63

Abdool Z[1], Shek C[1], Dietz H P[1]
1. *Pretoria Academic Hospital,University of Pretoria; Nepean Clinical School, University of Sydney*

THE EFFECT OF LEVATOR AVULSION ON HIATAL DIMENSIONS AND FUNCTION

Hypothesis / aims of study:
The levator ani muscle plays a major role in pelvic organ support. Significant levator trauma/damage as a result of vaginal childbirth (1) can result in pelvic floor morbidity and likely is a factor in the aetiology of female pelvic organ prolapse (2). The commonest morphological abnormality is an avulsion injury to the inferomedial aspects of the puborectalis muscle, most likely during crowning of the fetal head. This type of trauma is evident on 3D/4D pelvic floor ultrasound and has a marked effect on pelvic floor function as ascertained by palpation and instrumented speculum. In this observational study we intended to define whether such trauma is associated with abnormal hiatal biometry and/ or biomechanical properties of the levator muscle.

Study design, materials and methods
414 patients referred to a tertiary urogynaecological unit for lower urinary tract dysfunction and/ or female pelvic organ prolapse underwent a physical examination and pelvic floor ultrasound. Imaging was performed with the patient supine and after bladder emptying. Datasets were obtained at rest, on maximal Valsalva and on maximal pelvic floor muscle contraction (PFMC) and processed offline using the software GE Kretz 4D View v 5.0. We measured hiatal diameters, area and circumference as well as strain (a component of elasticity) on PFM contraction and Valsalva. The diagnosis of avulsion injury was made on observing an avulsion of the puborectalis muscle from the inferior pubic ramus in tomographic ultrasound images obtained on maximal pelvic floor contraction (see Figure 1 for an example of hiatal area measurements in a patient with unilateral avulsion injury). 'Ballooning', i.e., abnormal hiatal dimensions on Valsalva, was defined according to (3).

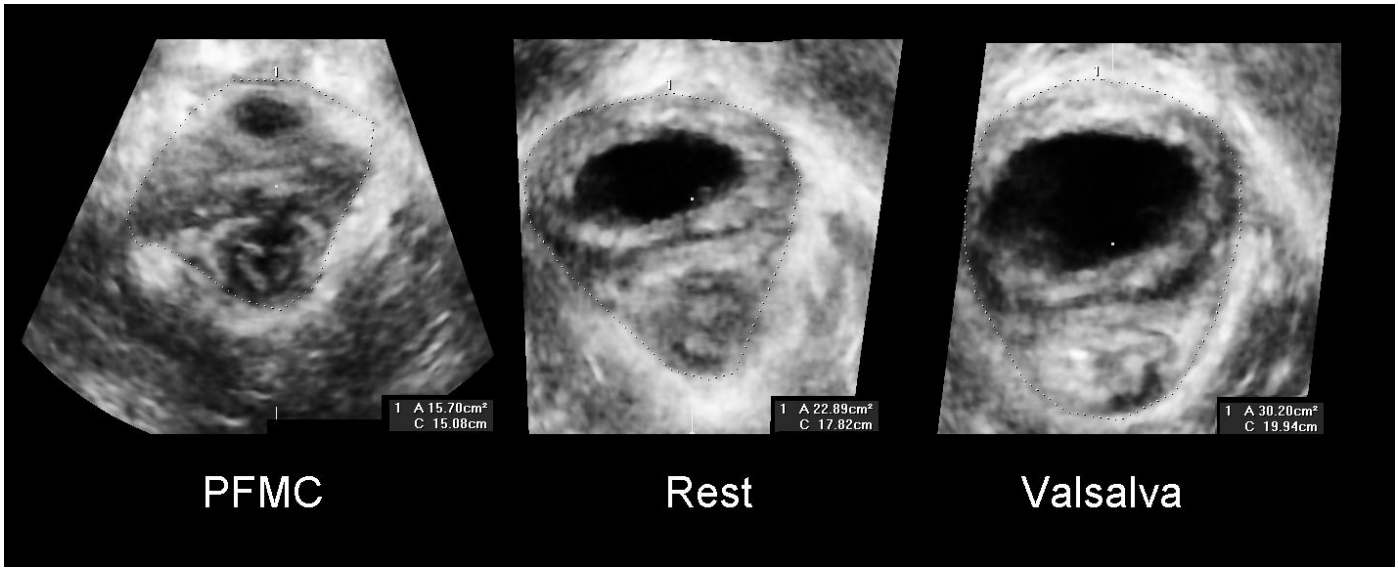

Figure 1: Measurement of the hiatal area on pelvic floor muscle contraction (left, 15.7 cm2), at rest (middle, 22.9 cm2) and on Valsalva (right, 30.2 cm2) in a patient with right-sided avulsion of the puborectalis muscle.

