V: Measurements take place in three different velocities	
V1	As slow as possible
V2	Speed of limb segment falling under gravity
V3	As fast as possible
Y: Angle of catching (muscle reaction)	

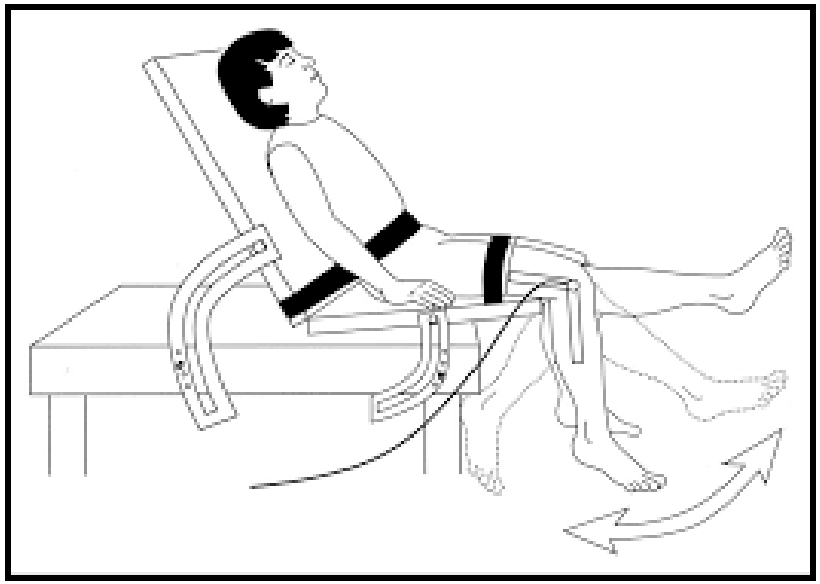
Tardieu and al., Rev. Neurol., 1954

How to evaluate?

- Other: Pendulum Test, King's Hypertonicity Scale, Tone Assessment Scale

Table 1: Tone Assessment Scale

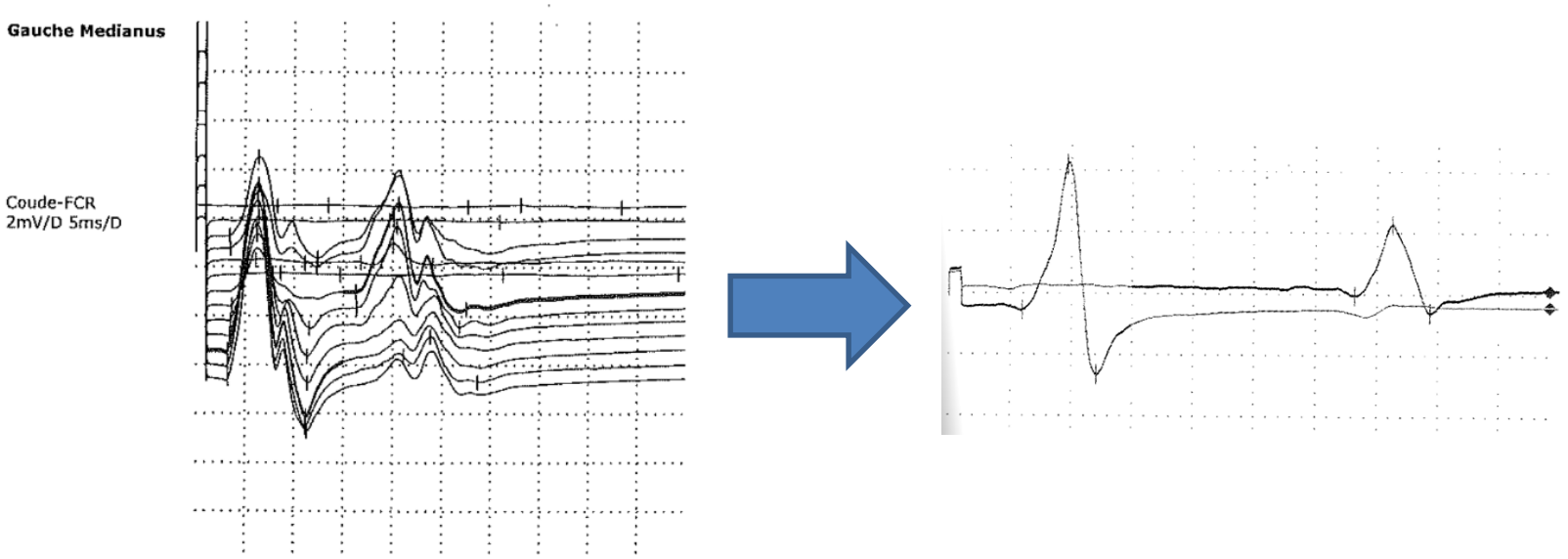
	0	1	2	3	4	5
1. Is the hand resting on the leg?			–	–	–	–
2. Are the shoulders level?			–	–	–	–
3. Is the foot flat on the floor?			–	–	–	–
4. Can you straighten the fingers, with the forearm in midposition and the wrist extended (sitting)?						
5. Can you flex the hand to the mouth and then fully extend the elbow within 2 seconds (sitting)?						
6. Is the lower limb flexible and the knee easily extended in sitting?						
7. Can you dorsiflex the foot from 20° to 10° of plantarflexion (mid-rotation, leg extended, patient supine)?						
8. Can you passively flex the hip/knee to 90° and return to full extension within 2 seconds						
9. Can you flex the knee with the hip extended, to move the foot over the edge of the bed, without resistance?						
10. Does the hand remain stationary on the leg as the subject elevates the opposite arm above the head?					–	–
11. Can the hand remain at trochanter level or lower on standing up?					–	–
12. Can the foot remain on the floor on standing up?			–	–	–	–



