

## THE ASSOCIATION BETWEEN LEVATOR-URETHRAL GAP MEASUREMENTS AND SYMPTOMS AND SIGNS OF FEMALE PELVIC ORGAN PROLAPSE

### Hypothesis / aims of study

Levator avulsion is a common childbirth-related injury to the levator ani muscle. It has been shown to be associated with an increased risk of female pelvic organ prolapse (FPOP) and prolapse recurrence after surgery [1]. It is characterised by a widened gap on palpation between the insertion of the puborectalis muscle on the inferior pubic ramus on the one hand and the urethra on the other hand. This gap (or a close equivalent) can also be detected on ultrasound (US) and magnetic resonance (MR) imaging. This study assesses the association between 4D translabial ultrasound levator-urethral gap (LUG) measurements [2] and symptoms and signs of FPOP, the main clinical manifestation of levator trauma, in an attempt to validate this measurement.

### Study design, materials and methods

This was a retrospective study involving US data sets of 450 women seen in a tertiary urogynaecological centre with signs and symptoms of pelvic floor dysfunction between January 2013 and February 2014. All underwent a standardized clinical assessment including clinical interview, ICS-POPQ prolapse assessment and 4D translabial US [1]. Bother of prolapse symptoms was quantified by visual analogue scale (VAS) [3]. 'Clinically significant prolapse' was defined as ICS POPQ Stage 2 or higher in any compartment. The definition of 'significant prolapse on US was based on previously published cut-offs (10 mm below the symphysis pubis (SP) or lower for a cystocele, 15mm below or lower for the rectal ampulla). Uterine / enterocele descent was rated as 'significant' if it was to the level of the SP or lower. Hiatal area on maximum Valsalva was obtained in an axial plane rendered volume [1]. Levator avulsion was diagnosed using tomographic imaging as previously described [1].

Offline measurement of the LUG, ie., the distance between the centre of the urethra and the levator ani insertion on the inferior pubic ramus was undertaken at a later date, on a desktop PC by the first author, using proprietary software, blinded against all other data. These measurements were performed on axial plane tomographic ultrasound slices, at 2.5mm inter-slice intervals, in volume data sets obtained on maximal pelvic floor contraction, or at rest if the former was impossible. A previously described cut-off of 25 mm were used to define an abnormal LUG [2]. The repeatability of LUG measurement (intraclass correlation coefficient, single measures, absolute agreement definition) between the first and second author was good (0.773; 95% CI 0.693-0.835).

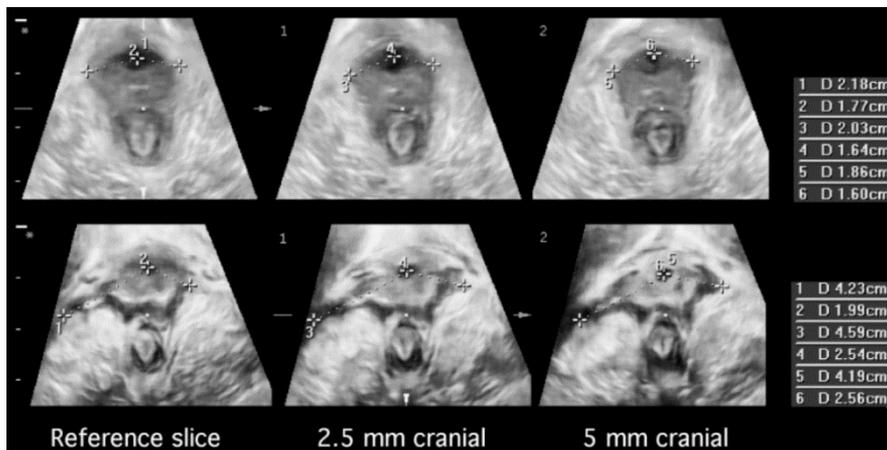


Figure 1 : Tomographic translabial ultrasound (axial plane) demonstrating measurement of the levator urethra gap in a patient with intact pelvic floor (upper three images) and a full avulsion (lower set of images).

### Results

Of 450 data sets, we were unable to retrieve ultrasound volumes in 18, leaving 432. All subsequent analysis refers to these 432 women. Mean age was 55.6 years (17-89) with 59% (n=255) being postmenopausal. Twenty-three (5.3%) were on HRT. Mean BMI was 29kg/m<sup>2</sup> (range, 15-59, SD 6.52). Median parity was 3 (0-9) with the mean age at first delivery of 23 years (15-38, SD 4.7). 90% (n=389) were vaginally parous. 22% (n=97) gave a history of instrumental delivery. 20% (n=87) and 18% (n=77) gave a history of hysterectomy and incontinence / prolapse surgery respectively.

