Influence of botulinum toxin injection on preferred walking speed and gait endurance in chronic stroke patients

Zwissig C.[1,2,3], Hennemann C.[1,4], Opsommer E.[2] & Malatesta D.[1]

[1]Institute of Sport Sciences (ISSUL), Faculty of Biology and Medicine, University of Lausanne (UNIL), Switzerland. [2]School of Health Sciences (HESAV), University of Applied Sciences and Arts Western Switzerland (HES-SO), Lausanne, Switzerland [3]Department of Clinical Neuroscience (DNC), Lausanne University Hospital (CHUV). Switzerland. [4]Department of Intensive Care (APSI), Geneva University Hospitals (HUG), Switzerland

Introduction

Community ambulation is one of the most important goals for stroke patients [1]. The spasticity of ankle plantarflexors is primary factor associated with reduced gait speed in chronic stroke [2].

Botulinum toxin injection (BTI) represents the gold standard therapy for focal spasticity [3]. However, it remains unclear whether BTI is really effective in functional improvements [4]. Walking abilities are frequently secondary outcomes and are often poorly investigated.

Purpose

The aim of this study was to assess influence of BTI in ankle plantarflexors on preferred walking speed (PWS) and gait endurance in chronic stroke patients.

Methods

Twelve participants (55.6 ± 11.6 years; 6.5 ± 2.7 years since stroke, BMI 28 ± 5.5 kg/m^2) were assessed before (T0) and one month (T1) after BTI at the service of Neuropsychology and Neurorehabilitation (CHUV).

Fig. 1: foot-worn inertial sensor

PWS and spatiotemporal parameters (STP) of gait were measured using two wearable inertial sensors (Physilog® - GaitUp, Switzerland, **Fig. 1**) during a 10-Meter Walk Test (10mWT). Gait endurance was assessed with a 6 minutes walk test (6MWT).

Passive range of motion (ROM), spasticity (Modified Ashworth Scale, MAS), strength (Motricity Index, MI), ambulation ability (Functional Ambulation Category, FAC), questionnaire on physical activities (Voorrips) and independence in activities of daily living (Barthel Index, BI) were also evaluated (**Fig.2**).

