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Association of Levator Ani Avulsion and Anatomical and Functional Disorders

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Abstract

Objective: The purpose of this study is to investigate relationship between levator avulsion and anatomical & functional disorders in women who had at least one parity.

Methods: Women who complained of pelvic organ prolapse, urinary or defecatory dysfunction were recruited this cohort case-control study. Cases (women with levator defect, diagnosed by 3D translabial ultrasound) and controls (women without levator defect) were compared regarding anterior & posterior vaginal wall prolapse, vaginal apex prolapse, stress & urge urinary incontinence, defecatory dysfunction, increase in urogenital hiatus size, perineal body length, and PFDI-20 questionnaire.

Results: The mean age, genital hiatus size, perineal body size, number of parities, normal vaginal deliveries, caesarean sections, measures of vaginal anterior and posterior wall prolapse, prolapse stages, paravaginal prolapse and defecatory disorder prevalence were significantly different between two groups. Body mass index, heaviest baby weight, measure of vaginal apex prolapses, urinary stress and urgency incontinence prevalence, and PFDI-20 questionnaire scores weren't significantly different between two groups.

Conclusion: Levator avulsions seem to increase the risk of vaginal anterior and posterior wall prolapse, voiding dysfunction, paravaginal prolapse and defecatory disorders. The higher age, genital hiatus size, number of parities & normal vaginal deliveries may be associated with the risk of avulsions.

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Introduction

Pelvic Organ Prolapse (POP) imposes a great economic burden on the health system and affects about 30% of women during their lifetime [1,2]. The incidence of this prolapse is increasing with the aging of the world's population. It has a negative effect on the quality of life of women and causes physical, mental and sexual disorders in them [3].

The prevalence of lower urinary tract disorders, bowel symptoms, and sexual dysfunction in women with POP is high, but inconsistently reported [4]. There are few data on incidence of POP associated symptoms, and studies evaluating causality are rare or contradictory [5]. Obstructive voiding, lower abdominal and pelvic pain, and sexual dysfunction are the most frequent symptoms associated with POP [3].

Optimal treatment of these patients is challenging for urogynecologist. Prolapse examination should be performed based on the exclusive Pelvic Organ Prolapse Quantification system (POP-Q) [6]. But physical examination is not enough to diagnose the cause of prolapse and it requires imaging tools. Recently, ultrasound is used as the most common imaging diagnostic modality due to its simple, low cost, universal available, radiation-free and portable application [7,8].

Damage to the Levator Ani Muscle (LAM) and its detachment during normal vaginal delivery are considered important risk factor for pelvic prolapse [9]. These detachments are diagnosed by pelvic MRI or translabial ultrasound [10]. Imaging studies have shown that there is about 10% to 30% LAM avulsion normal vaginal delivery. Imaging observations also suggested that LAM detachment and injury may be the most important factor for causing pelvic organ prolapse [11].

The translabial 3D ultrasound is more accessible than Magnetic Resonance Imaging (MRI) and is reproducible for diagnosing LAM defects [12]. It is shown that translabial ultrasound results are consistent with the MRI results [8,13].

Evaluation of anatomical and functional disorders following LAM detachment, makes it possible to find out how effective can the defect in this muscle be in pelvic prolapse or urinary & fecal incontinence [14].

The purpose of this study was to investigate the relationship between the detachment of levator ani muscle, with functional and anatomical disorders of the pelvis. Women with levator ani muscle defect, diagnosed by 3-dimentional ultrasound, and women without levator ani muscle defect were compared in this study. The results showed that levator ani muscle detachment seems to increase the risk of pelvic organ prolapses, voiding dysfunction, & defecatory disorders and it affects women's quality of life. The higher age, number of pregnancies & natural childbirths may be associated with the risk of levator ani muscle detachment. The use of translabial 3-dimentional ultrasound to diagnose the levator ani muscle avulsion increases the accuracy of the study. The current research had a clinically well-described study population and included a comprehensive comparison between the symptomatic patients with and without levator ani muscle detachment. As women with levator ani muscle avulsions are possibly at a higher risk of symptomatic disorders, special surgical methods have been proposed for muscle reconstruction. It is not generally acceptable to perform such surgeries in asymptomatic women and the main prevention therefore relies on avoiding levator ani muscle injury during delivery. Increased awareness about importance of prevention, can reduce the incidence of levator avulsions.

