

Prolapse symptoms are associated with abnormal functional anatomy of the pelvic floor

Zeelha Abdool^{1,2}  · Hans Peter Dietz³ · Barend Gerhardus Lindeque⁴

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Abstract

Introduction and hypothesis The etiology of pelvic organ prolapse (POP) likely includes over-distension or tears (avulsion) of the levator ani muscle. However, there is a lack of studies evaluating the association between symptoms of POP and these factors. This study was designed to determine the association between POP symptoms and clinical prolapse stage on the one hand, and pelvic floor functional anatomy on the other hand.

Methods This prospective observational study included 258 patients seen at a tertiary urogynecological unit with symptoms of POP as defined by pertinent ICIQ questions. After informed consent and a detailed history including ICIQ responses, 3D transperineal ultrasonography was performed using a GE Voluson i ultrasound system. Offline analysis was performed on de-identified datasets.

Results The mean age of the patients was 60.6 years (25–91 years) and their mean BMI was 29.8 kg/m² (18–53 kg/m²). Levator defects were found in 78 (32.4%) of the patients

and the defect was bilateral in almost half of these patients ($n = 36$). There were significant associations between awareness and visualization of a vaginal lump on the one hand and hiatal area measurements as well as diagnosis of avulsion on the other. Interference with everyday life was significantly associated with hiatal area and prolapse stage, but not with avulsion.

Conclusions There is a significant association between awareness, visualization and/or feeling of a vaginal lump and abnormal pelvic floor functional anatomy, that is, hiatal ballooning and levator avulsion.

Keywords Levator avulsion · Pelvic organ descent · Prolapse symptoms

Introduction

Symptomatic female pelvic organ prolapse (POP) is a common gynecological problem that negatively affects various quality of life domains [1]. Although the pathophysiology is still poorly understood, both macroscopic trauma (‘avulsion’) and microtrauma (irreversible overdistension) to the levator ani muscle are regarded as causative factors in at least some forms of symptomatic female POP [2]. The first prospective study to demonstrate a direct association between levator trauma and vaginal childbirth was published in 2005. In a prospective observational study of nulliparous women, levator avulsion was diagnosed using 3D transperineal ultrasonography between 2 and 6 months postpartum in 14 (36%) of 39 women delivered vaginally [3]. Subsequent prospective observational studies found that levator avulsion occurs in 13–36% of vaginally parous women and is also prevalent in patients presenting for urogynecological evaluation [4–6]. Levator avulsion is more common in patients with major

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✉ Zeelha Abdool
zeelha.abdool@up.ac.za

¹ Division of Urogynaecology, Department of Obstetrics and Gynaecology, University of Pretoria, Steve Biko Academic Hospital, Pretoria, South Africa

² Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa

³ Department of Obstetrics and Gynaecology, University of Sydney Medical School Nepean, Kingswood, Australia

⁴ Department of Obstetrics and Gynaecology, University of Pretoria, Steve Biko Academic Hospital, Pretoria, South Africa

prolapse and a risk factor for prolapse recurrence [7–10]. In an observational longitudinal cohort study of 269 primigravidae, levator avulsion was diagnosed in 21% of those with vaginal delivery, and these women reported more troublesome vaginal symptoms according to the validated International Consultation on Incontinence Questionnaire–Vaginal Symptoms (ICIQ-VS) [5, 11].

While early studies of pelvic floor symptoms focused primarily on evaluating the relationship with prolapse stage, a few studies have evaluated the association with functional pelvic floor anatomy using ultrasonography [12, 13]. In addition, most of the data in the literature were obtained in Caucasians. We sought to determine the relationship between the most commonly reported vaginal symptoms of POP (awareness of lump/bulge; visualization of lump/bulge and the need for digitation to empty the bowels) and clinical prolapse stage, levator hiatal area at rest, on maximum pelvic floor muscle contraction (PFMC) and on Valsalva maneuver, and levator avulsion, in a multiethnic population.

Materials and methods

Between June 2013 and March 2015, women who attended a tertiary urogynecology clinic with symptomatic POP were invited to participate in a prospective observational study on pelvic floor morphology in South African women as part of an ongoing PhD thesis. After providing informed consent, patients were requested to empty their bladder. Clinical examination was performed with the patient in the supine position with the hips and knees flexed at 90°. Prolapse was staged according to the POP-Q method [14]. To assess levator muscle morphology 3D/4D transperineal pelvic floor ultrasonography (TPUS) was performed with a GE Voluson i system using a 4–8 MHz RAB probe with an acquisition angle of 85°. Volume datasets were de-identified and acquired at rest, on maximum PFMC and on maximum Valsalva maneuver by the first author.

