Comparison of levator hiatal area and anteroposterior length between pelvic organ prolapse subject with and without bulging symptoms

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Abstract

Pelvic Organ Prolapse (POP) is defined as the descent of the pelvic viscera (uterus, bladder, urethra, and rectum) from its normal position. There are different stages of POP starting from early asymptomatic until late obvious symptomatic stages. Levator Anal Muscle (LAM) which plays an important part in POP pathogenesis, showed that there was difference in Levator Hiatal (LH) area and anteroposterior length on every grade of POP. It is important to determine early diagnose of asymptomatic POP clinically by anteroposterior length measurement, and determined its relation with LH area measurement using Ultrasound (US) imaging. To compare LH area and anteroposterior length between POP subject with and without bulging symptom. A cross-sectional study was conducted among women diagnosed as POP with and without bulging symptom in a Urogynecology Clinic between November 2019 to March 2021. Patients were examined using the POP-Q system and 3D/4D imaging of the LH area using Voluson type systems. Data were analyzed to compare LH area and anteroposterior length between groups. A total of 109 subjects were included in this study. There was a significance difference in LH area (28.9+5.59 cm^2 vs 19.6+4.63 cm^2, $p < 0.05$ during valsalva maneuver, 15.2+4.08 cm^2 vs 12.5+3.15 cm^2, $p <0.05$ during contraction) and anteroposterior length (8.6+1.06 cm, vs 6.8+1.13 cm, $p<0.05$) between groups with and without bulge symptom. LH area and anteroposterior length cut-off to differentiate between subject with and without bulging symptom was respectively 25,1 cm^2 [sensitivity 84,6%, specificity 92,9%, AUC 0,925 (0,864-0,986)] and 7,75 cm [sensitivity 87,2%, specificity 77,1%, AUC 0,859 (0,787-0,932)]. In patient without bulging symptom there was a significant difference of anteroposterior length between prolapse stage 1, 2, and 3. Post hoc analysis with Tukey test showed a significant difference of anteroposterior length only between grade 0 and 2, and grade 1 and 2. There was a significant difference in LH area and anteroposterior length between groups with and without bulging symptom. LH area cut-off at 25,1 cm^2, anteroposterior length cut-off at 7.75 cm showed good sensitivity and specificity to differentiate between 2 groups.

Introduction

Pelvic Organ Prolapse (POP) is defined as the descent of the pelvic viscera (uterus, bladder, urethra, and rectum) from its normal position.[1] POP causes a significant decreased quality of life due to discomfort, psychological complaint, sexual issue, occupational hindrance, and social limitations.[2] Prevalence of POP in the United States is estimated to increase by 46% with a total of 4.9 million women affected by 2050.[3] POP happens due to a weakened pelvic floor which is caused by various risk factors such as age, postmenopausal status, history of vaginal delivery, trauma during labor, and other condition which caused chronic increased of intraabdominal pressure. Levator Ani Muscle (LAM) plays an important part in POP pathogenesis.[4] Levator Hiatal (LH) area is a 'hernial portal' formed by LAM with high potency of prolapse. Besides, LH area is also the center opening of levator plate which showed association with signs and symptoms of POP and risk of recurrency. Vaginal birth process mainly creates a great stretch of LAM that may cause abnormal distensibility or 'ballooning' condition of LH area, which results in symptomatic prolapse. This condition can be detected by Ultrasound (US) measurement.[5]

POP actually can be prevented with earlier treatment. In the early stages POP is often asymptomatic, and usually negligible until it reaches a severe degree and becomes symptomatic. The treatment of POP also mostly starts when symptoms have already appeared, while based on physical examination nearly half of women over 50 years of age who have given vaginal birth have POP, and only 10 – 20% of them are symptomatic. That showed so far the initial management of those conditions was considered late. To sucessfully treat POP, we might start early treatment in any early stage of asymptomatic POP, which can be detected earlier by detecting early ballooning of LH area via US examination. Previous study showed that clinical examination can detect this condition. The sum of Gh+Pb measurement in POP-Q examination help clinicians to determine abnormal excessive hiatal distensibility or 'ballooning' without requiring ultrasound imaging.[6] The high prevalence of asymptomatic POP and the magnitude of problem caused by POP calls for a simpler screening system that can be used easily in daily practice. It is important to diagnose early asymptomatic POP clinically using anteroposterior length measurement, and to determine its relation with LH area measurement using US imaging. Hopefully this

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Availability of data and materials: All data underlying the findings are fully available.

