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THE EFFECT OF LUMBOPELVIC POSTURE ON PELVIC FLOOR MUSCLE ACTIVATION AND INTRAVAGINAL PRESSURE GENERATION IN CONTINENT WOMEN

Hypothesis / aims of study

Recruitment of the pelvic floor muscles (PFMs) is essential in stabilizing the urethra and enhancing urethral closure to maintain continence and in supporting the pelvic organs. It has recently been suggested that lumbopelvic posture may influence the ability of the PFMs to contract effectively [1]. The PFMs have anatomical connections on the pelvis and coccyx, and some PFM fibres cross the sacroiliac joints, making them susceptible to stretch or shortening during changes in lumbopelvic posture. Accordingly the length-tension relationship of the PFMs may be affected by postural adjustments. The aim of this study was to determine whether changes in lumbopelvic posture induce differences in the contractile activity of the PFMs and in the amount of intravaginal pressure generated during quiet standing, voluntary contractions of the PFMs and during tasks that challenge the continence system (coughing, Valsalva, and a standardized load catching task).

Study design, materials and methods

This study was an observational investigation involving a repeated-measures experimental design. Nulliparous, continent women between the ages of 22 and 40 years were recruited and provided written informed consent prior to participating. Each participant performed two sets of six tasks (quiet standing, maximal effort cough, Valsalva maneuver, maximum voluntary contraction (MVC) of the PFMs, and a standardized load-catching task with eyes open and with eyes closed) in three different standing postures: their habitual standing posture (normal), standing with an exaggerated lumbar lordosis (hyperlordosis), and standing with a reduced lumbar lordosis (hypolordosis). During the first set, electromyographic (EMG) activity was recorded from the PFMs bilaterally using a Periform^{TM} vaginal probe coupled to Delsys^{TM} D.E.2.1 electrodes and Delsys^{TM} Bagnoli-8 EMG amplifiers (band pass 20-450 Hz, Input impedance >1GOhm, gain 1000). During the second set, intravaginal pressure was recorded using a Peritron^{TM} perineometer coupled directly to the data acquisition card (NIDAQ PCMCIA). During both sets, pelvic angle was recorded simultaneously with EMG or intravaginal pressure using an Optotrak^{TM} 3D motion analysis system to ensure that subjects maintained the required posture throughout the three trials of each task.

All data were sampled at 1000 Hz and were filtered off line using a moving 200ms RMS window with 199ms overlap. Peak filtered EMG and pressure values were determined for each trial and each task after removing baseline activation levels. Separate two-way repeated measures analyses of variance (ANOVAs) were performed to determine the effect of changing lumbopelvic posture and task on PFM EMG activation amplitude and on intravaginal pressure. The interaction between task and posture was included in the model. A one-way ANOVA was performed on the lumbopelvic angles to ensure that the three postures were significantly different during all tasks. An alpha level of 0.05 was used for all statistical analyses, and Bonferroni post-hoc pairwise comparisons were performed as appropriate.

Results

Sixteen women participated, with mean age 27.1 (5.48) years and mean body mass index 22.8 (1.57) kg/m^2. The women were active, reporting a range of 5-10 hours of physical activity performed per week. None of the women had signs or symptoms of incontinence, low back pain or pelvic pain.

There were no significant posture by task interaction effects. There was significantly higher resting PFM activity in standing as compared to supine, and in the hypolordosis as compared to the normal and hyperlordotic postures (See Figure 1). During the MVC, coughing, Valsalva, and both load-catching tasks, subjects generated significantly more PFM EMG activity when in their normal posture as compared to either the hyper- or hypolordotic postures. As an example of these results, Figure 2 presents the results for the load catching task performed with eyes open. Discordant with the PFM EMG results, higher peak intra-vaginal pressures were generated in the hypolordotic posture at rest (Figure 3) and during all of the dynamic tasks (See Figure 4 for an example of these results) The PFM EMG activity and intravaginal pressure generated varied widely among the tasks and was highest for the coughing task and lowest for the standardized load catching tasks. The lumbopelvic angles were significantly different by approximately 5° among the three postures throughout all tasks.

