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Stafford R[1], Hodges P[1]
1. *University of Queensland*

DYNAMICS OF MALE PELVIC FLOOR CONTRACTION OBSERVED WITH TRANSPERINEAL ULTRASOUND IMAGING DIFFER BETWEEN VOLUNTARY AND EVOKED COUGHS

Hypothesis / aims of study

Stress urinary incontinence (SUI) is often provoked by coughing. Voluntary coughs are routinely assessed in clinical and research settings as a method to investigate the response of the muscles of the pelvic floor in patients, including men, who complain of these symptoms. Although there is some data available for women, there has been limited investigation of the control of continence during coughing in men. Recent studies of dynamics of the urethra with transperineal ultrasound imaging have highlighted unique strategies in men involving complex motion of the urethrovesical junction (UVJ) and mid urethra [1]. Motion of these regions needs to be studies in natural tasks such as coughing. Furthermore, it is not clear whether a voluntary cough is an adequate surrogate for the involuntary or spontaneous coughing that is associated with symptoms. A key issue is that unlike a spontaneous cough, a voluntary cough would enable greater preparation for the cough. Recent fMRI studies highlight different brain and brain stem control between voluntary and spontaneous coughing [2]. The aims of this study were; (i) to investigate the dynamics of urethral displacement in men during voluntary coughs; and (ii) to compare this to dynamics during an evoked cough.

Study design, materials and methods

Thirteen men aged between 28-42 years with no history of urological or neurological disease volunteered to participate in this study. Urethral position was recorded using real-time ultrasound imaging (in video format) with a transducer placed on the perineum in the mid-sagittal plane. A nasogastric pressure catheter quantified intra-abdominal pressure (IAP) and a pneumotachometer was used to record onset and amplitude of expiratory airflow. Abdominal muscle activity was recorded via surface electrodes. IAP, muscle activity and airflow recordings were synchronised with the ultrasound data via a footswitch. Participants sat in a semi-seated position and preformed voluntary and evoked coughs. For the voluntary cough participants inhaled deeply and then performed a strong voluntary cough, for 3 repetitions. Evoked coughing was stimulated by inhalation of nebulised capsaicin dissolved in saline as per the protocol described for fMRI [2]. A pre-determined, individualized concentration of capsaicin solution that elicited 2 or more involuntary coughs was inhaled to evoke a coughing response, and repeated 3 times.

Ultrasound video data were exported to single frame images and analysed frame-by-frame using a method described elsewhere [1] to calculate urethral displacements associated with activation of striated urethral sphincter (SUS), levator ani (LA) and bulbocavernosus (BC) muscles. Timing and amplitude of urethral displacements were calculated with variables which characterised cough generation including time of onset of IAP increase, time of initiation of expiratory airflow associated with the cough, time and amplitude of peak air flow, and time and amplitude of peak IAP. Temporal variables were calculated relative to onset of expiratory airflow and paired t-tests were used ($P<0.05$) to compare group data of timing and amplitude variables between voluntary and evoked coughs.

Results

Voluntary cough involved three phases. First, IAP increased without abdominal muscle activation as the participant inspired (pre-cough pressurisation phase). Second, IAP increased with abdominal muscle activation and slow posterior displacement of the mid-urethra (SUS contraction), with or without downward motion of the UVJ (lengthening of the LA) (cough pressurisation phase). This phase was either short or long, depending on the participant. Third, during the expulsion phase, SUS displaced the mid-urethra rapidly posterior, often initiated prior to onset of expulsion and reached its peak between mid to end of the expulsion. The UVJ either moved in a ventrocranial direction throughout the expulsion phase or continued to move dorsocaudally.

Evoked coughs differed from voluntary coughs in several respects. Time from onset of the increase in IAP to onset of expiratory airflow, and time from onset of expiration to peak air flow, were significantly longer during voluntary coughs. Time between onset of expiration and peak IAP was longer during evoked coughs. Peak IAP amplitude was higher during evoked coughs. Time of peak SUS displacement was earlier during voluntary coughs but consistently preceded time of peak UVJ elevation during both voluntary and evoked coughing efforts.

Interpretation of results

Patterns of dynamics of the urethra and IAP differed between participants and cough types, although several consistent features were observed. All participants maintained urinary continence during the experiment despite different dynamics. Consistent timing of peak SUS displacement prior to time of peak UVJ elevation provides evidence for the importance of timing of this muscle for maintenance of continence in men during coughing. Capsaicin inhalation evoked coughs which were stronger and had faster onset (decreased time from IAP onset to expiration) than voluntary coughs. This may have limited the potential for preparatory urethral displacement prior to expiration and may be more representative of cough events associated with SUI.

Concluding message

Early displacement at the mid-urethra (consistent with SUS contraction) prior to expulsive phase of coughing and peak UVJ elevation appears to be an important feature to maintain continence in men during voluntary and evoked coughs. Voluntary coughing has potential limitations for assessment of cough mechanics.

References

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Disclosures

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