

Hansen J¹, Fjorback M V¹, Media S², Nøhr M³, Biering-Sørensen F⁴, Sinkjær T¹, Rijkhoff N J M¹

1. Center for Sensory-Motor Interaction, Aalborg University, Denmark, 2. Paraplegic function, Rheumatological Department, Viborg Hospital, Denmark, 3. Department of Urology, Aalborg Hospital, Denmark, 4. Clinic for Para- and Tetraplegia, Copenhagen University Hospital, Denmark

AUTOMATIC EVENT DRIVEN ELECTRICAL STIMULATION FOR TREATMENT OF NEUROGENIC DETRUSOR OVERACTIVITY IN SPINAL CORD INJURED PATIENTS

Hypothesis / aims of study

Neurogenic detrusor overactivity (NDO) is a common urodynamic observation in patients with spinal cord injury (SCI). It is characterised by involuntary detrusor contractions during the filling phase which may be spontaneous or provoked. Patients with NDO often have high intravesical pressures, low bladder capacity and suffer from incontinence. If left untreated the high pressures can lead to upper urinary tract damage.

NDO is usually managed conservatively by medication, such as anticholinergic drugs. Many patients are however refractory to this treatment or they cannot tolerate the side effects. In that case surgical options are usually considered to prevent kidney damage. An alternative treatment option is electrical stimulation. It has been shown that electrical stimulation of pudendal nerve afferents can inhibit bladder contractions in SCI patients and that bladder capacity can be increased by continuous [1] as well as conditional stimulation [2]. The aim of this study was to evaluate the feasibility and clinical relevance of automatic event driven electrical stimulation of the dorsal penile/clitoral nerve in treatment of NDO in individuals with SCI.

Study design, materials and methods

The study was approved by the local Ethics Committee and informed consent was obtained from all patients. A total of 16 SCI patients have been examined (14 M, 2 F). Inclusion criteria were occurrence of NDO at bladder capacities below 500 ml, age over 18 years and complete or incomplete suprasacral SCI. Participants were not asked to discontinue medication prior to participating in this experiment. Stimulation was conducted using surface electrodes placed on the base of the penis or on the clitoris and parameters were: 20 pulses/s, pulse width 200 μ s and amplitude two times threshold for elicitation of the bulbocavernosus reflex.

P_{ves} and P_{abd} were measured using a custom made portable device [3] and electrical stimulation was applied based on the calculated P_{det} . In each patient 2 sessions of natural bladder filling were monitored:

Session 1: Untreated filling (without stimulation).

Session 2: Treated filling (with stimulation applied when $P_{det} > 10$ cmH₂O).

During session 2, stimulation was stopped in the following cases:

- Automatically, when P_{det} had been under the threshold for a period of 10 s.
- Manually, when a leakage was detected (by visual inspection).
- Manually, when stimulation had been on for more than 2 minutes without a decrease in pressure.

In order to evaluate the effect of penile/clitoral nerve stimulation 4 parameters were calculated/extracted:

- A) Bladder volume at first contraction during treated filling. *
- B) Bladder volume at the time of leakage in treated filling. **
- C) The average peak pressure of P_{det} during contractions in the untreated filling.
- D) The average peak pressure of P_{det} during suppressed contractions in the treated filling.

* Calculated on the assumption of linear urine production during the time of treated filling.

** Measured as volume leaked + residual urine at the end of the treated filling.

Results

Stimulation increased bladder capacity in 13 out of 16 patients (81%). In 2 patients stimulation could not inhibit the first undesired contraction and leakage occurred and 1 patient could not tolerate the stimulation. Figure 1 shows the individual bladder capacities as well as the mean capacity (box) and its standard deviation (T-bar). Figure 2 shows the individual average peak pressure of P_{det} during untreated and treated filling together with mean and standard deviation.

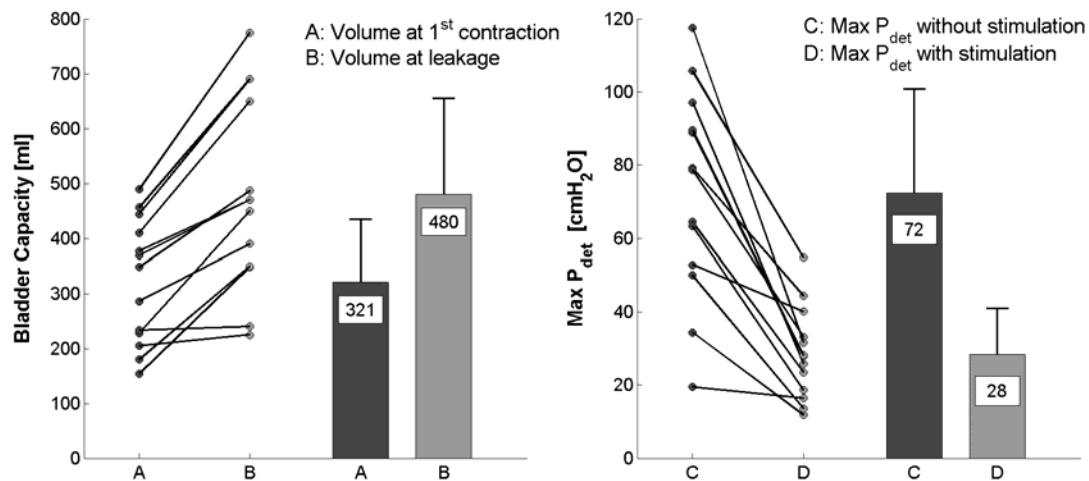


Figure 1: Bladder capacity at first contraction and at leakage during treated filling. (Boxes indicate mean value and T-bars indicate standard deviation)

Figure 2: Max detrusor pressure with and without stimulation. (Boxes indicate mean value and T-bars indicate standard deviation)

Interpretation of results

Results from the 13 good responders indicate that it is feasible to treat NDO by event driven electrical stimulation. An average bladder capacity increase of 53% was obtained. The average peak detrusor pressure during suppressed contractions in the stimulated filling was 28 cmH₂O (range 12 - 55 cmH₂O) and is thus sufficiently low to prevent kidney damage.

Concluding message

In 81% of the patients bladder capacity was increased and storage pressure decreased as a result of automatic event driven electrical stimulation. Although the setup in this experiment is not suitable in the chronic setting, the treatment modality is promising. Today implants stimulating the pudendal nerve afferents are available but they use continuous stimulation. Habituation of the involved reflexes and a reduced life span of the electrodes have been suggested as possible reasons for a timely decline in the number of good responders. This makes it relevant to investigate event driven stimulation. Steps are being taken in order to develop a non-catheter based monitoring of bladder activity, since this is needed in order to apply stimulation automatically.

References

- [1] Bladder inhibition by penile nerve stimulation in spinal cord injury patients, J Urol, 1992. 147: p.100-103
- [2] Conditional stimulation of the dorsal penile/clitoral nerve may increase cystometric capacity in patients with spinal cord injury, Neurourology and Urodynamics, 2003. 22(2): p. 130-137
- [3] A Portable Device for Experimental Treatment of Neurogenic Detrusor Overactivity, Neuromodulation, 2003. 6(3): p. 158-165

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