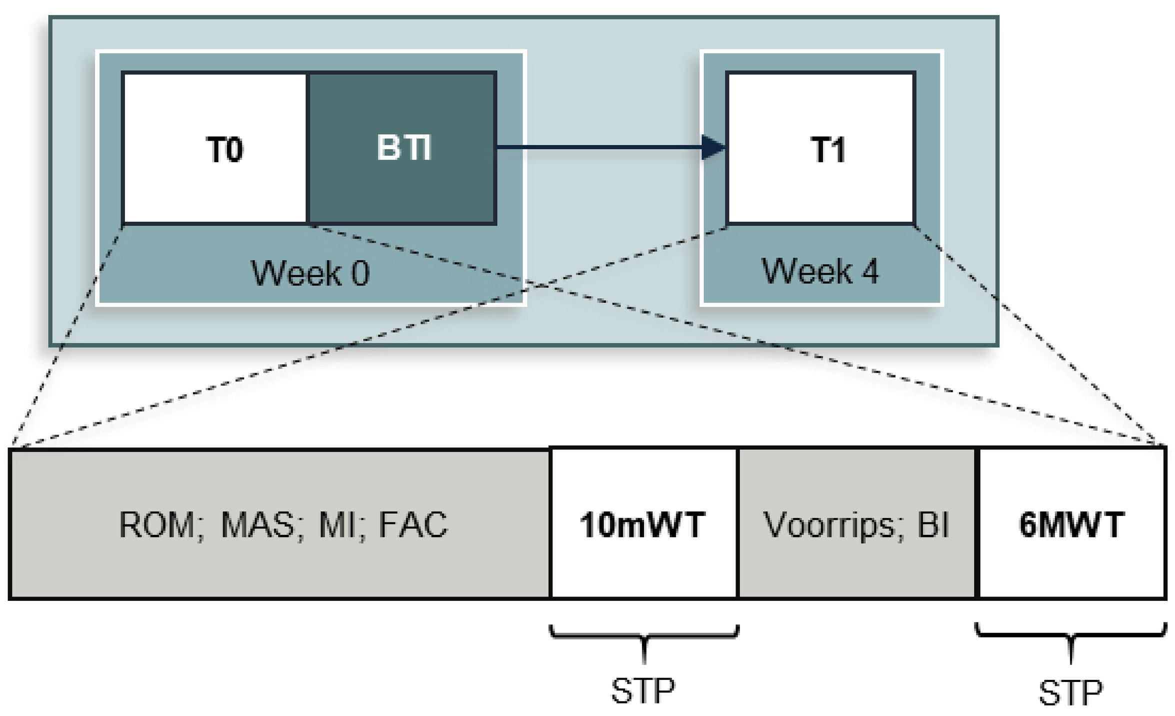

Fig. 2: Assessment process

Results

Range of motion & spasticity

A significant improvement was found on passive ankle dorsiflexion (p = 0.031, small effect size) and on MAS in ankle plantarflexors (p = 0.004, medium effect size) (**Table 1**).

Table 1: Range of motion and spasticity before and after BTI.

Variables	T0		T1		*P* value	Effect size	
	A	*NA*	*A*	*NA*		*A*	*NA*
ROM ADF [°]	-5.25 ± 14.85	27.83 ± 5.56	0.50 ± 14.96	27.75 ± 5.69	**0.031$^{*,\$}$**	0.39 (S)	0.01
MAS APF [0-5]	1.83 ± 0.81	0.00 ± 0.00	1.21 ± 0.92	0.00 ± 0.00	**0.004$^{*,\$}$**	**0.73 (M)**	-

Mean values ± standard deviation (SD). A, affected; ADF, ankle dorsiflexors; APF, ankle plantarflexors; M medium; MAS, Modified Ashworth Scale; NA, non-affected; S small; ROM, Range of motion.

P value, *P* value for interaction [time (T0 vs. T1) x side (A-NA)] of the 2-way repeated-measures design ANOVA

*significant time (T0 vs.T1) effect (p < 0.05) $^\$$significant side (A vs.NA) effect (p < 0.05)

Preferred walking speed

One month after BTI, PWS was significantly improved from 0.66 m/s to 0.78 m/s (+ 18%, p = 0.04, small effect size) (**Fig. 3**).