Ethics approval and consent to participate: The Ethics Committee of Faculty of Medicine Universitas Indonesia approved this study (KET-1171/UN2.F1/ETIK/PPM.00.02/2019). The study is conformed with the Helsinki Declaration of 1964, as revised in 2013, concerning human and animal rights. All patients participating in this study signed a written informed consent form for participating in this study.

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could be used to screen and detect asymptomatic prolapse which then could be treated earlier in order to prevent severe grade symptomatic prolapse.

Materials and Methods

The aim of this study is to compare levator hiatal area and anteroposterior length between POP subjects with and without bulging symptom.

This was a cross-sectional study with consecutive sampling method. Subjects included in this study were POP patients with and without bulging symptom who came to Dr. Cipto Mangunkusumo General Hospital, Indonesia. The exclusion criteria of this study were patients with pelvic organ

Table 1. Clinical characteristics of subjects

Characteristics	Group, n (%)		P-Value
	With Bulging Symptom	Without Bulging Symptom	
Group age			
28 – 49 years old	3 (7.7)	36 (51.4)	0
50 – 59 years old	13 (33.3)	21 (30.0)	
60 – 76 years old	23 (59.0)	13 (18.6)	
Age mean (SD)	59.4 (6.51)	48.8 (11.11)	0
Nutritional status (body mass index)			
Under/Normoweight	22 (56.4)	32 (45.7)	0.573
Overweight	12 (30.8)	25 (35.7)	
Obese	5 (12.8)	13 (18.6)	
BMI mean (SD)	25.7 (3.51)	26.6 (4.57)	0.303
Body weight mean (SD)	61.1 (8.76)	63.3 (12,01)	0.310
Body height mean (SD)	1.54 (0.05)	1.54 (0.05)	0.942
Physical activity			
Low	16 (41.0)	61 (87.1)	0
High	23 (59.0)	9 (12.9)	
Parity			
Nulipara	0 (0)	6 (8.6)	
Primipara	2 (5.1)	8 (11.4)	0.027
Secundipara	8 (20.5)	28 (40.0)	
Multipara	29 (74.4)	28 (40.0)	
Menopausal status			
No	5 (12.8)	37 (52.9)	0
Yes	34 (87.2)	33 (47.1)	
Maximal baby birth weight			
< 3,325 kg	15 (38.5)	41 (64.1)	0.011
3,325 + kg	24 (61.5)	23 (35.9)	
Grade of uterine prolapse			
Grade 0	0 (0)	17 (24.3)	
Grade 1	5 (12.8)	37 (52.9)	
Grade 2	10 (25.6)	16 (22.9)	0
Grade 3	17 (43.6)	0 (0)	
Grade 4	7 (17.9)	0 (0)	
Grade of cystocele			
Grade 0	0 (0)	15 (21.4)	
Grade 1	0 (0)	21 (30)	0
Grade 2	9 (23.1)	34 (48.5)	
Grade 3	26 (66.7)	0 (0)	
Grade 4	4 (10.2)	0 (0)	
Grade of rectocele			
Grade 0	0 (0)	23 (32.9)	
Grade 1	4 (10.2)	34 (48.6)	0
Grade 2	25 (64.1)	13 (18.5)	
Grade 3	9 (23.1)	0 (0)	
Grade 4	1 (2.6)	0 (0)	
Grade the biggest POP			
Grade 0	0 (0)	12 (17.1)	
Grade 1	0 (0)	23 (32.9)	0
Grade 2	5 (12.8)	35 (50.0)	
Grade 3	27 (69.2)	0 (0)	
Grade 4	7 (18.0)	0 (0)	
Levator hiatus area during valsava (cm2)			
<= 25	5 (12.8)	65 (92.9)	0
> 25	34 (87.2)	5 (7.1)	
Levator hiatus anteroposterior length (cm)			
< 7	0 (0)	47 (67.1)	0
7 +	39 (100)	23 (32.9)	