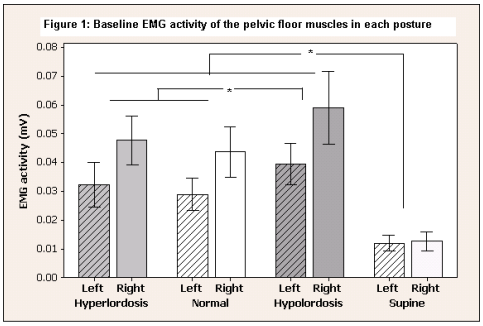
Figure 1: Baseline EMG activity of the pelvic floor muscles in each posture
EMG activity (mV)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
*
*
Left Right
Hyperlordosis
Left Right
Normal
Left Right
Hypolordosis
Left Right
Supine

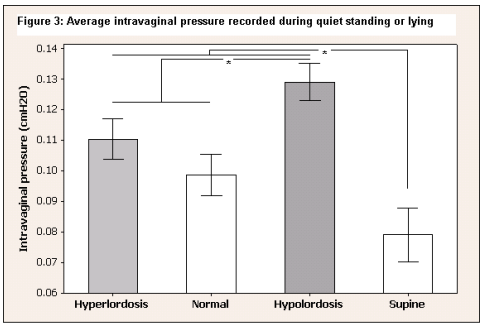
Figure 3: Average intravaginal pressure recorded during quiet standing or lying
Intravaginal pressure (cmH2O)
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
*
*
*
Hyperlordosis
Normal
Hypolordosis
Supine

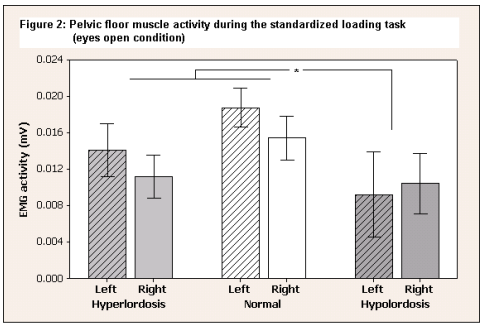
Figure 2: Pelvic floor muscle activity during the standardized loading task
(eyes open condition)
EMG activity (mV)
0.024
0.020
0.016
0.012
0.008
0.004
0.000
*
Left Right
Hyperlordosis
Left Right
Normal
Left Right
Hypolordosis

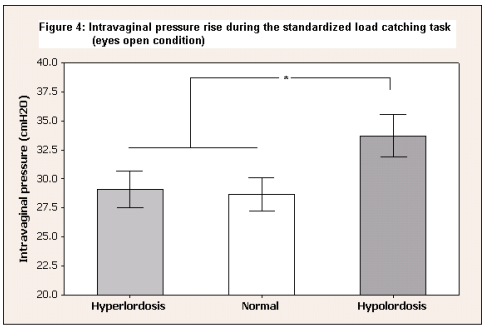
Figure 4: Intravaginal pressure rise during the standardized load catching task
(eyes open condition)
Intravaginal pressure (cmH2O)
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
*
Hyperlordosis
Normal
Hypolordosis

Interpretation of results

The contractility of the PFMs may be altered with postural changes due to alterations in the length of the PFM fibres. Creating a hyper- or hypolordosis distorts the PFMs by changing the orientation their attachments to the sacrum, coccyx, pubic symphysis and ligamentous structures. An anterior pelvic tilt (hyperlordosis) causes a posterior rotation of the coccyx relative to the pubic bones thereby producing a stretch on the PFMs and hence lengthening the muscle fibres. A posterior pelvic tilt (hypolordosis) causes an anterior rotation of the coccyx and thus creates a shortening of the muscle fibres. Both of these distortions decrease the ability of the PFMs to generate maximum contractility due to the length tension properties of the muscle.

Despite optimal PFM EMG activation being found in the neutral posture, this posture was not the ideal position for the generation of intra-vaginal pressure. Higher pressures may be produced in the hypolordotic position due to the orientation of the PFMs relative to the vaginal lumen. In hypolordosis, the PFMs are oriented approximately perpendicular to the vaginal canal. Although the PFMs are not contracting as strongly in this position, intra-vaginal pressure may be maximized due to optimal transmission of the anterior forces generated through PFM contraction squeezing the vaginal lumen between the pubic symphysis and the PFMs. In a normal or hyperlordotic posture, the PFM contraction may create lower resultant closure forces because the force vector is further away from being perpendicular to the vaginal lumen in these postures.

Concluding message

The results of this study may have important implications for individuals with urinary incontinence, as they demonstrate that postural intervention may be a useful adjunct to physical therapy. Instructing patients to decrease their lumbar lordosis while contracting their PFMs may help to prevent urine leakage during tasks that increase intra-abdominal pressure.

References

1. Sapsford RR, Richardson CA, Maher CF,Hodges PW. Pelvic floor muscle activity in different sitting postures in continent and incontinent women. Arch Phys Med Rehabil. 89:1741-7, 2008

Specify source of funding or grant	**National Sciences and Engineering Research Council of Canada (NSERC)**
Is this a clinical trial?	**No**
What were the subjects in the study?	**HUMAN**
Was this study approved by an ethics committee?	**Yes**
Specify Name of Ethics Committee	**Queen's University and Allied Teaching Hospitals' Health Sciences Research Ethics Board**
Was the Declaration of Helsinki followed?	**Yes**
Was informed consent obtained from the patients?	**Yes**