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THE EFFECT OF PELVIC FLOOR MUSCLE TRAINING ON LEVATOR ANI ANATOMICAL CONFIGURATION IN STRESS URINARY INCONTINENT (SUI) WOMEN: AN MRI STUDY.

Hypothesis / aims of study
Pelvic floor muscle (PFM) training has proven to be effective in reducing stress urinary incontinence (UI) in women.[1] However, the underlying anatomical and physiological mechanisms by which PFM training prevents urine leakage are not yet fully understood. In order to better understand the role of the PFM, it is important to examine the effect of physiotherapy programs on the anatomy of the PFM, especially the levator ani (LA) portion at rest and during contraction. This study seeks to quantify the effect of PFM training on the anatomical configuration of LA using magnetic resonance imaging (MRI).

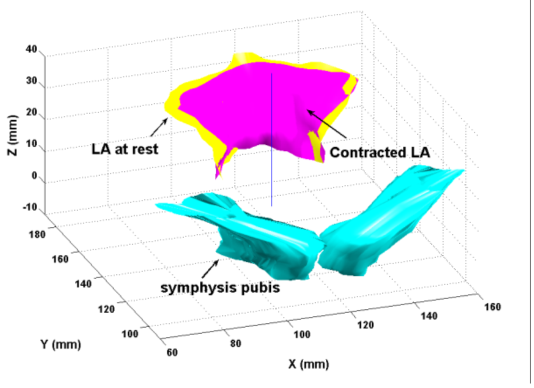
Study design, materials and methods
This is a quasi-experimental pre-test/post-test design study, examining pre- and post-PFM training MRI data. Five incontinent women were recruited from a major university hospital through urologist/gynaecologist referrals. To be eligible, participants had to have urodynamically proven stress UI and no prior surgery, MRI incompatibility or PFM training within the last year. The participants' mean age was 44.40 $\pm$ 7.77 years [33 to 53]; mean BMI was 24.88 $\pm$ 3.51 [22.60 to 30.10] and mean parity 2.4 $\pm$ 0.55 babies.

A physiotherapist specialized in PFM training instructed the participants in how to correctly perform PFM contraction using vaginal palpation. Over 2.5 months, they participated in seven 1-hour group exercise sessions of strengthening and motor-relearning exercises and were expected to perform these same exercises at home, seven days a week, throughout the treatment.

Image data were acquired with a General Electric SIGNA twin-speed, 1.5-Tesla magnet. With subjects in the supine lying position, a PA torso coil tuned for PFM imaging was centered at the symphysis pubis. A spoiled gradient sequence of T1-weighted images was used with the following parameters: TR= 70 ms, TE min full, flip angle = 60^{o}, field of view (FOV) 24 cm, slice thickness 3 mm, 0.5 mm gap, matrix 256 x 256, NEX two, scan time 36 s. Eight axial images were taken for two different conditions: at rest and during a PFM voluntary contraction. This MRI acquisition sequence was performed prior to the first and just after the last PFM training session in the program.

Source images were manually segmented and surface modeling was applied to build a three-dimensional (3-D) model of the LA and symphysis pubis (Figure 1). The geometry of the 3-D LA model was measured by means of the following three parameters: a) the LA surface area at rest (***S)***; b) the percentage of LA retraction ***(R)***; and c) the symphysis pubis movement during PFM voluntary contraction ***(SP)***.

Figure 1. 3-D model of the LA and Symphysis Pubis



Pre- and post-treatment values of the three parameters were compared for each participant with paired t-tests to evaluate the changes. Two-sided P values < 0.05 were considered significant. All analyses were carried out using SPSS for Windows (version 11.0) software.

Results
After PFM training, the LA surface area at rest (***S)*** was significantly smaller than before training, decreasing from 144.45 $\pm$ 9.60 mm^2 to 132.37 $\pm$ 7.71 mm^2 (P = 0.04). The percentage of LA surface retraction during a voluntary contraction ***(R)*** was significantly increased from 65.61% to 81.70% (P = 0.02). Finally, the symphysis pubis movement ***(SP)*** during PFM contraction was significantly reduced after physiotherapy, from 1.45 $\pm$ 0.59 mm before PFM training to 0.44 $\pm$ 0.27 mm after PFM training (P = 0.05).

Interpretation of results
To our knowledge, this is the first study to describe changes in muscle morphology after PFM strength training, using MRI. Evidence is provided to demonstrate that PFM exercises result in anatomical changes on the LA and reduced pubic movement. At rest, following PFM training, the LA surface area was smaller, suggesting an increase in LA support capacity or tone. During voluntary contraction, the percentage of LA surface retraction was significantly higher post-PFM training. This supports the hypothesis that PFM physiotherapy increases the levator strength and the forward squeeze movement around the urethra, vagina and rectum. Finally, symphysis pubis movement during contraction was reduced following PFM training. This finding can be related to an improvement in PFM neuromuscular functioning following PFM training. Although preliminary, these results offer further insight into the underlying anatomical and physiological mechanisms by which rehabilitation prevents urine leakage.

Concluding message
This study suggests that PFM training produces changes in the anatomical configuration of the PFM at rest as well as during PFM contraction. In addition, post-physiotherapy, participants performed PFM voluntary contractions in a more focused way. Further studies using a larger sample population are now needed to explore LA morphological changes following PFM physiotherapy.

References
1.Pelvic floor muscle training versus no treatment, or inactive control treatments, for urinary incontinence in women. Cochrane Database Syst Rev. 2006 Jan 25;(1):CD005654.

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CLINICAL TRIAL REGISTRATION: This clinical trial has not yet been registered in a public clinical trials registry.
HUMAN SUBJECTS: This study was approved by the Ethics committe of the Skejby University Hospital, Denmark and followed the Declaration of Helsinki Informed consent was obtained from the patients.