390

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BREATHING WITH THE PELVIC FLOOR: COORDINATED ACTIVITY OF THE PELVIC FLOOR MUSCLES DURING INSPIRATORY AND EXPIRATORY EFFORTS

Hypothesis / aims of study

Pelvic floor muscle activity is modulated during respiration (1). This is predictable as pelvic floor muscle activity is required to maintain continence when intra-abdominal pressure, and thus intra-vesicle pressure, is modulated during the respiratory cycle as a consequence of contraction of the diaphragm and abdominal muscles to ventilate the lungs (2). During normal quiet breathing intra-abdominal pressure is elevated in inspiration due to contraction and descent of the diaphragm. When respiration is increased, such as during breathing with hypercapnoea, the change in intra-abdominal pressure is biphasic with a peak of pressure during inspiration and a smaller peak during expiration. Although simple biomechanics would predict that the activity of the pelvic floor muscles should be greater in association with the peak in intra-abdominal pressure during inspiration, recent data indicate predominantly expiratory activity, in conjunction with activity of the abdominal muscles (1). This tends to suggest coupling of activity of the pelvic floor muscles to activity of that abdominal muscles, rather than intra-abdominal pressure. The problem of control of the pelvic floor muscles during respiratory efforts can be comprehensively studied during graded inspiratory and expiratory efforts that would be expected to independently modulate pressure and abdominal muscle activity. This was the aim of the present study. A second aim was to compare the activity between the deep and superficial components of the pelvic floor muscles with a novel electrode as earlier data have indicated differences in these regions of the pelvic floor muscles during coughing.

Study design, materials and methods

Recordings of pelvic floor muscle electromypgraphic activity (EMG) were made during graded inspiratory and expiratory efforts in 8 women with no symptoms of incontinence. Seven women had a history of vaginal delivery. Pelvic floor muscle EMG was recorded with a custom-built vaginal surface electrode. The electrode was fabricated from 4 pairs of surface electrodes (Silver wire, 1 mm diameter, 15 mm exposed) attached to either side of a pelvic floor Educator (NEEN, UK). The electrodes were placed either side of the base of the Educator and 20 mm from the base in a vertical direction (Fig 1A). The wires were threaded through holes drilled in the probe and exited through the middle of the base for connection to the EMG amplifier. The placement of the electrodes was designed to enable recording from the deep and superficial regions of the PF muscles and on each side of the vagina. EMG activity was also recorded from transversus abdominis (TrA), obliquus internus (OI) and externus abdominis (OE), and rectus abdominis (RA) with fine wire electrodes inserted under guidance of ultrasound imaging. EMG activity was amplified 2000 times, filtered between 30 Hz – 1 kHz and sampled at 2 Hz. Pressure at the mouth was recorded with a pressure transducer attached to a mouthpiece and intra-abdominal pressure was recorded with an air-filled respiratory balloon fixed over the end of modified urinary catheter that was placed in the rectum. Subjects performed maximal isometric inspiratory (maximum inspiratory pressure: MIP) and expiratory (maximum expiratory pressure: MEP) efforts through a mouthpiece the valve closed on the mouthpiece. Three repetitions were performed for 5 s and the peak amplitude for 1 s was recorded as the maximum pressure. Subjects then performed contractions at 25, 50 and 75% of the MIP and MEP efforts with visual feedback of the mouth pressure and the target amplitude. Subjects also performed maximal voluntary contractions (MVC) of the pelvic floor and abdominal muscles for normalisation of EMG amplitude. Mouth pressure, intra-abdominal pressure and root mean square (RMS) EMG amplitude were recorded for 2 s during the MIP and MEP tasks. Normalised pressure and EMG amplitude data were compared between tasks (inspiratory and expiratory efforts) and between mouth pressure levels (25, 50, 75, 100%) with a repeated-measures ANOVA.

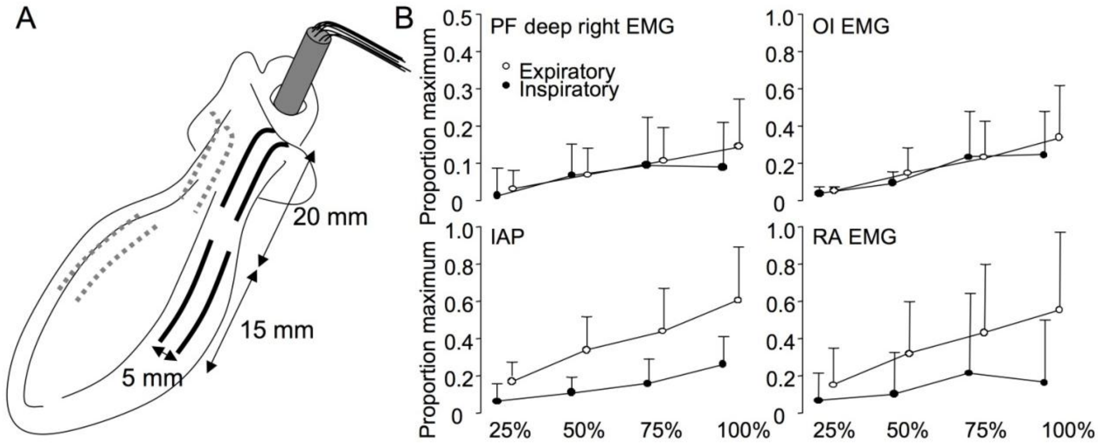

***Figure 1. A** Custom-built EMG electrode to record from deep and superficial regions of pelvic floor muscles. Four pairs of silver wire were threaded through holes drilled in the pelvic floor Educator (NEEN, UK). **B** Group data for one representative pelvic floor muscle (deep right), two abdominal muscles that responded differently (OI and RA) and intra-abdominal pressure (IAP). Mean and 95% confidence intervals are shown.*

Results

Mouth pressure generated during the MIP was 95 (36)% of that during the MEP efforts. Intra-abdominal pressure increased with each successive increment in mouth pressure (main effect – pressure level: P<0.001) during both inspiratory and expiratory efforts, but was greater during expiratory efforts (main effect – task: P<0.03)(Fig. 1B). Despite the difference in intra-abdominal pressure between tasks, there was no difference in pelvic floor EMG recorded with any of the four electrodes between MEP and MIP efforts (main effect – task: all P>0.18)(Fig. 1B). Pelvic floor EMG increased to 9.6-19.6% MVC for the more superficial electrode and 16.5-27.4% for the deep electrode. Abdominal muscles were active during both inspiratory and expiratory efforts. Although there was no difference in TrA, OI and OE EMG between MEP and MIP efforts (main effect – Task: all P>0.19), RA EMG was greater during MEP efforts above 50% maximum (interaction – Task x level: P<0.004, post hoc: all P<0.001)(Fig. 1B).

Interpretation of results

These data confirm that activity of the pelvic floor muscles is influenced by respiration; activity increased during both inspiratory and expiratory efforts. Furthermore, the data convincingly show that pelvic floor muscle activity is more closely coupled with changes in activity of the lateral abdominal muscles (TrA, OI and OE) than changes in intra-abdominal pressure. Although intra-abdominal pressure differed between inspiratory and expiratory efforts, pelvic floor and lateral abdominal muscle EMG did not.

Concluding message

These findings provide further evidence of tight neural coupling between the activity of the pelvic floor and abdominal muscles during function. This suggests that coordination of abdominal and pelvic floor muscle is likely to be important and rehabilitation of pelvic floor dysfunction.

References

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Was this study approved by an ethics committee?	**Yes**
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Was the Declaration of Helsinki followed?	**Yes**
Was informed consent obtained from the patients?	**Yes**