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INTERACTION BETWEEN BLADDER NECK ELEVATION, INTRA-ABDOMINAL PRESSURE AND ACTIVITY OF THE PELVIC FLOOR AND ABDOMINAL MUSCLES DURING ABDOMINAL AND PELVIC FLOOR MANOEUVRES

Aims of study
The aim of this study was to assess the associations between bladder neck elevation during pelvic floor muscle (PFM) contraction, transverse abdominis muscle (TrA) contraction and abdominal tasks at different amounts of effort of the contractions in relation to the intra-abdominal pressure (IAP).
The interaction between PFM contraction, IAP and displacement of the bladder neck is complex, yet adequate control of urethral pressure and bladder neck position is required to maintain continence during increased IAP. The interactions must be carefully coordinated by the nervous system. However, the relative affect of different patterns of muscle activation remains unclear. Thus, recommendations for clinical practice in terms of advice for training cannot be determined.
This study focused on gentle and moderate contractions (low amount of effort) during abdominal tasks and pelvic floor muscle contractions.

Study design, materials and methods
The study involved 9 healthy young women with no history of pelvic floor disorders.
Bladder neck elevation was assessed with perineal ultrasound (3.5 - 6 MHz curved transducer; GE Medical, USA). Bladder neck position was measured using a coordinate system with the x-axis going through the pubic symphysis.
EMG recordings were obtained from the PFM using an intravaginal probe (Periform®). Fine-wire needle and superficial electrodes were used to record EMG activity of the abdominal muscles (lower and middle part of the transverse abdominis muscle: lowTrA and midTrA, obliquus internus abdominis muscle: OI, obliquus externus abdominis muscle: OE and rectus abdominis muscle: RA).
Intraabdominal pressure (IAP) was measured with a custom-made rectal pressure transducer above the level of the pelvic floor. EMG and IAP were recorded real time and simultaneously displayed on a monitor.
Subjects performed a range of contractions: transverse abdominis (TrA), brace (BR), head lift (HL), Valsalva (VAL) and a pelvic floor muscle contraction (PFM). All tasks were performed with two levels of effort: a very gentle contraction rated as 3 out of 15 on a modified Borg scale and a gentle to moderate contraction rated as 7 out of 15. Maximal voluntary contractions (MVC) of each muscle were performed for normalization.
The sequence of each task was: breathing in, breathing out and then performing the task (indicated by lifting a finger).
Root mean square (RMS) EMG amplitude, and IAP amplitude were measured for 1 s at rest and during contraction. EMG data were normalised to the maximum RMS EMG amplitude. Displacement of the bladder neck was calculated as the net displacement of the bladder neck. EMG was compared between rest and contraction, between muscles and between tasks with a repeated measures ANOVA. To determine whether the bladder neck displacement and the change in IAP were different to “no change”, data for each task were compared to zero with a t-test for single samples. To adjust for multiple comparisons the significance was adjusted using a Bonferoni correction.

Results
IAP was increased during each of the contractions of the abdominal and pelvic floor muscles (range: 0.46 cm H_2O during gentle TrA to 1.59 cm H_2O during moderate VAL, $P<0.05$). The IAP increased during the very gentle contractions, however the amplitude was small compared to that recorded during the moderate and maximal efforts. IAP increased by 16.3 (17.1) cm H_2O during the maximal PFM contraction task.

The bladder neck was only significantly elevated during pelvic floor and transverse abdominis contractions ($P<0.0001$), despite activity of the pelvic floor muscles in all tasks. The elevation of the bladder neck was greatest during moderate PFM contraction. There was no elevation of the bladder neck during gentle and moderate brace, head lift and Valsalva tasks ($P> 0.56$).

PFM activity (EMG) was increased during all tasks ($P<0.002$) and was greatest in the moderate PFM contraction followed by gentle PFM and moderate TrA contraction. The pattern of the functional tasks differed between tasks. The external obliquus and the rectus abdominal muscle were not activated in any of the gently and moderately performed tasks ($P>0.01$). During the gentle efforts there was no increase in activity of OI ($P>0.27$) or RA ($P>0.10$). A moderate PFM contraction, brace and VAL however significantly increased the OI activity ($P<0.02$).

LowTrA EMG increased with all tasks except the gentle PFM contraction (P<0.007). Although lowTrA EMG increased with all moderate effort tasks, midTrA EMG did not increase during the PFM and TrA contractions (P>0.18).
During a maximal PFM contraction, there was a co-activation with increased EMG amplitude in all abdominal muscles (by 8.2% MVC –midTrA to 32.8% MVC -lowTrA) and also the greatest increase in IAP.

Interpretation of results

The results of this study suggest that although a voluntary gentle and moderate pelvic floor muscle contraction increases the intraabdominal pressure, pelvic floor muscle activity is sufficient to overcome the increase in intraabdominal pressure and results in elevation of the bladder neck. During the abdominal manoeuvres, bladder neck elevation was only apparent when intraabdominal pressure and pelvic floor muscle activity were appropriately matched. The counteraction of the PFM seems important to maintain the bladder neck position. Of the abdominal manoeuvres included in this study, bladder neck elevation only occurred during the isolated Transverse abdominis contraction.

Concluding message

As all muscles surrounding the abdominal cavity have the potential to increase IAP. Increased IAP causes descent of the bladder neck and co-activation of the PFM is critical to maintain the position of the bladder neck during tasks that involve abdominal and diaphragm muscle contraction. If PF muscle activity is insufficient or abdominal muscle (IO, EO and RA) co-activity results in an associated increase in IAP, bladder neck descent may occur during functional tasks. Such descent of the bladder neck has been argued to be associated with urine loss.
We have shown that an increased amount of effort of a pelvic floor contraction leads to an increase in abdominal muscle activity which in turn may result in bladder neck descent. Consideration of the coordination of the pelvic floor and abdominal muscles is likely to be important in the management of stress urinary incontinence.

FUNDING: Financial support or the National Health and Medical Research Council of Australia
HUMAN SUBJECTS: This study was approved by the Institutional Medical Research Ethics Committee and followed the Declaration of Helsinki Informed consent was obtained from the patients.