Results
Mean age was 55 years (range 19-89 years). 29 (7%) of 414 women were nulliparous, 365 (88%) had given birth vaginally. 43% described symptoms of prolapse, 67% complained of stress incontinence and 67% of urge incontinence. In 21.4% of vaginally parous women an avulsion of the levator muscle was diagnosed, and in 8.6% it was bilateral. Levator trauma was strongly associated with increased coronal hiatal diameters at rest, on Valsalva and on contraction (all P< 0.001), axial diameters on Valsalva and contraction, and increased hiatal area (see Table 1). The relative risk of ballooning (i.e., an abnormal hiatal area on Valsalva of 25 cm2 or above) was 3.5 (CI 1.7-6.5) in unilateral and 3.96 (CI 1.7- 9.2) in bilateral avulsion. Avulsion increased muscle distensibility (positive 'strain') on Valsalva by almost 50% (P< 0.001). Negative 'strain' (muscle fibre shortening) on PFMC was reduced by more than 50%, but only in women with bilateral avulsion (P< 0.001) (see Table 1).

Measure	No avulsion	Unilateral avulsion	Bilateral avulsion	P value
Midsagittal hiatal diameter (rest)	5.81 (0.84)	5.91 (0.73)	5.74 (0.83)	NS
Coronal hiatal diameter (rest)	4.36 (0.59)	4.61 (0.6)	4.97 (0.7)	< 0.001
Hiatal area (rest)	18.05 (4.8)	19.59 (4.37)	19.44 (4.27)	0.048
Midsagittal hiatal diameter (Valsalva)	6.65 (1.11)	7.32 (0.98)	7.15 (0.93)	< 0.001
Coronal hiatal diameter (Valsalva)	5.14 (0.86)	5.82 (0.96)	6.39 (0.89)	< 0.001
Hiatal area (Valsalva)	25.83 (8.27)	32.27 (9.39)	32.14 (6.95)	< 0.001
Midsagittal hiatal diameter (PFMC)	4.93 (0.8)	5.16 (0.78)	5.32 (0.95)	0.018
Coronal hiatal diameter (PFMC)	4.09 (0.58)	4.37 (0.78)	4.89 (0.69)	< 0.001

Hiatal area (PFMC)	14.63 (3.79)	16.65 (5.07)	18.17 (4.6)	< 0.001
Strain (Valsalva %)	25.79 (22.86)	37.25 (22.58)	37.73 (18.33)	< 0.001
Strain (PFMC %)	-16.58 (10.7)	-15.5 (11.23)	-7.97 (13.52)	< 0.001

Table 1: Hiatal dimensions and strain in patients with intact muscle, unilateral and bilateral avulsion injury. Figures signify means and standard deviations. PFMC= pelvic floor muscle contraction. NS=not significant. ANOVA statistics.

Interpretation of results

Avulsion of the pubovisceral muscle is associated with altered levator biometry, both static and dynamic. The most marked effect of avulsion is on coronal diameters, which is clearly due to detachment of the muscle from the inferior pubic ramus. Axial diameters and area measurements are also affected, with hiatal area on Valsalva increased by over 6 cm2. Most interestingly, muscle distensibility is markedly increased in women with avulsion. Our data on pelvic floor muscle contraction ('negative strain') confirms previous data obtained on palpation and with instrumented specula, implying reduced contractile function.

Concluding message

This study clearly illustrates that avulsion injury of the puborectalis muscle alters normal levator biometry and function. This form of trauma is associated with a relative risk of 3.5-4 of abnormal hiatal distensibility, i.e., 'ballooning'. Our results further support the hypothesis that childbirth-related trauma to this muscle is an important aetiological factor in pelvic floor morbidity and related symptoms of female pelvic organ prolapse and lower urinary tract dysfunction.

References

1. Obstet Gynecol 2005; 106(4):707-712.
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Specify source of funding or grant	**None**
Is this a clinical trial?	**Yes**
Is this study registered in a public clinical trials registry?	**No**
What were the subjects in the study?	**HUMAN**
Was this study approved by an ethics committee?	**Yes**
Specify Name of Ethics Committee	**Sydney West Area Human Research Ethics Committee**
Was the Declaration of Helsinki followed?	**Yes**
Was informed consent obtained from the patients?	**Yes**