

ANALYSIS OF THE COUPLING BETWEEN EFFERENT NERVOUS EXCITATION OF DETRUSOR AND SPHINCTER DURING PHASIC DETRUSOR OVERACTIVITY IN WOMAN.

Hypothesis / aims of study

Detrusor overactivity (DO) is a frequent urodynamic diagnosis in patients with urge syndrome. DO is characterized by involuntary detrusor contractions (IDC). The precise mechanism underlying DO remains discussed but evaluation of the detrusor excitation during IDC and subsequent voiding could allow determining some ways of research. It is usual to distinguish phasic (P) (wave(s) with or without leakage) from terminal (T) DO.

After a previous study dedicated to detrusor excitation, our objective was now to analyze the efferent nervous control of both detrusor and striated sphincter during IDC using the VBN mathematical model of micturition [1-2].

Study design, materials and methods

Cystometries (filling rate 50 mL/min, triple lumen urethral catheter 7F) of 15 women (with lower urinary tract symptoms due to incontinence or frequency) were analyzed; all women had urodynamically proven PDO. Urethral sensor was located at the site of maximum urethral closure pressure (MUCP).

The VBN model [1] was applied to the recordings to deduce from the recorded pressures the mean firing rate F of the efferent neurons or the ratio F/F_{\max} [2]. The calcium concentration in the muscular cell is a delayed function of the firing rate with a time constant $T_{\det}=6s$ and $T_{\text{sph}}=3s$ [2]. The muscular force is almost proportional to the calcium concentration.

In each cystometry, each IDC was analyzed independently.

Results

Mean age was $47\pm 21y$ [18-86y]; 3 women had a history of neurological disease (multiple sclerosis). Only 1 woman had MUCP lower than the value expected for age.

The mean number of IDC during bladder filling was 5.6 ± 1.4 [3-8].

For the 15 women, each IDC was interpreted with an all or none variation of the detrusor excitation. Before IDC (time $t < t_{d1}$), $(F/F_{\max})_{\det}$ was near 0. At the beginning of IDC, $(F/F_{\max})_{\det}$ reached a high, constant value which persisted during the whole IDC ($t_{d1} \leq t < t_{d2}$). At $t = t_{d2}$ $(F/F_{\max})_{\det}$ returned abruptly to its initial value. The "high value duration" (HVD = $t_{d2} - t_{d1}$) was 9.5 ± 2.8 s. The detrusor pressure followed the efferent excitation with a time constant $T_{\det} = 6s$.

For 13/15 women, detrusor excitation during each IDC was roughly synchronized with a decrease of the sphincter excitation (also an all or none process). There was a high initial $(F/F_{\max})_{\text{sph}}$ value related to the closure pressure of the urethra, then a lower, constant value during IDC. The onset of the sphincter relaxation occurred slightly after the beginning of the detrusor excitation ($t_{s1} - t_{d1} = 3.4\pm 3.1$ s [0-10]). The sphincter excitation stopped after the onset of detrusor relaxation: $(t_{s2} - t_{d2}) = 4.9\pm 3.3$ s. After t_{s1} the sphincter pressure followed the excitation with a time constant $T_{\text{sph}}=3s$. After t_{s2} , the time constant was always $T_{\text{sph}}=3s$ except for 7 patients for whom $T_{\text{sph}}=T_{\det}=6$ s.

For 2/15 women, the sphincter behavior during IDC was not relaxation but steady in one case and reinforcement in the other one.

The figure gives an example of analysis of an IDC.

Interpretation of results

Several authors ascribe DO to abnormal afferent signalling due to abnormal intrinsic bladder reflexes. No animal model is able to reproduce all the phenomena which generate DO.

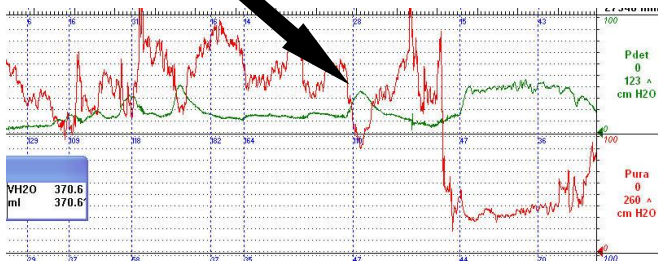
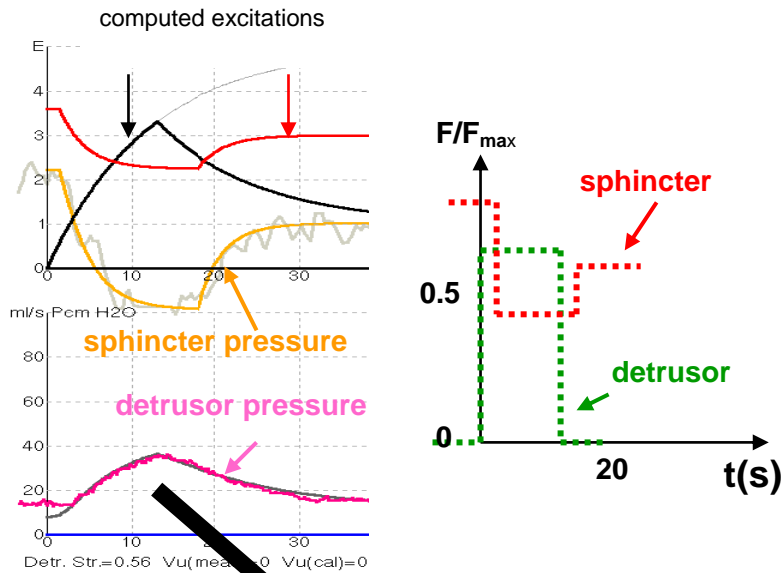
A merit of mathematical modelling is to allow analysis of urodynamic recordings from individuals. From our analysis, the detrusor excitation appears as the leading phenomenon. The "high value duration" of the detrusor excitation, greater than T_{\det} is consistent with an inhibitory feedback.

The sphincter relaxation occurring after the onset of the detrusor excitation could be analogous to the voiding reflex. The inhibitory feedback which stops the detrusor excitation allows the sphincter excitation to regain a value compatible with continence.

Explanation of the 2 abnormal sphincter behaviors (steady and reinforced) needs a larger population.

Concluding message

That first study of the efferent signals suggests that an afferent signal would trigger a normal voiding which components are separately and quickly inhibited. HVD slightly greater than T_{\det} is consistent with an inhibitory loop including, as suggested in [3], a urothelium-derived inhibitory factor.



Example of analysis of an IDC

References

1. NAU 2000; 19: 153-176
2. UroToday International Journal 2010 vol 3(4) August
3. NAU 2008; 27: 79-87

Specify source of funding or grant	None
Is this a clinical trial?	No
What were the subjects in the study?	HUMAN
Was this study approved by an ethics committee?	No
This study did not require ethics committee approval because	It involved retrospective analysis of urodynamic studies from a database.
Was the Declaration of Helsinki followed?	Yes
Was informed consent obtained from the patients?	No