malignancy, intraabdominal tumor >10 cm, history of pelvic surgery, inability to do Valsalva maneuver, absence of an indication for US examination, and presence of a chronic perineal rupture. All subjects had undergone POP-Q examination and 3D/4D translabial US examination.

Bulging symptom is defined as bulging sensation experienced by the subjects. US examination was done by a urogynecologist using *General Electric Voluson E8 Expert BT09 (GE Medical System, Zipf, Austria)* with 4.0 – 9.0 Mhz convex probe RIC5-9-D (120^{o} acquisition angle) and translabial approach. The bladder was emptied prior to the examination. All subjects were examined in the LH area using US during Valsalva and contraction maneuvre, and anteroposterior length was clinically examined during Valsalva maneuver.

Data was collected and analyzed with student t-test to see the difference between LH area and anteroposterior length between the 2 groups. ROC analysis was performed in order to obtain cut-off with the best sensitivity and specificity in differentiating POP subjects with and without bulging symptoms.

Result

A total of 109 subjects were included in this study: 39 subjects with POP and bulging symptoms and 70 subjects with POP without bulging symptoms. The subject's clinical characteristics can be seen in Table 1. There was statistically significant difference between the groups with and without bulging symptoms in age, physical activity, number of parities, maximal baby birth weight, menopausal status, grade of uterine prolapse, grade of cystocele, grade of rectocele, grade of biggest POP, LH area and anteroposterior length during Valsalva maneuver.

The uterine prolapse parameter between the groups with and without bulging symptoms can be seen in Table 2. There was a significant difference in LH area during Valsalva maneuver and contraction, GH length, PB length, and GH+PB length between the 2 groups. The group with bulging symptom has a higher uterine prolapse parameter than those without bulging symptom.

An ROC analysis was performed to obtain LH area and anteroposterior length cut-off to differentiate between groups with and without bulging symptoms. Levator hiatus area of 25.1 cm^2 had a sensitivity of 84.6% and specificity of 92.9% with AUC 0.925 (95% CI 0.864-0.986) and levator hiatus anteroposterior length of 7.75 cm had sensitivity of 87.2% and specificity of 77.1% with AUC 0,859 (95% CI 0.787-0.932, Figure 2).

Analysis of uterine prolapse parameter with a grade of uterine prolapse in subjects without bulging symptom can be seen in Table 3. There was a significant difference of GH+PB mean length between prolapse grades 1, 2, and 3. Post hoc analysis with the Tuckey test showed no significant difference in GH + PB mean length between prolapse grade 0 and 1, but there was a significant difference between prolapse grade 0 and 2, and grade 1 and 2. Table 4 shows post hoc analysis with Bonferoni test for GH+PB length.

Discussion

There was a significant difference in age, physical activity, number of parities, and menopausal status between the groups with and without bulging symptoms in this study. Sayko *et al.*[7] showed that age is a major factor affecting the degree of uterine prolapse. Nygaard *et al.*[8] showed that physical activity did not increase POP anatomical abnormality in middle age woman seeking POP treatment. However, strenuous physical activity (≥21 hours/week) during the teenage years increased the risk of POP (p=0.046). The number of parities was known to increase POP risk. Among parous women, the odds for symptomatic pelvic organ prolapse increased 3.3-fold higher among mothers of 4 than among mothers of 1.[9] Study from Bali, Indonesia also conclude that severe stage POP is most likely to be found in women with high parity, older

Table 2. Uterine prolapse parameter.

