

Repetition of conditional stimulations as treatment for detrusor hyperreflexia may potentiate the effect

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Abstract

Introduction Conditional short duration electrical stimulation can inhibit hyperreflexic detrusor contractions and increase cystometric capacity in spinal cord injured patients significantly. **Material and Methods** Six patients had a standard cystometry performed as a control. To optimize stimulation parameters conditional electrical stimulation using 8, 15 and 30 pulses per second (pps) in randomized order was performed during three subsequent cystometries. The stimulation was performed on the penile/clitoral

nerve in response to one or more hyperreflexic detrusor contractions during the three cystometries. **Results** Mean cystometric capacity increase compared to control: 1st cystometry 48%, 2nd 59%, 3rd 63%. The most effective pulse-frequency was 8 pps. Increase compared to control: 8 pps 70%, 15 pps 43% 30 pps 57%. **Conclusion** Our findings suggest that repetition of conditional stimulation may lead to potentiation rather than habituation. A stimulation frequency of 8 pps seems to be more effective than 15 pps and 30 pps.

Introduction

Spinal cord injured patients with a lesion above the sacral micturition center suffer from detrusor sphincter dyssynergia and detrusor hyperreflexia. The injury impairs or eliminates the regulatory input from the higher centres, leading to lower urinary tract dysfunction. Detrusor hyperreflexia disturbs the storage function and it may cause incontinence and reflux. The pharmacological treatments are in many cases insufficient to prevent incontinence episodes and high bladder pressures. More efficient treatments for detrusor hyperreflexia involve surgery, either in bladder augmentation procedures or in dorsal rhizotomy. Bladder augmentation procedures carries side-effects related to the mucosal surface of the neo-bladder, whereas rhizotomy involves irreversible division of nerves and leads to loss of reflex erection^{1,2}.

Activity in the dorsal penile/clitoral nerve, which is an exclusively afferent branch of the pudendal nerve, is inhibitory to the micturition reflex³⁻⁵. Our group performed a study in 10 spinal cord injured patients using conditional short duration stimulation of the dorsal penile/clitoral nerve (2-25 s). The parameters were: 20 pulses per second (pps), pulselwidth 200 µs, amplitude 2 times threshold for eliciting the bulbocavernosus reflex. Hyperreflexic contraction could be inhibited repeatedly and cystometric capacity was increased by 72%^{5,6}.

In order to optimize the stimulation parameters the present study was initiated. By performing conditional stimulation using different pulse-frequencies during 3 consecutive standard cystometries, the effect of repeated treatments and of different pulse-frequencies can be investigated. The study is ongoing.

Material and Methods

The local ethical committee approved of the study, and informed consent was obtained from the 6 patients enrolled.

Inclusion criteria were: detrusor hyperreflexia demonstrated at less than 500 ml infused during a standard cystometry on the day of the experiment, complete or incomplete suprasacral spinal cord injury irrespective of pathophysiological origin, age over 18 years and 6 months or more post injury. Exclusion criteria were: damage to peripheral nerves involved in the reflex-loops investigated, other serious disease or pregnancy. Medical treatment for detrusor

hyperreflexia or other diseases was not discontinued prior to the experiment

Cystometries were performed according to ICS-definitions transurethrally, as one continuous infusion of body-warmth saline with an infusion-rate of 60 ml/min via a Ch-8 catheter while intra-vesical pressure was measured through another Ch-8 catheter, using a Dantec Menuet®, Dantec Duet® or an MMS® Urodynamic Computer. Cystometric capacity was established as leakage volume, the volume at which hyperreflexic phase started defined as the part of the cystometry where repeated contractions merged and led to a prolonged phase of oscillatory high pressures, or

the maximal infused volume of 600 ml. The cystometry performed as part of the inclusion criteria served as the patient's control-cystometry. Electrical stimulation was performed using a bipolar electrode (HUSH-bar™ electrode, Dantec-Medtronic®), which was held by the investigator on the skin over the dorsal penile/clitoral nerve. Switching stimulation-trains on/off was performed manually, the "stimulation on"-trigger signal being a increase in P_{det} of 5 cmH₂O, the "stimulation

off"-trigger signal being a decrease in P_{det} . Both trigger-signals were obtained by visual inspection of the monitor of the Urodynamic Computer. Pulse-frequencies of 8, 15 and 30 pps were tested in randomised order (Table 1). Repeated stimulation-sequences were performed in response to repeated bladder contractions during one cystometry. Control cystometric capacity was compared to the 3 treatment cystometry capacities.