Materials and Methods

In this case-control study, which has been performed between September 2021 and October 2022 at Imam Reza Hospital, Kermanshah University of Medical Sciences, the studied population was women with history of at least one parity (normal vaginal delivery or caesarean section) and also pelvic complaints including prolapse, stress or urge urinary incontinence or defecatory dysfunctions who referred to the pelvic floor clinic of the hospital. Patients' inclusion criteria consisted of age over 18 years, history of at least one parity, and any of the pelvic floor complaints such as prolapse, urge or stress urinary incontinence, and defecatory dysfunction. Exclusion criteria consisted of multiple pregnancy, premature birth, abnormal fetus, connective tissue disorders, history of vaginal, perineal or vulvar surgery, history of delivery with instrument, history of urinary or fecal incontinence and prolapse before pregnancy.

To recruit participants, the patients were visited by a urogynecologist and a complete history was taken. Clinical examination, evaluation of anatomical disorders, and staging of the prolapse, were performed by Pelvic Organ Prolapse-Quantification (POP-Q) system. Five important points in this system, which include the size of the prolapse in the anterior wall (Ba), posterior wall (Bp), or apex of the vagina (C), Perineal Body Length (Pb), and Genital Hiatus (GH) were recorded. If the largest protrusion height was at the level of hymen or beyond, the prolapse and otherwise the absence of prolapse was recorded.

The presence of functional disorders such as urinary incontinence and defecatory problems was investigated by asking patients separately and also by the PFDI-20 questionnaire. The questionnaires were filled out by asking the patients. This questionnaire is used to examine specific pelvic (POPDI-6), intestinal (CRAD-8), and bladder (UDI-6) symptoms. The reliability and validity of the questionnaire in Iran has been confirmed previously [15].

In PFDI-20 questionnaire, each of the scales has 6 to 8 questions about the patient's symptoms. Score of each scale is between 0-100 and PFDI-20 is between 0-300. The higher numbers and closer to 300, the lower quality of life.

In the next step, patients underwent 3D translabial ultrasound of the pelvic floor muscles. To perform the 3D ultrasound, the 4 MHz to 7 MHz probe was placed translabial. Ultrasound was performed by an experienced sonologist who trained in pelvic floor imaging. The muscles of both the right and left sides were observed and recorded. Muscle damage, even on one side of the pelvis, was considered a defect. Severity of LAM damage was divided into healthy, incomplete weakness and complete weakness. After performing ultrasound, patients were divided into two groups: Cases were women with LAM avulsion on one or both sides, and the control group were women without LAM defect. The two groups were matched according to age and BMI.

To evaluate the relationship between LAM detachment and pelvic floor functions or anatomical disorders, case and control groups were compared regarding anterior vaginal wall prolapse (Ba point), posterior vaginal wall prolapse (Bp point), vaginal apex prolapse (C point), Stress Urinary Incontinence (SUI), Urge Urinary Incontinence (UUI), fecal incontinence, increase in urogenital hiatus size (GH), Perineal body size (Pb), quality of life according to PFDI-20 questionnaire and any of its 3 scales, woman's body mass index, and heaviest baby weight. The SPSS software version 20 (SPSS Inc., Chicago, US) was used for statistical analysis. Independent t test was used to compare quantitative data between groups and chi square was used to compare qualitative data between the two groups. P-value less than 0.05 was considered as a significant relationship.

The study was in accordance with the Declaration of Helsinki and approved by Kermanshah University of Medical Sciences ethics committee (code: IR.KUMS.MED.REC.1400.035). Written informed consents were provided by all the participants. All the evaluations were non-invasive and done free of charge, and the data of the patients were kept confidential.

