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Original Research Article

A study of the changes in pelvic floor biometry in pregnancy by trans labial ultrasonography: cross sectional observational analytical study

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ABSTRACT

Background: The pelvic floor, a crucial structure for urinary and anal continence, sexual function, and pelvic organ support, undergoes significant changes during pregnancy and childbirth. Damage to this area can lead to female pelvic floor disorders (FPFDs) such as urinary incontinence, fecal incontinence, and pelvic organ prolapse. This study aimed to evaluate the changes in pelvic floor biometry during pregnancy using translabial ultrasonography (USG) in Indian women.

Methods: This cross-sectional observational analytical study recruited 112 women from December 2022 to July 2023 at Sparsh Hospital. The participants included nulliparous women (n=12) and pregnant women in their second and third trimesters, divided into primigravida (n=50) and second gravida (n=50) groups. Translabial 2D and 4D USG was performed in the study.

Results: The study found statistically significant changes in bladder neck mobility and hiatal area in primigravida patients compared to nulliparous women. Bladder neck mobility increased with parity, especially during the Valsalva maneuver, suggesting a greater descent in multiparous women. The thickness of the levator ani muscle also increased during pregnancy, showing a significant change during contraction in primigravida patients. While hiatal area did not significantly change with increasing parity, bladder neck mobility was notably higher in second gravida patients compared to primigravida patients, particularly during contraction.

Conclusions: Translabial USG is a valuable, non-invasive tool for assessing these changes, which can help clinicians and patients anticipate potential PFDs and implement preventative post-delivery care.

Keywords: Female pelvic floore disorders, Pelvic floor biometry, Ultrasonography

INTRODUCTION

The pelvic floor, or pelvic diaphragm, is a heterogeneous anatomical structure at the inferior part of the bony pelvis.[1] It is this intricate amalgamation of skeletal and smooth muscles, ligaments, and fascia that is critical to the physiological functions of the body, offering essential support for the pelvic organs and ensuring urinary and anal continence. It is also a critical part of sexual function.[2,3] The main muscular elements of the pelvic floor are the levator ani and coccygeus muscles and their supporting connective tissues.[4]

The pelvic floor gives critical support to the pelvic organs. Pregnancy and childbirth are catalysts for change that may weaken the pelvic floor, ultimately resulting in such conditions as urinary and fecal incontinence and pelvic organ prolapse. The progressively increasing weight of the gravid uterus causes compression against the pelvic floor muscles and their neurovascular supply, and the hormone relaxin is known to augment ligamentous laxity and joint instability.

Such pregnancy-related alterations can be accurately measured by means of translabial ultrasonography (USG), which is an affordable and reproducible method. USG facilitates the measurement of dynamic alterations in the pelvic floor, like the change in the hiatal region, which could prove useful in predicting subsequent difficulties during labor and making clinical decisions. The technique also helps in enlightening the patient about possible risks and importance of postpartum pelvic floor care.

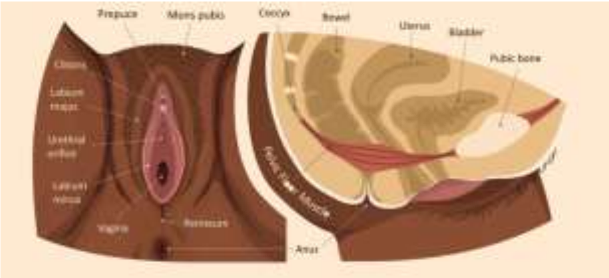

Figure 1: Female external genitalia and internal pelvic viscera; pelvic floor muscles.

The purpose of the present study was to compare the alterations in pelvic floor biometry in pregnancy through translabial USG in Indian women.

METHODS

This was a cross-sectional analytical observational study carried out at Sparsh Hospital between December 2022 and July 2023. The hospital ethical committee provided approval for the study protocol.

Patient selection

112 patients were enrolled after taking written informed consent. The study group included a control group consisting of 12 nulliparous women and 100 pregnant singleton women, distributed into four groups: 25 primigravida in the second trimester, 25 primigravida in the third trimester, 25 second gravida in the second trimester, and 25 second gravida in the third trimester.

Inclusion criteria

Pregnant women during the second and third trimesters with singleton pregnancy, visiting the antenatal clinic with no other symptoms. The mean age was 32.5 years (range 21-35), and the mean BMI was 26. For the control group, nulliparous women were chosen with a mean age of 28 years (range 21-30) and a mean BMI of 25. They were not having any history of hormonal consumption, pelvic organ prolapse (POP), or stress urinary incontinence (SUI).

Exclusion criteria

Patients with previous pelvic floor surgery, neuromuscular disease, smoking, pelvic tumors, hormonal use, chronic constipation, chronic cough, or any other medical condition were excluded.

Procedure

All the translabial ultrasound scans were done by a single practitioner with more than 20 years of experience on a GE VOLUSON 8P machine and a 2D and 4D volume probe. Patients were told to void urine, retaining 30-50 ml in the bladder for scanning. They were placed in a supine lithotomy position with flexed knees and heels near the buttocks. The probe was wrapped in a disposable transparent cover for every patient.

Measurements were recorded for three standardized maneuvers: rest, contraction of the pelvic floor muscle, and Valsalva maneuver. For the Valsalva maneuver, the patients were to hold their breath for 10-15 seconds. To contract effectively, they were asked to contract their vagina and anus.