	No stimulation	Conditional stimulation		
	Control cystometry	1 st cystometry: pulses/s	2 nd cystometry: pulses/s	3 rd cystometry: pulses/s
1, Female		8	15	30
2, Male		30	8	15
3, Male		15	8	30
4, Female		15	30	8
5, Male		8	30	15
6, Male		30	15	8

Table 1.

The 6 possible combinations of the three different simulation-frequencies were randomised before examinations.

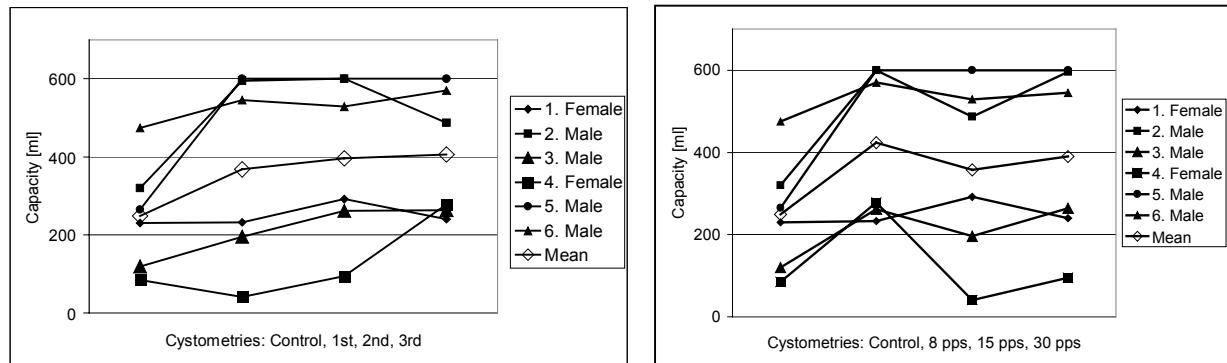


Fig 1.

The cystometric capacity of the control cystometry and the three consecutive cystometries.

Fig 2.

The cystometric capacity of the control cystometry and the treatment cystomtries ranked by stimulation frequency.

Results

A typical control cystometry consisted of a normal compliant storage phase followed by a rapid change into the hyperreflexic phase.

During the treatment cystometries, inhibition stimulation was considered effective if a pressure reduction elicited was markedly lower than observed during the natural pressure oscillations of the hyperreflexic phase found during the control cystometry. According to this criterium inhibition was effective in 4 of the 6 patients (Fig 1 and 2). Of the patients where inhibition was ineffective, one (#4) was in treatment for urinary tract infection and the other patient (#5) was stimulated with relatively low

amplitude (18 mA) due to partially preserved sensation. One patient (#3) reported some bladder sensation and the occasional use of penis squeezing to postpone voidings.

The mean capacity increased with repetition of the cystometries (Increase compared to control: 1st cystometry 48%, 2nd 59%, 3rd 63%). Marked difference between the control and the first stimulated cystometry was noted, whereas the increments between the three stimulated cystometries were smaller. The most effective pulse-frequency was 8 pps (Increase compared to control: 8 pps 70%, 15 pps 43% 30 pps 57%).

Discussion

These preliminary data supports the conclusion of the previous study performed by this group: conditional stimulation of the dorsal penile nerve inhibits hyperreflexic detrusor contractions and leads to increases in cystometric capacity. The fact that one patient uses squeezing of the penis to postpone voidings, which is equivalent to our experimental treatment, underlines the potency of the reflex arc exploited. The capacity and pressure properties of the bladder have been shown to be less adaptive to repeated bladder fillings than case is with detrusor hyperreflexia in non-spinalised patients⁶⁻⁸. Accordingly changes between control and treatment cystometries seen in the present study can be ascribed to the stimulation performed. Conditional stimulation

increases capacity by 50-60%, the increase gets slightly larger as treatment cystometries are repeated. Thus, our findings suggest that repetition of the conditional stimulation may lead to potentiation rather than habituation. A stimulation frequency of 8 pps seems to be more effective than 15 pps and 30 pps. A study in 15 paraplegics using conditional stimulation via an anal plug electrode found 5, 10 and 20 pps stimulation-frequencies to be equally effective⁹. Continuous stimulation of the dorsal penile nerve using 1 and 5 pps was effective in eliminating hyperreflexic contractions and increasing cystometris capacity^{3,4}. Further studies are needed to optimize stimulation parameters and substantiate the effect of repeated conditional stimulation cystometries.

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