Results

Eighty participants were included the study. Descriptive data of the participants are shown in Table 1. Fifty-two participants (65%) suffered from LAM detachment (cases) and 28 participants (35%) didn't suffer from LAM detachment (controls).

All participants (80 people) suffered from vaginal prolapse. Prevalence of vaginal prolapse stages were 9 people stage I (11.3%), 35 people stage II (43.8%), 31 people stage III (38.8%), and 5 people stage IV (6.3%).

Prevalence of other disorders among participants were as follow: 35 people with right paravaginal prolapse (43.8%), 25 people with left paravaginal prolapse (31.3%), 40 people with stress urinary incontinence (50%), 49 people with urge urinary incontinence (61.3%), 30 people with defecatory dysfunction (37.5%), 36 people with right LAM detachment (45.0%), and 27 people with left LAM detachment (33.8%).

According to Table 2 Mean of genital hiatus size was 7.04 cm (SD: 1.15) in case group and 6.32 cm (SD: 0.94) in control group (P-value:

Table 1: Descriptive data of the participants.

	Minimum	Maximum	Mean	SD
Age (year)	26	85	50.13	11.36
BMI (kg/m²)	21	42.21	26.14	2.59
Heaviest baby weight (gr)	3000	5000	3730	398.05
Parity	1	11	3.83	2.11
Normal Vaginal Delivery	0	11	3.17	2.42
Caesarean Section	0	3	0.66	0.95

Table 2: The comparison of quantitative parameters between groups with levator ani muscle avulsion (cases) and without levator ani muscle avulsion (controls).

Parameter (unit)	Case Mean ± SD†	Control Mean ± SD†	p-value (T-test)
Age (year)	53.00 ± 10.83	45.21 ± 10.70	0.004
Parities (n)	4.34 ± 2.21	2.89 ± 1.57	0.001
NVDs (n)	3.88 ± 2.34	1.85 ± 2.17	<0.001
Sections (n)	0.46 ± 0.762	1.04 ± 1.16	0.025
BMI (kg/m²)	26.04 ± 3.11	26.31 ± 1.30	0.624
Heaviest baby weight (gr)	3780.00 ± 418.08	3630.00 ± 340.64	0.102
Ba (anterior vaginal wall prolapse) (cm)	1.70 ± 2.01	-0.50 ± 1.03	<0.001
Bp (posterior vaginal wall prolapse) (cm)	0.96 ± 2.01	-0.71 ± 2.08	0.001
C (apex vaginal prolapse) (cm)	-0.33 ± 4.43	-1.14 ± 4.40	0.434
Residual urine volume (ml)	44.04 ± 45.90	8.57 ± 17.78	<0.001
Genital hiatus size (cm)	7.04 ± 1.15	6.32 ± 0.94	0.004
Perineal body size (cm)	3.52 ± 0.96	4.07 ± 0.76	0.008
POPDR-6 (pelvic organ prolapse distress)	41.90 ± 28.88	33.33 ± 28.46	0.206
CRADI-8 (colorectal–anal distress)	13.70 ± 11.58	9.93 ± 13.50	0.217
UDI-6 (urinary distress)	43.74 ± 20.70	40.62 ± 18.48	0.492
PFDI-20/Total score	99.35 ± 45.98	83.89 ± 40.86	0.128

†: Standard Deviation

Table 3: The comparison of qualitative parameters between groups with levator ani muscle avulsion (cases) and without levator ani muscle avulsion (controls).