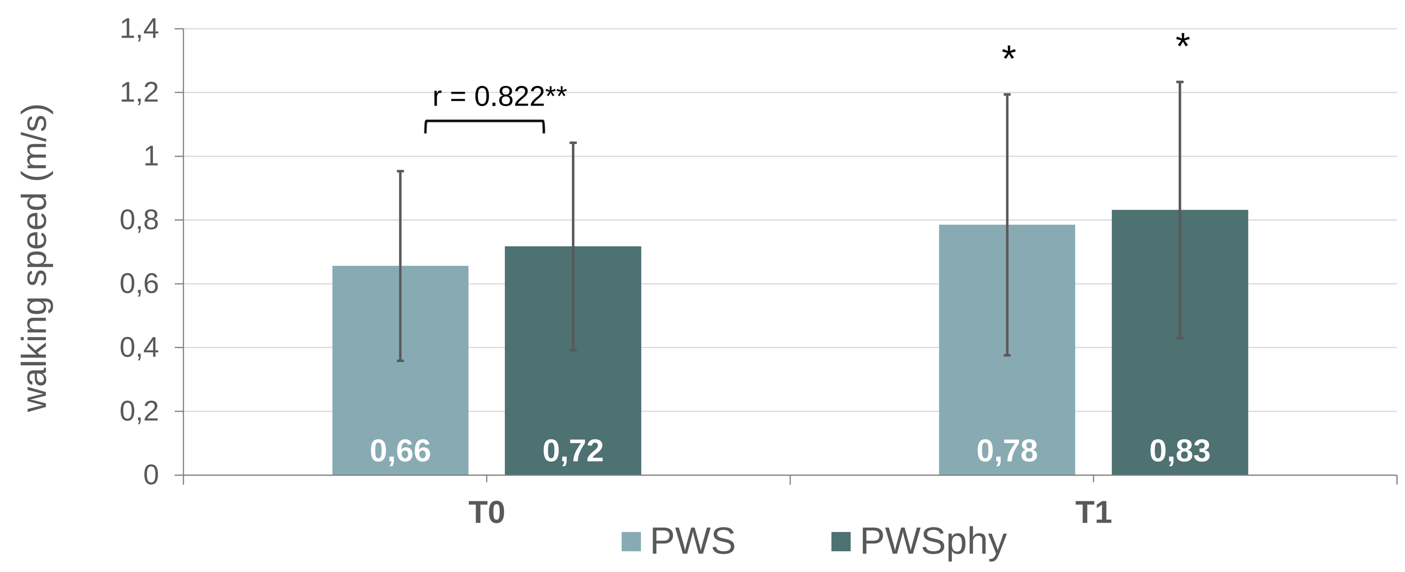

Fig. 3: Preferred walking speed with stopwatch (PWS) or Physilog (PWS_{PHY}). *significant time effect (p < 0.05); **p < 0.001

Spatiotemporal Parameters

Table 2: STP on 10mWT before and after BTI

Variables	T0		T1		*P* value	Effect size	
	A	*NA*	*A*	*NA*		A	NA
Cadence [step/min]	88.9 ± 18.2	89.2 ± 20.3	95.0 ± 26.6	97.8 ± 26. 4	0.333$^{†,\$}$	0.31 (S)	**0.40 (M)**
Stride length [m]	0.98 ± 0.32	0.90 ± 0.31	1.08 ± 0.40	0.98 ± 0.35	0.873†	0.26 (S)	0.26 (S)
Stride speed [m/s]	0.71 ± 0.32	0.66 ± 0.32	0.81 ± 0.41	0.80 ± 0.45	0.114*	0.29 (S)	**0.40 (M)**
Loading response [%]	6.54 ± 1.41	7.32 ± 4.35	7.84 ± 3.72	8.29 ± 4.89	0.721	**0.51 (M)**	0.21 (S)

See table 1

PWS improvement after BTI was highly correlated with enhancement of NA stride speed (r=0.91, p=0.000), NA stride length (r=0.81, p=0.002) and A relative loading response duration (r=0.88, p=0.000).

Gait endurance

BTI had no significant effect on walking endurance (T0: 268 ± 158 m and T1: 289 ± 187 m ; p = 0.133, less than small effect size).

The other outcomes showed no significant effect

Conclusions & Perspectives

(1) BTI alone improved PWS in chronic stroke patients but had no effect on gait endurance after one month.

(2) Decrease in ankle plantar flexors spasticity and increase in passive dorsiflexion appeared to improve the initial stance phase on affected lower limb, thus optimizing swing phase on unaffected side.

➔ It would be interesting to assess combination of BTI with aerobic training and specific strengthening exercises. This association would optimize the effect of BTI on gait endurance.

References

[1] Barclay RE, Stevenson TJ, Poluha W, Ripat J, Nett C, Srikesavan CS. Interventions for improving community ambulation in individuals with stroke. Cochrane Database of Systematic Reviews 2015, Issue 3. Art. No.: CD010200. DOI: 10.1002/14651858.CD010200.pub2.

[2] Mentiplay BF, Adair B, Bower KJ, Williams G, Tole G, Clark RA. Associations between lower limb strength and gait velocity following stroke: A systematic review. Brain Injury 2015, 29(4), 409-422. DOI: 10.3109/02699052.2014.995231

[3] McIntyre A, Lee T, Janzen S, Mays R, Mehta S, Teasell R. Systematic review of the effectiveness of pharmacological interventions in the treatment of spasticity of the hemiparetic lower extremity more than six months post stroke. Top Stroke Rehabil. 2012;19:479–490. DOI: 10.1310/tsr1906-479

[4] Demetrios M, Khan F,Turner-Stokes L, Brand C, Mc Sweeney S. Multidisciplinary rehabilitation following botulinum toxin and other focal intramuscular treatment for post-stroke spasticity. Cochrane Database of Systematic Reviews 2013, Issue 6. Art. No.: CD009689. DOI: 10.1002/14651858.CD009689.pub2.

Contact details

For further information, please contact camille.zwissig@hesav.ch

Communication

Approved by the Swiss Ethics Committees on research involving humans (Swiss Trial Register 2016-00471).

Results were presented at the European Congress of NeuroRehabilitation 2017 (Lausanne, Switzerland) and at the World Confederation for Physical Therapy 2019 (Geneva, Switzerland)