Levator hiatal areas were measured at rest, on maximum PFMC and on maximum Valsalva maneuver 6–8 weeks after volume acquisition using 4D View version 10 software, following the rendered volume method described previously [15]. Measurements were obtained by the first author, blinded against all clinical data. Tomographic ultrasound imaging (TUI) on maximum PFMC was used to diagnose levator avulsion as previously described [16]. Figure 1 illustrates marked distension (ballooning) of the levator hiatus on maximum Valsalva maneuver and the corresponding midsagittal plane in a woman presenting with a cystocele [17].

Patients completed the ICIQ-VS which is routinely used at our urogynecology clinic. This study was approved by the National Research Ethics Committee (University of Pretoria, 226/2011). Statistical analysis was performed after normality testing which included histogram analysis and/or Kolmogorov-Smirnov testing using SPSS version 23. Our null hypothesis was defined as “prolapse symptoms/clinical prolapse stage are *not* associated with levator hiatal area and avulsion of the levator ani muscle as diagnosed by TPUS.”

To determine the relationship between commonly reported vaginal symptoms/POP-Q stage and levator avulsion, chi squared statistics were used since avulsion is a binary variable. The ICIQ produces four-point or five-point Likert responses, and thus we used analysis of variance tests to determine the relationship between vaginal symptoms and levator hiatal area (at rest, on maximum PFMC and on maximum Valsalva maneuver). A *p* value <0.05 was considered statistically significant.

Results

The datasets from 5 of 263 women recruited had missing information. Thus, 258 women were included in the study. Their mean age was 60.6 years (range 25–91 years), their median parity was 3 (range 0–9) and their mean BMI was 29.8 kg/m² (range 18–53 kg/m²). Of the 258 women, 254

Fig. 1 Transperineal 3D ultrasound images in the midsagittal plane in a woman presenting with a cystocele. **a** Measurement of cystocele descent. **b** The corresponding axial view shows marked distension (ballooning) of the levator hiatus on maximum Valsalva maneuver (*S* pubic symphysis, *B* bladder, *R* rectal ampulla, *L* levator ani, *A* anal canal)

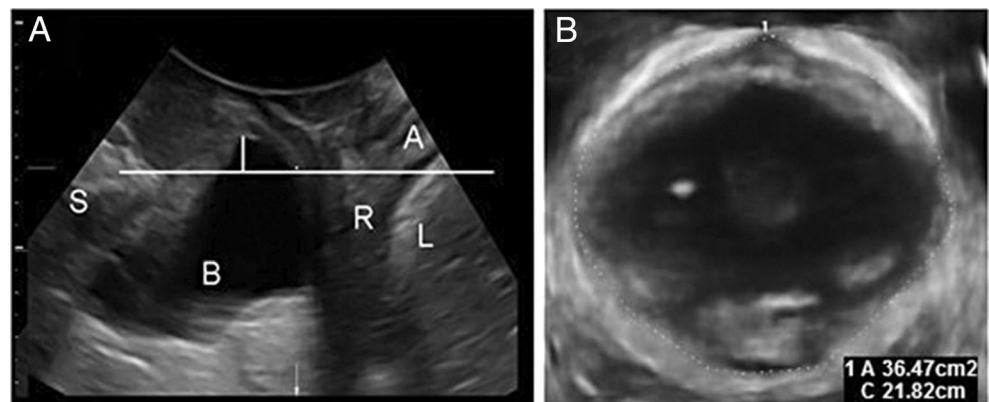


Table 1 Demographic characteristics of the 258 included women

Parameter	Value
Age (years), mean \pm SD	60.64 \pm 12.1
BMI (kg/m ²), mean \pm SD	29.83 \pm 6.3
Parity, median	3
Recall of assisted delivery, <i>n</i> (%)	38 (14.7)
Previous prolapse surgery, <i>n</i> (%)	55 (21.3)
POP-Q stage, <i>n</i> (%)	
I	19 (7.4)
II	124 (48.1)
III	96 (37.2)
IV	19 (7.3)
Avulsion, <i>n</i> (%)	78 (32.4)

(98.5%) were vaginally parous. Previous assisted delivery was recalled by 38 women (14.7%), and 55 (21.3%) had undergone a previous prolapse operation. The study cohort was racially diverse: 31 (12%) Asian, 107 (41.5%) Black, and 120 (46.5%) Caucasian; ethnicity was self-reported. POP-Q stage II was detected in 124 patients (48.1%) and POP-Q stage III or IV in 115 (44.5%). The demographic characteristics of the 258 women are shown in Table 1. Only 236 datasets were analyzed for levator avulsion as 22 patients could not perform a pelvic floor muscle contraction, and four could not perform a Valsalva maneuver despite repeated coaching, leaving 254 datasets for hiatal area assessment.