The majority presented with stress and urge incontinence; 70% (n=302) and 71% (n=305) respectively, followed by frequency in 35% (n=151), nocturia in 43% (n=184) and symptoms of voiding dysfunction in 36% (n=157). 56% (n=243) reported symptoms of prolapse in the form of either a lump in the vagina and/or a dragging sensation.

Clinically, 76% (n=329) had significant prolapse (ICS POPQ stage  $\geq 2$ ) in any compartment. This was anterior compartment descent in 57% (n=245), uterine descent in 10% (n=44), enterocele in 3% (n=12) and posterior compartment descent in 57% (n=245). Mean Gh+Pb was 7.7 cm (4-13, SD1.3). Mean Ba and Bp were -0.7 cm (-3 to 8) and -1.0 cm (range, -3 to +9). Mean C was -4.1cm (-9-8).

On imaging, 65% (n=280) had a cystocele in 44% (n=188), significant uterine descent in 21% (n=89), enterocele in 10% (n=43) and significant descent of the rectal ampulla in 39% (n=169). On postprocessing of translabial ultrasound volume datasets, we obtained a total of 2592 LUG measurements (3 per side in 432 patients). Mean LUG was 22.5mm (12.1-38.9, SD 4.6). Mean

maximum LUG in individuals was 26.4mm (14.2-40.5, SD 6.0). Using a previously determined cut-off of 25mm, we identified at least one abnormal LUG in 222 women (51%). The current definition of a levator avulsion, ie. an abnormal LUG in all 3 slices on at least one side, was fulfilled in 103 women (24%).

LUG measurements were strongly associated with symptoms and signs of prolapse, prolapse bother and significant prolapse clinically and on US (see Table 1). On multivariate analysis, we found no significant confounding effect of age, BMI, history of instrumental delivery, previous hysterectomy or incontinence / prolapse surgery and prolapse stage.

Table 1:

	Mean LUG (mm)	Max LUG in any slice (mm)	Any LUG $\geq$ 25mm (1/0)	Number of LUG $\geq$ 25 mm	All abnormal LUG in 3 central slices on $\geq$ one side (1/0)
<b>Symptoms of prolapse (yes/no)</b>	23.4 vs 21.3 *(P<0.001)	27.7 vs 24.9 *(P<0.001)	OR 2.1 (95% CI 1.4-3.0) #(P<0.001)	#P<0.001	<b>OR 3.1</b> (95% CI 1.9-5.1) #(P<0.001)
<b>Prolapse bother (1-10)</b>	0.194 *(P<0.001)	0.185 *(P<0.001)	3.8 vs 2.7 *(P=0.002)	^P=0.001	4.4 vs 2.9 *(P<0.001)
<b>ICS POPQ stage 2+ (yes/no)</b>	23.2 vs 20.4 *(P<0.001)	27.3 vs 23.8 *(P<0.001)	OR 2.4 (95% CI 1.5-3.8) #(P<0.001)	#P<0.001	<b>OR 4.8</b> (95% CI 2.3-10.3) #(P<0.001)
<b>Sign. prolapse on US (yes/no)</b>	23.6 vs 20.6 *(P<0.001)	27.8 vs 23.9 *(P<0.001)	OR 2.8 (95% CI 1.9-4.3) #(P=0.001)	#P<0.001	<b>OR 5.1</b> (95% CI 2.7-9.4) #(P<0.001)

Association between Levator Urethral Gap Measurement on tomographic US and prolapse symptoms, bother score, significant prolapse clinically and on imaging.

#### Interpretation of results

The levator- urethra gap is a highly repeatable, simple measurement that is strongly associated with symptoms and signs of prolapse. The proposed minimal criteria for diagnosing levator avulsion (3 central slices showing abnormal LUG) carry odds ratios for significant POP clinically and on US imaging of 4.8 (95% CI 2.3-10.3) and 5.1 (95% CI 2.7-9.4) respectively.

Concluding message : The LUG as measured on tomographic ultrasound imaging seems to be highly reliable and valid in the assessment of functional pelvic floor anatomy. Abnormal levator-urethral gap measurements are strongly associated with symptoms and signs of female pelvic organ prolapse.

#### References

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3. Ulrich D, Guzman Rojas R, Dietz HP, Trutnovsky, G. The 'bother' of prolapse. Ultrasound Obstet Gynecol 2013; DOI: 10.1002/uog.13222

#### Disclosures

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