

## PELVIC FLOOR MUSCLE STRENGTH, ENDURANCE AND VAGINAL RESTING PRESSURE ARE POSITIVELY ASSOCIATED WITH MUSCLE THICKNESS, SIZE OF LEVATOR HIATUS AND POSITION OF THE BLADDER IN WOMEN WITH PROLAPSE STAGE I, II AND III. A 3D/4D ULTRASOUND STUDY

### Hypothesis / aims of study

To date there is scant knowledge about the relationship between pelvic floor muscle (PFM) strength and morphology of the pelvic floor including position of the pelvic organs. The aim of the present study was to investigate the association between three PFM variables (strength, endurance and vaginal resting pressure) and muscle thickness, size of levator hiatus and position of the bladder in women with pelvic organ prolapse (POP) stage I, II and III.

### Study design, materials and methods

In this cross sectional study 109 women with POP, regardless of symptoms, were enrolled by community gynaecologists. Eligibility criteria were more than one year since last delivery. Exclusion criteria were stage 0 or 4 on POP-Q, inability to contract the PFM, breastfeeding, previous POP surgery, radiating back pain, pelvic cancer, neurological or psychiatric disorders. Participants filled out a validated symptom-bother questionnaire (1) prior to a physical therapist examination. PFM strength, endurance and vaginal resting pressure, were assessed using a responsive, reliable and valid vaginal squeeze pressure transducer. The POP-Q and 3D/4D pranserineal ultrasound examination were performed at a university hospital by a gynecologist blinded to results of the clinical examination of PFM function. The ultrasound images were stored by anonymous code numbers and analysed offline (4D View v 5.0 and 6.3; GE Healthcare) by a single investigator blinded to clinical and background data. Levator hiatus area and thickness of the pubovisceral muscle was measured from 3D static volumes captured in lithotomy position at rest and analysed in the axial plane of minimal hiatal dimensions. The resting position of the bladder was captured in standing position from 4D volumes and analysed in the mid-sagittal plane as the vertical distance from a reference line going through the middle of the symphysis pubis (2). Statistical analysis was performed using SPSS version 15. PFM strength, endurance and vaginal resting pressure were evaluated using univariate and multiple regressions models including position of bladder neck, muscle thickness, levator hiatus area, parity, age, postmenopausal status, BMI, heavy occupational work and socioeconomic status. Differences in size of levator hiatus between stages of POP were analysed with Student t-test. Normality was checked with Kolmogorov-Smirnov and Shapiro-Wilk tests. P-values <0.05 were considered significant.

### Results

Mean age of the 109 participants was 48.9 years (SD 11.8), median parity 2 (range 1-5) and mean body mass index (BMI) 25.9 kg/m<sup>2</sup> (SD 4.5). Nineteen women were classified as POP stage I, 65 as stage II and 24 as stage III. In the univariate regression analyses maximum strength and endurance was predictive for muscle thickness (standardized regression coefficient  $\beta$  of 0.49 and 0.44,  $p < 0.001$ , respectively). All three PFM variables were associated with levator hiatus area ( $\beta$  -0.41 to -0.46,  $p < 0.001$ ) and the resting position of the bladder neck ( $\beta$  0.38 to 0.42,  $p < 0.001$ ). Multiple regression analysis showed that maximum strength was independently associated and made the strongest contribution to explain muscle thickness ( $\beta$  0.31,  $p = 0.001$ ), while vaginal resting pressure gave the strongest contribution to levator hiatus area ( $\beta$  -0.35,  $p = 0.021$ ) and the resting position of the bladder neck ( $\beta$  0.26,  $p = 0.021$ ). There was a strong association between size of levator hiatus and stage of POP (test of trend  $p < 0.001$ ). Women with POP stage I compared to stage II had a 2.7 cm<sup>2</sup> (95%CI 0.1 – 5.4,  $p = 0.042$ ) smaller levator hiatus area. The area of the levator hiatus was 3.1 cm<sup>2</sup> (95%CI 0.5-5.7,  $p = 0.019$ ) larger for women with POP stage III compared to POP stage II.

### Interpretation of results

The present study demonstrated a strong association between PFM strength, endurance and vaginal resting pressure with muscle thickness, size of levator hiatus and position of the bladder neck. Since the PFM are regular skeletal muscle these skills are trainable. PFM training has shown to be effective in women with both urinary incontinence and POP, and a randomized controlled trial on POP women stage I, II and III has shown improvement in PFM morphology and elevation of the bladder and bowel after supervised PFM training (3). PFM training in healthy young women may have the potential to be a primary prevention intervention for POP. This has to be tested in a randomized controlled trial with a huge number of non symptomatic women followed for a long period of time.

### Concluding message

There is a strong association between strength, endurance and vaginal resting pressure with muscle thickness, size of levator hiatus and position of the bladder neck.

### References

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<i>Is this a clinical trial?</i>	No
<i>What were the subjects in the study?</i>	HUMAN
<i>Was this study approved by an ethics committee?</i>	Yes
<i>Specify Name of Ethics Committee</i>	Norwegian Regional Medical Ethics Committee (S-05146)
<i>Was the Declaration of Helsinki followed?</i>	Yes
<i>Was informed consent obtained from the patients?</i>	Yes