Gregson et al., APM&R, 1999

How to evaluate?

- EMG assessment: Hmax/Mmax
- Poor correlation with MAS in DOC patients (subcortical lesions)



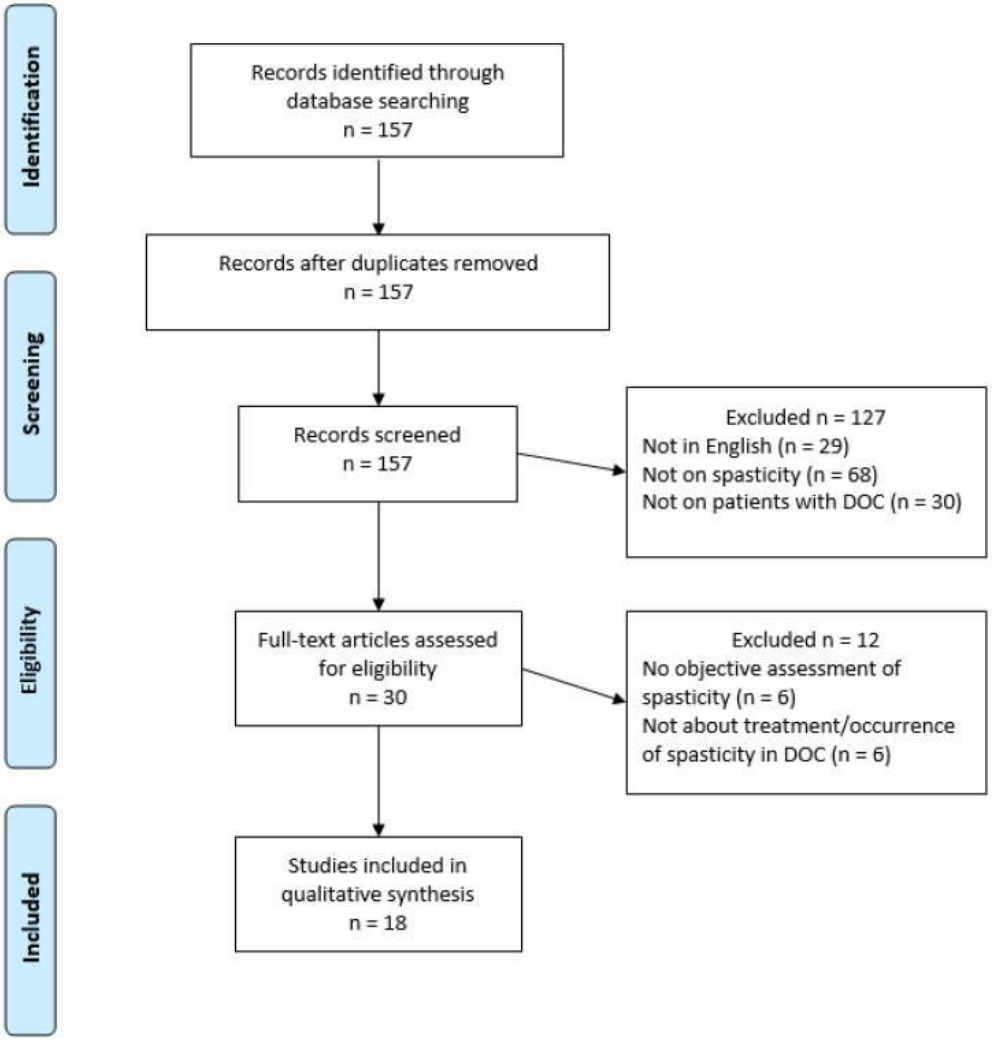
Martens et al., Clinical Neurophysiology, In Press