		Paravaginal prolapse N (%)		P-value	Urinary stress incontinence N (%)		P-value	Urinary urgency incontinence N (%)		P-value	Defecatory disorder N (%)		P-value	Vaginal prolapse stage N (%)				P-value
		No	Yes		No	Yes		No	Yes		No	Yes		1	2	3	4	
Levator ani avulsion	Yes	4	48	<0.001	25	27	0.407	19	33	0.376	27	25	0.007	4	24	20	4	0.04
	(case)	-7.7	-92.3		-48.1	-51.9		-36.5	-63.5		-51.9	-48.1		-7.7	-46.2	-39	-7.7	
	No	28	0		15	13		12	16		23	5		20 (71.4)	5	2	1	
	(control)	-100	0		-53.6	-46.4		-42.9	-57.1		-82.1	-17.9			-17.8	-7.1	-3.6	

0.004). Mean of perineal body size was 3.52 cm (SD: 0.96) in case group and 4.07 cm (SD: 0.76) in control group (P-value: 0.008).

According to Table 2 the mean age was higher in case group. The mean number of parities and normal vaginal deliveries were significantly more in group with LAM avulsion and the mean number of caesarean sections were significantly more in group without LAM avulsion (Table 2).

According to Table 2, measures of vaginal anterior and posterior wall prolapses and also residual urine volume were significantly more in case group.

PFDI-20 questionnaire total, pelvic, intestinal, and bladder scores weren't significantly different between two groups (Table 2).

According to the Table 3, paravaginal prolapse and defecatory disorder were significantly different between two groups. 92.3% of cases had paravaginal prolapse (67.30% right, and 48.07% left), while none of controls had paravaginal prolapse and 48.1% of cases had defecatory disorder, while 17.9% of controls had defecatory disorder. Prevalence of urinary stress incontinence and urinary urgency incontinence did not differ significantly between groups.

Prevalence of 4 vaginal prolapse stages was significantly different between groups with and without LAM detachment (Table 3). Prevalence of stages 1, 2, 3, and 4 were 7.7%, 46.2%, 38.5% & 7.7% in case group, and 71.4%, 17.8%, 7.1%, & 3.6% in control group, respectively.

Discussion

This study showed that in group with LAM avulsion, the prevalence of parity, normal vaginal delivery, point Ba, point Bp, GH size, residual urine volume, paravaginal prolapse and defecatory disorder were significantly higher, but the caesarean section rate and the mean perineal body length were higher in intact LAM.

Most of the patients who complained of pelvic anatomical or functional dysfunctions, had LAM detachment which diagnosed by 3D translabial ultrasound. Obstetric anal sphincter injury and LAM trauma are common disorders in parous women [16]. Levator trauma can be asymptomatic, with abnormality arising years later. Discontinuity of the LAM is the main sonographic sign but may appear as increased hiatal area in severe cases [16]. One of the proposed reasons for levator ani avulsion, is sudden fundal pressure on the uterus. Women who undergo fundal pressure in the second stage of labor, have a higher chance of muscle damage [17]. Due to the prevalence of fundal pressure in obstetric departments, it may be one of the important causes of muscle rupture and then pelvic prolapses.

Mean genital hiatus size was significantly more and mean of perineal body size was significantly less in case group. According to Notten et al., a larger hiatus was associated with POP and recurrent POP which are related to LAM defects [12].

All patients in this study complained from vaginal prolapse. Handa et al., reported prolapse was associated with levator hiatus area [9]. In our study, prevalence of vaginal prolapse stages was significantly different between groups. Stage 1 was more prevalent in control group and stages 2, 3, & 4 were more prevalent in case group.

Measures of Ba point and Bp point were significantly more in case group. LAM defects in a selected population of patients with pelvic floor dysfunction, were associated with POP. Moreover, these defects increase the risk of cystocele and uterine prolapse, and are associated with recurrent POP to [12].

In our study, the prevalence of cesarean section was higher in the control group. Most of these patients had the elongation of point C and the amount of prolapse was lower in points Ba and Bp. The majority of these patients had cervical elongation and apical prolapse had caused high stages. Although prolapse in the anterior compartment was less in the control group, there were still cases of stress urinary incontinence.

Maternal characteristics at birth such as age increase the risk of LAM detachment and pelvic floor dysfunction, labor and birth factors play an important role to [18]. The mean age of case group was higher in current study and the mean number of parities and normal vaginal deliveries were significantly more in case group while the mean number of caesarean sections were significantly more in control group. Kimmich's study showed; 14% of women suffered a complete LAM avulsion after vaginal birth and assessing for LAM trauma by translabial ultrasound might be worthwhile [19].

