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CAN WE PREDICT URINARY STRESS INCONTINENCE BY USING DEMOGRAPHIC, CLINICAL, IMAGING AND URODYNAMIC DATA?

Hypothesis / aims of study

Urinary stress continence in women is due to a combination of factors that are poorly understood (1). The diagnostic evaluation of women with lower urinary tract dysfunction should allow us to assess several of those factors. The intrinsic quality of the urethra is evaluated with urethral pressure profilometry. Urethral fixation, that is, pressure transmission, can be assessed via the imaging of urethral mobility, and the quality of the pelvic floor musculature may be investigated by palpation or 4D ultrasound imaging (2, 3). It has been claimed that urethral hypermobility and resting urethral pressure can largely explain stress continence in women (1). In this study we tried to replicate these findings in an unselected cohort of women seen for urodynamic testing, including as many potential confounders as possible.

Study design, materials and methods

This study is a retrospective analysis of data obtained on urodynamic testing at a tertiary Urogynaecology unit. Between January 2009 and April 2010, 454 women attended the unit for urodynamic testing due to symptoms of pelvic floor dysfunction. We excluded 113 women with a history of previous anti- incontinence and prolapse surgery, leaving 341 data sets. All subsequent analysis pertains to those 341 patients. All patients had a standardized in-house, nonvalidated interview, a clinical assessment using the ICS POP-Q, along with a 4D transperineal pelvic floor ultrasound using GE Kretz Voluson 730 expert and Voluson i systems, and multichannel urodynamic testing (Neomedix Acquidata, Neomedix, Sydney, Australia). Significant prolapse was defined as a cystocele ≥ Stage 2 (ICS POP-Q). Levator contraction strength was assessed digitally, using the Modified Oxford Grading (MOS).

Urethral sphincter function was assessed with urethral profilometry. Maximal urethral pressure (MUCP) was obtained with a perfused fluid- filled catheter with a freehand pull- through technique. Maximum abdominal pressure and maximum cough pressure were obtained in the standing position on Valsalva and coughing. All ultrasound images were analyzed offline using proprietary software (4D View v 10), with the computer operators (GS and EW) blinded against all clinical data. Urethral mobility was described by vectors of movement from rest to maximum Valsalva of 6 equidistant points marked along the length of the urethra from bladder neck (point 1) to external urethral meatus (point 6) in the mid sagittal plane, as previously described (2). For midurethral mobility analysis we used vector 4. Hiatal dimensions at rest and on Valsalva were measured in the plane of minimal hiatal dimension, as previously described (3). Levator trauma was identified by tomographic ultrasound (TUI) as previously described (3).

The binary outcome of USI was analysed using binary logistic regression. Both univariate and multivariate models were developed for USI and USI grade (0-4). A backwards elimination approach was used to optimize models. Candidate variables were age, BMI, symptoms of prolapse, vaginal parity, significant prolapse (compartment- specific), avulsion, hiatal area, Oxford grading, midurethral mobility, MUCP, maximum cough pressure and maximum valsalva pressure.

Results

A test-retest series of urethral mobility vectors performed by 2 authors showed excellent repeatability, with an Intraclass Correlation Coefficient for single measures of 0,839 (95%CI 0,745- 0,897) and 0,870 (95%CI 0,811- 0,911) for segmental urethral mobility. A test- retest series for hiatal biometry also demonstrated excellent repeatability, consistent with multiple previous reports, with an ICC for single measures of 0,854- 0,950 (for hiatal diameters) and 0,960- 0,974 (for area). All continuous parameters were tested for normality (histogram and Kolmogorov- Smirnov testing) and were found to be normally or near- normally distributed.

Mean age was 54 (19-89) years, BMI was 29 (17-59). 75% complained of stress urinary incontinence, 68% of urge incontinence, 29% of frequency, 47% of nocturia, 28% of symptoms of voiding difficulty (hesitancy, straining and stop- start voiding), and 42% of symptoms of prolapse (lump or dragging sensation). Mean vaginal parity was 2.5 (0- 10), and 89% were vaginally parous. A Vacuum or Forceps was reported by 25%, a hysterectomy by 23%. On examination a cystocele stage 2+ was found in 42%, significant central compartment prolapse in 9%, and a significant clinical rectocele (stage 2+) in 43%. In 62% we detected a prolapse >=stage 2. Mean Oxford grading was 2.4 (SD 1.2), mean bladder neck descent was 30.6 (SD 12.8), mean midurethral mobility was 17.6 (SD 7.1) mm. Midsagittal hiatal diameter on Valsalva was 6.7 (1.2) cm, mean hiatal area on Valsalva 28.7 (SD 9.6) cm2. A total of 67 patients (20%) had an avulsion of the puborectalis muscle. Urodynamic findings were as follows: Mean MUCP was 42 (SD 20), mean maximum abdominal pressure was 87 (SD 35), mean maximum cough pressure was 110 (SD 35). The urodynamic diagnosis was USI in 216 patients (65%). It was mild in 50, moderate in 68, marked in 34 and severe in 64. DO was diagnosed in 28%, voiding dysfunction in 31%.

On binary logistic regression, the following parameters were predictive of USI: Age (P= 0.03), significant rectocele (P= 0.02), max. abdominal pressure reached (negatively, P< 0.0001), midurethral mobility (P= 0.0004), MUCP (negatively, P< 0.0001).

Multivariable analysis, accounting for multiple interdependencies, showed the following parameters as still significant: MUCP (negatively, P<0.0001), rectocele (p=0.01), max. abdominal pressure (negatively, P< 0.0001), max cough p (P=0.003), avulsion (negatively (P= 0.03), midurethral mobility (P= 0.0005).

On univariate linear modeling with USI grade (0-4) as outcome, the following parameters were significantly associated with USI grade: age (P <0.0001), vaginal parity (P= 0.04), maximum abdominal pressure (negatively, P< 0.001), maximum cough pressure (negatively, P= 0.007), midsagittal hiatal diameter on Valsalva (P= 0.03), midurethral mobility (P= 0.0013), MUCP (negatively, P< 0.001).

On multivariate analysis against USI grade, accounting for multiple interdependencies (eg between significant cystocele, BND and midurethral mobility), the following predictors remained significant: maximum abdominal pressure reached (negatively $P< 0.0001$), cough pressure ($P=0.006$), midurethral mobility ($P= 0.003$) and MUCP (negatively, $P< 0.0001$), giving an R^2 of 0.24.

Interpretation of results
We have again confirmed that MUCP and mid-urethral mobility are important predictors of USI, although we have been unable to replicate the findings reported by DeLancey. While his model reached a Nagelkerke R^2 of over 60%, ours at best reached about 24%. This may be due to differences between methods and populations.

Concluding message
Mid- urethral mobility and MUCP are the main predictors of USI. Demographic and clinical data are at best weak predictors. Our results suggest the presence of major unrecognised confounders. One of them may be urethral kinking, a topic that requires further research.

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