How to treat?

- Non-pharmacological treatment: physical therapy, orthoses, TENS
- Pharmacological agents: Diazepam, Clonazepam, Gabapentin, Baclofen, Tizanidine, Dantrolene, Phenol, Botox, ITB
- Surgical interventions: tenotomy, neurotomy…

- **What about DOC ?**

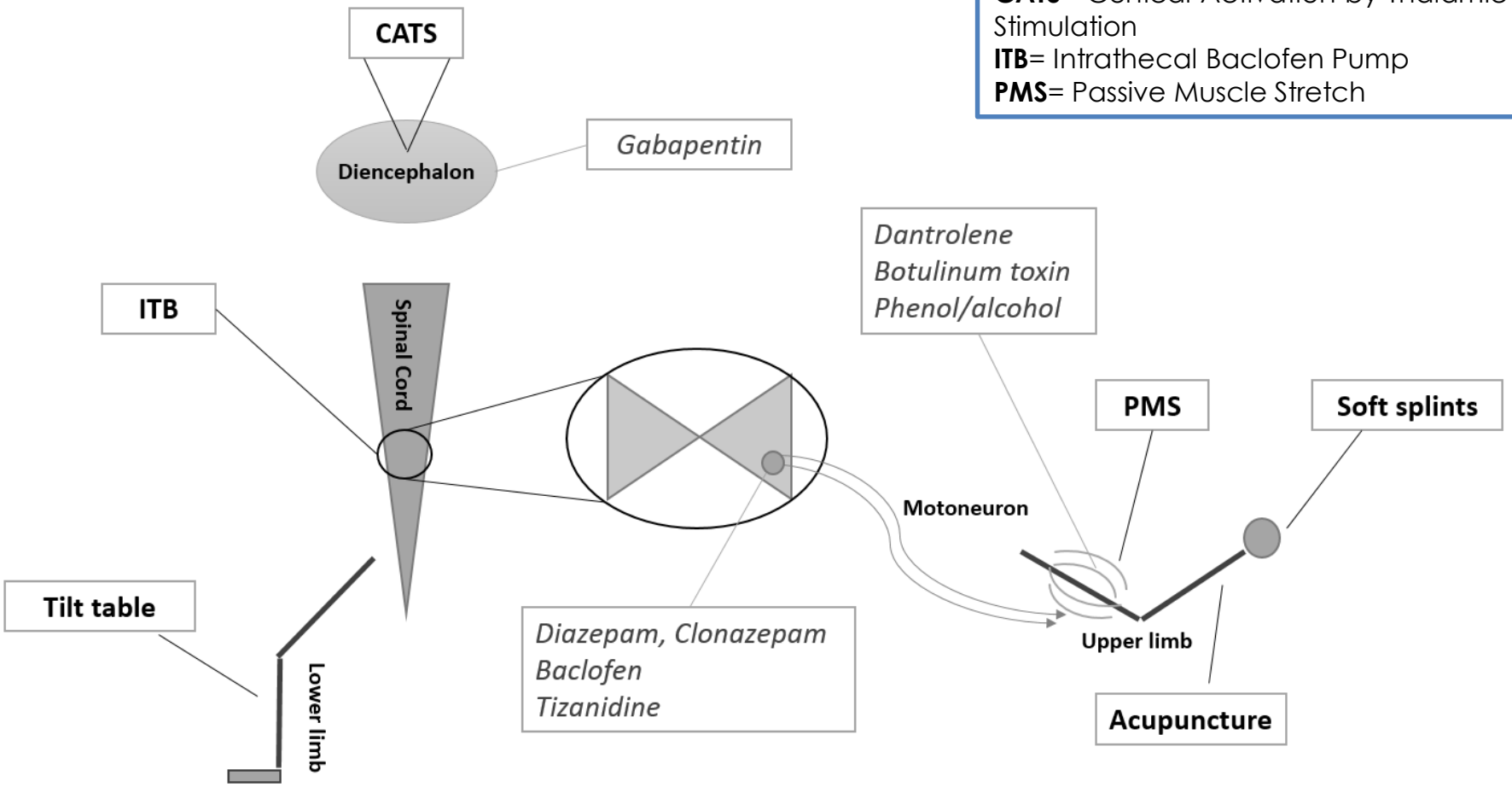
Review of interventions



Martens et al., Brain Sciences, 2017

Review of interventions

CATS= Cortical Activation by Thalamic Stimulation
ITB= Intrathecal Baclofen Pump
PMS= Passive Muscle Stretch



Martens et al., Brain Sciences, 2017

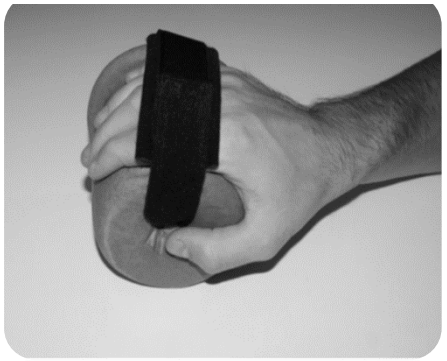
Soft splints

Impact of soft splints on upper limb spasticity in chronic patients with disorders of consciousness: A randomized, single-blind, controlled trial

Aurore Thibaut[1], Thierry Deltombe[2,3], Sarah Wannez[1], Olivia Gosseries[1,4,5], Erik Ziegler[6], Cyril Dieni[2], Maxime Deroy[2], & Steven Laureys[1]

[1]Coma Science Group, Cyclotron Research Centre and Neurology Department, University and University Hospital of Liège, Liège, Belgium, [2]Motor Sciences Faculty, Catholic University of Louvain, Louvain-la-Neuve, Belgium, [3]Physical Medicine and Rehabilitation Department, CHU Dinant – Godinne/UCL Namur (University of Louvain), Yvoir, Belgium, [4]Center for Sleep and Consciousness, Department of Psychiatry, [5]Postle Laboratory, Department of Psychology, University of Wisconsin, Madison, WI, USA, and [6]Cyclotron Research Centre, University and University Hospital of Liège, Liège, Belgium