Parameter	With bulging symptom (n=39) Mean (SD)	Without bulging symptom (n=70) Mean (SD)	P-Value
Levator hiatus area (cm^2):			
- valsava	28.9 (5.59)	19.6 (4.63)	0
- contraction	15.2 (4.08)	12.5 (3.15)	0
Length of GH (cm)	5.6 (0.91)	4.1 (1.13)	0
Length of PB (cm)	3.0 (0.71)	2.7 (0.70)	0.035
Length of GH + PB (cm)	8.6 (1.06)	6.8 (1.13)	0

Table 3. Uterine prolapse parameter with grade of uterine prolapse in subjects without bulging symptom.

Parameter	Gr 0 (n=12) Mean (SD)	Gr 1 (n=23) Mean (SD)	Gr 2 (n=35) Mean (SD)	P
Levator hiatus area during valsalva maneuver (cm^2)	17.9 (4.61)	19.9 (5.32)	20.5 (2.37)	0.262
GH + PB length (cm)	6.3 (1.27)	6.5 (0.80)	7.8 (1.06)	0

Table 4. Post hoc analysis with Bonferoni test for GH+PB length

Parameter	Gr 0 (n=12) Mean (SD)	Gr 1 (n=23) Mean (SD)	Gr 2 (n=35) Mean (SD)	P
GH + PB length (cm)	6.3 (1.27)	6.5 (0.80)		1,000
	6.3 (1.27)		7.8 (1.06)	0,000
		6.5 (0.80)	7.8 (1.06)	0,000

age (≥60 years old), and who went through menopause already.[10] Saimin *et al.*[11] found that menopaused women had higher POP prevalence compared to pre-menopausal women. Menopause is associated with older age and decreased of estrogen levels. Decreased of estrogen level causes thinning of supportive pelvic structure and connective tissue therefore increasing the risk of prolapse. Beside those, maximal baby birth weight was also known to increase POP risk. Martinho *et al.*[12] concluded the birthweight of the first vaginally born baby is associated with levator avulsion and subsequent POP. Valsky *et al.*[13] showed that birth weight >3400 grams increased the risk of levator avulsion by 1.094 (p=0.028) for every 100 grams increase in baby birth weight. Baby birth weight is strongly associated with head circumference therefore it is also associated with puborectalis muscle stretch during vaginal delivery. Bigger head circumference is also associated with longer phase 2 labor. However, the baby's birth weight is a better univariate predictor for levator avulsion than maximal baby birth weight. The rupture is more likely to happen during the first labor and risk of rupture in the next labor is unlikely.

There was also a significant difference in the grade of uterine prolapse, cystocele grade, rectocele grade, and grade of largest POP between groups with and without bulging symptom. In general, the group with bulging symptom had a higher grade of prolapse. This result was consistent with a study by Digesu *et al.*,[14] which found that prolapse severity is significantly higher in those women symptomatic of prolapse. This result is also consistent with a study by Dunivan *et al.*[15] which found that the length of GH and PB could be used as a predictor for prolapse grade severity. Gerges *et al.*[6] found that the total of GH and PB length had strong association with signs (p>0.001) and symptoms (p<0.001) of POP with an optimal classification of abnormal hiatus distensibility ballooning to mild, moderate, significant and severe respectively 7.0-7.99 cm, 8.0-8.99 cm, 9.0-9.99 cm and more than 10 cm.