Table 2 shows the associations between questionnaire answers, POP-Q staging and ultrasound measurements of functional pelvic floor anatomy. Statistically significant associations were found between awareness of lump or bulge in the vagina (question 5a of the ICIQ-VS), feeling and visualization of the lump or bulge (question 6a) and levator avulsion ($p = 0.003$, and $p = 0.000$, respectively)

and for all measurements of hiatal area and POP-Q stage. Interference with everyday life was statistically significantly associated with POP-Q stage ($p = 0.009$) and hiatal area on Valsalva maneuver ($p = 0.028$) but not with levator avulsion. The correlation between visualization of bulge and interference with everyday life and hiatal area at rest did not reach statistical significance ($p = 0.052$ and $p = 0.065$, respectively). Exclusion of women with previous prolapse surgery did not materially change these results.

Discussion

This prospective observational study in a multiethnic population demonstrated strong correlations between abnormal functional pelvic floor anatomy and the core symptoms of POP defined according to the ICIQ-VS. This correlation was strongest for core symptoms such as awareness of lump/bulge and visualization or feeling of lump/bulge on the outside. Associations were weaker for the question on digitation to defecate. This is not surprising as the need for digitation has been shown to be positively associated with true rectoceles for which there is no strong link with abnormal levator ani anatomy [9, 18]. Of note, we chose to test the relationship between abnormal functional pelvic floor anatomy and the core symptoms of POP, as the other questions (“Are you aware of pain in your lower abdomen”, “Are you aware of soreness in your vagina”, “Do you feel that you have a reduced sensation in or around your vagina”) are nonspecific for POP, and statistical analysis did not reveal significant correlations with levator avulsion, levator hiatal area or POP-Q stage. ICIQ question 14 investigated by us is much less specific (“Overall, how much do vaginal symptoms interfere with your everyday life?”) as it would also be

Table 2 Associations (p values) between pelvic floor symptoms and POP-Q stage, hiatal area measurements and levator avulsion in the 258 included women

Symptom	POP-Q stage (<i>n</i> = 258) ^a	Hiatal area (<i>n</i> = 254) ^a			Avulsion (<i>n</i> = 236) ^b
		At rest	On maximum pelvic floor muscle contraction	On Valsalva maneuver	
1. Are you aware of a lump or bulge coming down in your vagina?	0.001	0.001	0.025	0.001	0.003
2. Do you feel a lump or bulge come out of your vagina, so that you can feel it on the outside or see it on the outside?	0.001	0.016	0.021	0.001	0.001
3. Do you have to insert a finger into your vagina to help empty your bowels?	0.320	0.264	0.163	0.384	0.275
4. Overall, how much do vaginal symptoms interfere with your everyday life?	0.009	0.065	0.050	0.028	0.124

^a ANOVA tests^b Chi-squared test for levator avulsion

answered positively by women suffering, for example, from vaginal atrophy and/or dyspareunia.

The etiology of POP is thought to be multifactorial, but it is increasingly evident that in many instances prolapse is mediated by alterations in pelvic floor functional anatomy. There seems to be little doubt that major levator trauma is a factor in the pathogenesis of POP [9]. While a cause and effect relationship seems highly plausible for avulsion, the role of excessive hiatal distensibility, i.e. ballooning, is complex [19]. Since there is some evidence that ballooning often persists after a successful prolapse procedure, it may plausibly be considered a ‘cause’, but this remains unproven [20]. The findings of our study support this contention.

Considering that levator avulsion has a significant effect on both pelvic floor anatomy and function, it is not surprising that such trauma is associated with awareness and visualization of bulge [21–24]. Interestingly, this is not the case for other symptoms of pelvic floor dysfunction such as stress urinary incontinence, urge incontinence and anal incontinence [17, 25]. Dietz et al. [25] studied the relationship between levator avulsion and bladder function in 420 women presenting with pelvic floor dysfunction and lower urinary tract symptoms and found that women with avulsion were less likely to report stress urinary incontinence ($p < 0.001$) and urodynamic stress incontinence ($p = 0.065$) and were more likely to present with POP symptoms. The lack of association between levator avulsion and stress urinary incontinence/urodynamic stress incontinence and anal incontinence is most likely explained by the complex nature of the pathophysiology of urinary and fecal incontinence.

To our knowledge this is the first study conducted at a tertiary urogynecology clinic presenting data demonstrating an association between prolapse questionnaire components and abnormal functional anatomy of the pelvic floor. The multiethnic composition of our population could be considered a major strength, and we plan to report the findings of interethnic variation on pelvic organ descent and distensibility in a separate publication. Limitations of the study include the fact that ultrasonography and clinical examination were both performed by the first author. To overcome this potential bias, volumes were de-identified during acquisition and only analyzed 6–8 weeks later. Hence, the ultrasonography data presented here should not have been confounded by assessment bias. Also, we are aware that levator avulsion may be diagnosed at rest [26], but at the time of recruitment we decided to only allow diagnosis of levator avulsion on TUI during maximum PFMC, as originally described [16]. Finally, it would also be of interest to investigate the association between other symptoms of pelvic floor dysfunction (symptoms of bladder and sexual

dysfunction) and pelvic floor functional anatomy. We are in the process of performing such a study in this cohort.

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Compliance with ethical standards

Conflicts of interest None.

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