- 17 patients – MAS, Tardieu, ROM fingers/wrist/elbow + hand opening



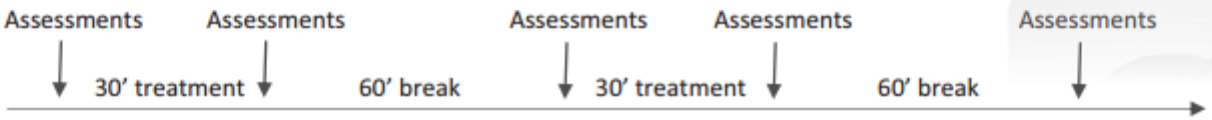
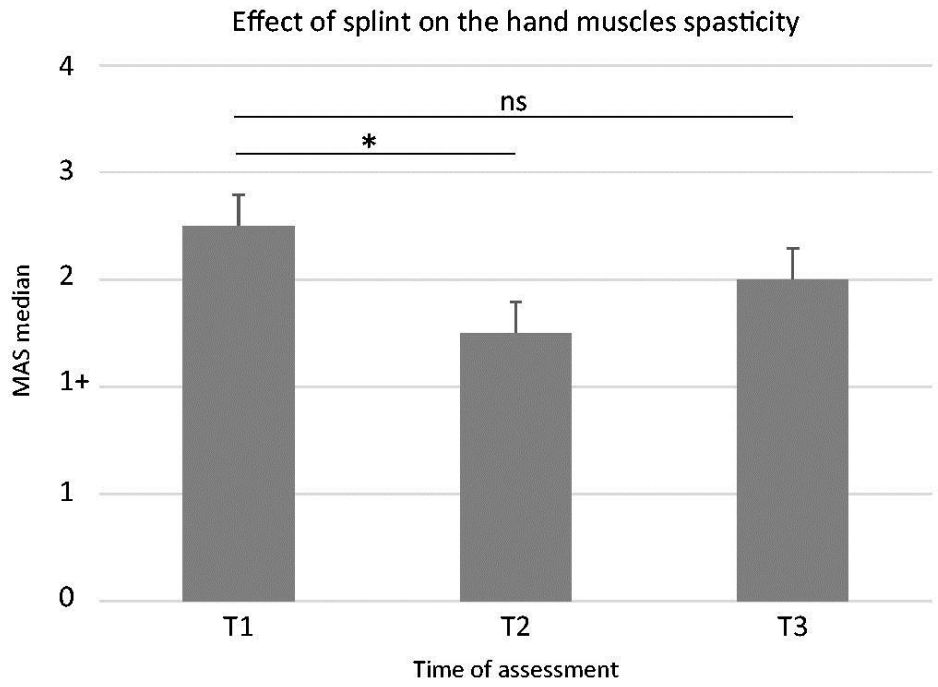


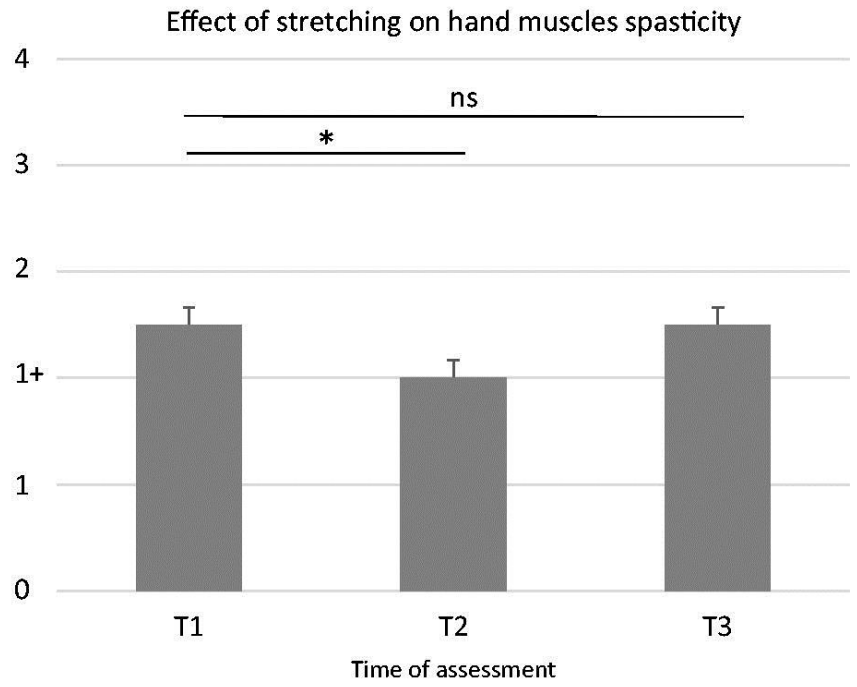
Figure 2. Experimental protocol. Technique A = splint; technique B = manual stretching; technique C = no treatment;assessments: physiotherapist 1; treatments: physiotherapist 2.

Thibaut et al., Brain Injury, 2015

Soft splints: Results

- Spasticity decreases after stretching and splinting
- Hand opening improves after splinting
- Effects transient





Thibaut et al., Brain Injury, 2015

Soft splints: Next Steps

- Long term study
- 3 weeks
- Compare DOC vs. stroke
- Tolerability?
- Effects on tone? Pain? QoL?

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Conclusions

- Spasticity = common motor disorder affecting muscle tone
- Concerns a high proportion of patients with DOC
- Likely to cause pain

- **How to approach:**

1) Identify (scales)
2) Treat: PT (stretching), OT (positioning, splinting/casting)
3) Soft splints: valuable adjuvant to treatment
4) Follow-up

THANK YOU

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