From the ROC curve we obtained LH area of 25.1 cm^2 had a sensitivity of 84.6% and specificity of 92.9% with AUC 0.925 (CI 95% 0.864-0.986) and LH anteroposterior length of 7.75 cm had a sensitivity of 87.2% and specificity of 77.1% with AUC 0.859 (CI 95% 0.787-0.932) in differentiating groups with and without bulging symptoms. A previous study showed there were various cut off for LH area and anteroposterior length. Dietz *et al.*[5] found that cut off above 25 cm^2 was associated with bulging symptom with sensitivity of 55% and specificity of 77%. Khunda *et al.*[16] found that the mean of LH area in asymptomatic patients was 23.47 cm^2 and in symptomatic patients was 31.14 cm^2. The LH area in prolapse grade 2 or more as 18.6 cm^2 in asymptomatic patients and 29.99 cm^2 in symptomatic patients. Handa *et al.*[17] showed that the risk of prolapse increased by 50% for every 5 cm^2 increase in LH area. Based on the study by Andrew *et al.*,[18] it can be concluded that an increase of LH area was associated with POP occurrence and severity. Kustarto and Moegni[19] found the cut-off for LH anteroposterior length between prolapse grade 2 and 3 was 7.5 cm and between prolapse grade 3 and 4 was 8.3 cm. Khunda *et al.*[16] found that the total length of GH and PB in symptomatic patients was 8.38 cm while in asymptomatic patients was 7.25 cm (p<0.001). In subjects with prolapse grade 2 or more, the total length of GH + PB was 8.33 cm in symptomatic patients and 6.12 cm in asymptomatic patients. The LH anteroposterior length was correlated with the risk of abnormality and increased risk of prolapse. Levator ani muscle avulsion was predicted to cause increased levator hiatus area. Avulsion of this muscle increased the LH area and caused damage to muscle fascia and connective tissue. A study from Volloyhaug *et al.*[20] also found that although it is not as predictive as LH area, anteroposterior length allows easier and simpler measurement to identify women with levator avulsion.

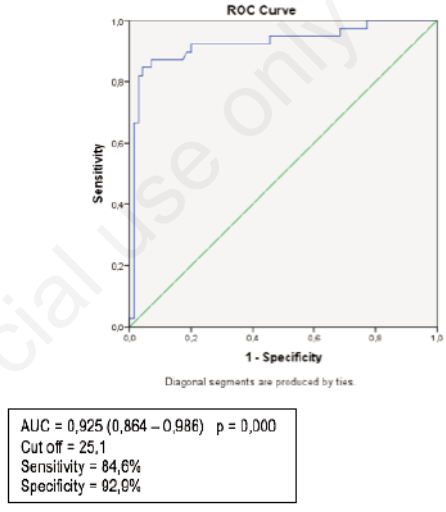

Figure 1. ROC curve of levator hiatal area based on bulging symptom.

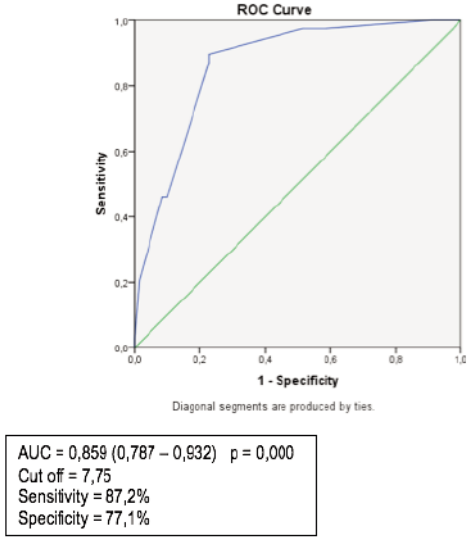

Figure 2. ROC curve of levator hiatal AP length based on bulging symptom.

Strength and Limitation

This study was the first study to search for LH area and anteroposterior length cut-off between POP patients with and without bulging symptom. The limitation of this study was the possibility of bias in data collection due to the research being a single-center study. Primary data of POP-Q results were collected by a few teams with different measurement instrument. There are also some significant differences in clinical characteristics between study groups which may influence the results. Moreover, our proposed cut-off value had not been verified in a different population. Thus, further validation is necessary.

Conclusions

There was a significant difference in LH area and anteroposterior length of POP patients between groups with and without bulging symptoms.

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