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INFLUENCE OF INCREASED COUGH INTENSITY ON THE ACTIVATION TIMING AND CONTRACTILE FORCE OF ASSOCIATED PELVIC FLOOR MUSCLE CONTRACTION IN CONTINENT WOMEN

Hypothesis/aims of study

The pelvic floor muscles (PFM) play a major role in continence since they participate in urethral occlusion during increased intra-abdominal pressure (IAP). These circumstances are known to be critical for stress incontinent women, especially when the increase in IAP is abrupt, as in coughing. Based on the observation that PFM contraction occurs before coughing [1], it has been suggested that the PFM occlude the urethra to counteract the increase in IAP to prevent urinary leakage. To date, evaluation of the PFM response has been limited to maximal coughs. However, since women experience urinary leakages not only during maximal effort, it is important to study the way that the central nervous system modulates the PFM response during different cough intensities. The aim of this study was to determine whether the cough intensity influences 1) the early activation timing and 2) the contractile force of the PFM in continent women.

Study design, materials and methods

Ten continent women, aged between 24-44 years, participated in the study. Their continence status was confirmed by a pad test and the Urogenital Distress Inventory Questionnaire. During the PFM measurements, women adopted a supine lying position with knees and hips flexed, feet flat on a conventional examination table.

A dynamometric speculum was inserted in the vaginal cavity to evaluate the PFM contractile force during coughing. This new instrument is reported to provide a direct and valid measurement of the PFM during increase in IAP [2]. At the same time, electromyographic (EMG) signals of the PFM were recorded by surface Medtronic electrodes placed on the lower branch of the dynamometer. To monitor the intensity of coughing, IAP was measured with an intra-rectal balloon connected to a pressure transducer.

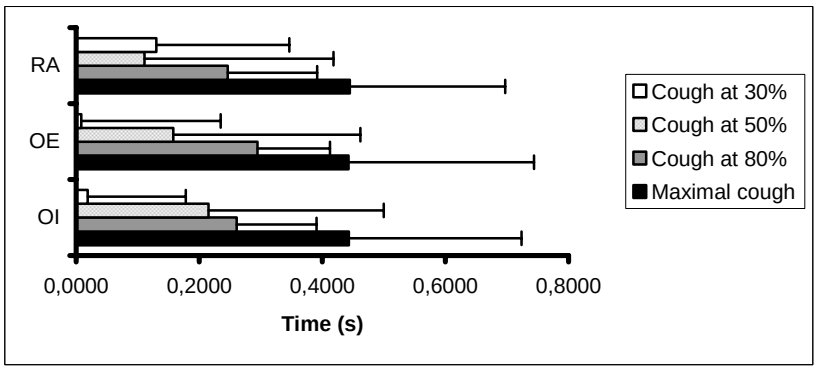
To assess the PFM activation timing during various cough intensities, we compared the onset of PFM EMG to the onset of the abdominal muscles (rectus abdominis (RA), obliquus internus abdominis (OI), obliquus externus abdominis (OE)) recorded through surface electrodes. The timing analysis was based on EMG onsets of PFM and abdominal muscles rather than the onset of the IAP or dynamometric measurement, since the latter measurements may involve a mechanical delay. The abdominal muscle EMG was therefore taken as an indicator of IAP. Muscle onset was determined by a technique previously reported [3].

All signals were recorded by a laptop computer. The subjects were instructed to cough maximally and then at 30, 50 and 80%. Subjects had access to visual feedback of the IAP to perform the required cough intensities properly. The PFM response (activation timing and contractile force of the PFM) were compared for the different cough intensities using ANOVAs for repeated measures. The differences between cough intensities were evaluated using Student t tests with a Bonferroni adjustment for multiple comparisons.

Results

As shown in Figure 1, the PFM activation timing is related to cough intensities. The ANOVAs indicated that the PFM activation timing is significantly different across cough intensities ($p < 0.003$). When assessing differences between cough intensities, the activation timings differed significantly between the maximal cough and the 30% cough ($p<0.002$). Therefore, early activation of the PFM, i.e. before the abdominal muscles contract, is more pronounced when the cough is near maximal while a light cough resulted in a delayed activation of the PFM.

Figure 1. Muscle activation timing for different cough intensities (onset of the abdominal muscle minus onset of the PFM). Standard deviations (SD) are illustrated.



To obtain the global onset for all abdominal muscles, we calculated the onset of the PFM relative to the average of the three abdominal muscles. The ANOVA indicated a significant difference across cough intensities ($p=0.001$). Similar to the results for individual abdominal muscles, the Student t tests showed a difference between the 30% and the 100% coughs ($p<0.001$).

Regarding the PFM contractile force (Table 1), the ANOVA revealed significant differences across cough intensities ($p<0.001$). Student t tests indicated that the contractile forces were different for each cough intensity ($p<0.03$). Hence, there is a modulation of the PFM contractile force which is dependent on the cough intensity.

Table 1. PFM response during coughs at various intensities.

Cough intensities	IAP (cm H_2O) ± 1 SD	Mean PFM contractile force (N) ± 1 SD	Mean PFM activation timing (relative to the global onset for all abdominal muscles) (s) ± 1 SD
30%	5.6 ± 3.5	1.8 ± 0.8	0.0523 ± 0.1630
50%	11.2 ± 6.6	3.5 ± 1.2	0.1872 ± 0.2992
80%	19.2 ± 11.3	5.4 ± 2.0	0.2670 ± 0.1188
100%	28.1 ± 14.9	8.1 ± 3.3	0.4433 ± 0.2706

Interpretation of results

The results indicate that a voluntary cough is preceded by an involuntary contraction of the PFM that is scaled to the intensity if the cough. Meanwhile, the early activation timing increases, suggesting that there should be enough time for the muscle tension in PFM to build up to a level compatible with the IAP magnitude associated with the cough intensity. Thus, the central nervous system seems to adapt the PFM response to the intensity of effort in order to adequately occlude the urethra and prevent urinary leakages.

Concluding message

The capacity to modulate the PFM response both in activation timing and contractile force during coughing may be affected in stress incontinent women. More studies on the PFM response during increased IAP should be undertaken in order to better understand stress urinary incontinence patho-physiology.

References

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