PFDI-20 questionnaire total, pelvic, intestinal, and bladder scores weren't significantly different between two groups. No relationships between LAM detachment and total PFDI-20, pelvic organ prolapse, colorectal–anal & urinary distress scores are shown previously [20]. The reason could be the subjective nature of the questionnaire which reduces its accuracy.

More than 90% of the cases had paravaginal prolapse, while none of the controls had it. Lateral tears of anterior vaginal wall are called paravaginal defects and results in cystourethrocele. The incidence of paravaginal defects in patients with anterior vaginal wall prolapse in Liu's study is reported up to 80% and both the levator ani muscle and the sides of the pelvic fascia were at a high risk of injury [21]. Delancey et al. showed that prevalence of right paravaginal prolapse was 89% and left was 87% [22]. Prevalence of right paravaginal prolapse was more in our study, too.

Near half of cases had defecatory disorder, while less than one fifth of controls had it. LAM avulsion produces an increase in the anorectal angle at rest, during contraction and in Valsalva, especially in cases of bilateral LAM avulsion [23]. Melendez-Munoz found a weak association between LAM avulsion and measures of anal incontinence, which largely remained significant when controlling for anal sphincter trauma [24]. Heliker showed in a prospective cohort that, the risk of levator ani avulsion is almost 6 times higher after forceps-assisted vaginal delivery as compared with spontaneous vaginal delivery [25].

Prevalence of urinary stress incontinence and urinary urgency incontinence did not differ significantly between groups. Smeets, by a systematic review and meta-analysis, has shown that there is no relationship between levator ani muscle avulsion and stress urinary incontinence in women. The diagnosis of levator ani muscle avulsion was made with translabial ultrasound or magnetic resonance imaging in all studies which have been recruited in meta-analysis [26].

On the other hand, residual urine volume was significantly more in case group. Gonzalez-Díaz showed that postpartum voiding dysfunction is common and self-limited in LAM avulsion patients, but in less than one-fifth of cases it persists more than 3 days and levator ani muscle avulsion acts as an independent risk factor for it. Early diagnosis and appropriate treatment of persistent postpartum voiding dysfunction, can reduce any long-term urogynecologic disorders [27].

Endovaginal 3D US is comparable to MRI in its ability to identify both normal and abnormal LAM anatomy [28]. Translabial 3D ultrasound is reproducible for diagnosing LAM defects and detecting LAM defects with translabial 3D ultrasound compared with magnetic resonance imaging showed a moderate to good agreement [12]. One of the advantages of this study is the use of translabial 3D ultrasound to diagnose the LAM avulsion. Another strength is that the current research had a clinically well-described study population and included a comprehensive comparison between the symptomatic patients with and without LAM detachment. Limitations of our study not performing MRI for evaluation of LAM, and low number of participants.

Finally, as women with LAM avulsions are possibly at a higher risk of symptomatic anatomical & functional disorders, special surgical methods have been proposed for LAM reconstruction [20]. However, it is not generally acceptable to perform such surgeries in asymptomatic women and the main prevention therefore relies on avoiding LAM injury during delivery. Increased awareness about importance of prevention, can reduce the incidence of levator avulsions [20]. More research is needed concerning the successful ways of avoiding LAM injury during delivery.

Conclusion

Our study confirms levator avulsions seem to increase the risk of anterior and posterior vaginal wall prolapse severity, voiding dysfunction, paravaginal prolapse and defecatory disorders. Moreover, our study indicates that higher age, genital hiatus size, number of parities & normal vaginal deliveries may be associated with the risk of avulsions, which implies that special care must be taken during delivery to avoid pelvic levator trauma. More severe stages of prolapse in cases without muscle avulsion were caused by apical prolapse, and the prolapse of the anterior and posterior compartments was less. The prevalence of stress urinary incontinence was less in these patients, too.

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