Parameters measured

2D measurements (interval between the posteroinferior surface of the pubic symphysis and the anorectal angle. Interval between the bladder neck and the imaginary line joining the posteroinferior pubic symphysis and the anorectal angle); 3D measurements (interval between the urethra and the lateral midpoint of the levator ani muscle (bilateral). Interval between the urethra and the posterior fourchette); thickness of the levator ani muscle; hiatal area.

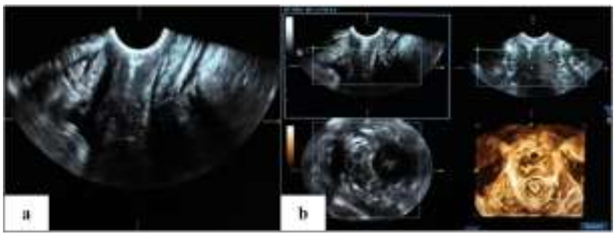

Figure 2: (a) Pelvic floor in 2D USG; (b) pelvic floor in 3D USG.

Statistical analysis

Statistical analysis was carried out by an experienced professional within the Department of Community Medicine. Comparisons were made between the various patient groups (nulliparous, primigravid, and second gravida) and between the trimesters through analysis of the biometry measurements. Statistical significance of the differences was ascertained using Student's t-test and Welch's t-test, the p-value considered to be statistically significant being <0.05.

RESULTS

Table 1 show an increase in levator ani muscle thickness in primigravida patients that is statistically significant during contraction ($p<0.001$). This is due to hypertrophy and fat deposition. The study also finds a statistically significant decrease in levator thickness in third-trimester second gravida patients compared to the second trimester ($p<0.05$), which contrasts with the non-significant change observed in primigravida patients between trimesters. This could indicate a different pattern of muscle remodeling or stretching in multiparous women.

Table 1: Levator thickness.

Levator thickness	Statistical test	Statistical value	df	P value
In primigravida				
Rest	Welch's t	-1.38	34.9	0.176
Contraction		-4.85	32.6	<0.001
Valsalva		-1.52	27.8	0.140
Comparison of 2nd and 3rd trimester in primigravida patients				
Rest	Welch's t	1.609	43.0	0.115
Contraction		0.268	47.0	0.79
Valsalva		-0.27	47.7	0.788
In second gravida patients				
Rest	Welch's t	3.04	45.7	0.004
Contraction		2.49	47.9	0.016
Valsalva		2.17	47.7	0.035
Comparison of 2nd and 3rd trimester in second gravida patients				
Rest	Welch's t	1.78	45.5	0.082
Contraction		3.01	44.3	0.004
Valsalva		2.20	46.3	0.033

Table 2: Bladder neck mobility.

Bladder neck mobility	Statistical test	Statistical value	df	P value
Comparison of 2nd and 3rd trimester in primigravida patients				
Rest	Welch's t	-1.36	47.8	0.179
Contraction		-1.86	43.0	0.069
Valsalva		-2.26	47.6	0.028
Comparison of 2nd and 3rd trimester in second gravida patients				
Rest	Welch's t	-0.389	40.9	0.699
Contraction		-3.717	32.5	<0.001
Valsalva		1.080	37.1	0.287
Comparison of primi and second gravida patients				
Rest	Student's t	-0.990	48.0	0.327
Contraction		4.321	48.0	<0.001
Valsalva		-5.512	48.0	<0.001

Table 3: Changes in hiatal area during rest, contraction, and Valsalva maneuver.

Hiatus area	Statistical test	Statistical value	df	P value
Rest	Welch's t	-3.85	26.4	<0.001
Contraction		-3.10	22.1	0.005
Valsalva		-2.56	28.8	0.016

Table 4: Independent sample T-test comparing vesicourethral position in nulliparous vs. primigravida women.

Vesicourethral position	Statistical test	Statistical value	df	P value
Rest	Student's t	4.39	34.8	<0.001
Contraction		0.711	35	0.482
Valsalva		6.758	35	<0.001

Table 2 shows that bladder neck mobility is more pronounced in second gravida patients compared to primigravida, especially during contraction and Valsalva ($p<0.001$). This supports the idea that prior pregnancies and deliveries cause lasting damage that increases with parity. The statistically significant change in bladder neck mobility in third-trimester primigravida patients during Valsalva (p=0.028) also highlights the progressive nature of these changes as pregnancy advances.

Table 3 reports a significant enlargement of the hiatal area in primigravida patients compared to nulliparous women across all three maneuvers: rest, contraction, and Valsalva ($p < 0.001$, 0.005, and 0.016, respectively). This is a crucial finding, as a larger vaginal hiatus is associated with weaker pelvic floor support. However, the study notes that the hiatal area does not change significantly between the second and third trimesters in primigravida patients, and also not between primigravida and second gravida patients in the second trimester. This might suggest that the primary enlargement occurs during the initial pregnancy and does not progressively worsen with subsequent pregnancies, although this requires further investigation.

This result sows that there is significant change in position of neck of bladder in prime patients in comparison to nulliparous women. this change in position is statistically significant in rest and Valsalva, p value is <0.001. these changes due to the excessive pressure exerted on bladder and connective tissues supporting the urethra. stretching of supporting tissues led to downward displacement of bladder neck.

The vesicourethral position shows a clear downward displacement in primigravida women. In the resting state, nulliparous women have a mean value of 1.88 whereas primigravidas have a mean value of 1.54. Under the Valsalva maneuver, the difference is even greater with the mean value of 1.27 for primigravidas, reflecting increased descent under stress. The lower minimum values for the primigravida group also suggest a wider range of motion and greater vulnerability in some individuals.

Table 5: Descriptive analysis of vesicourethral distance, hiatal area changes, levator ani muscle in nulliparous and primigravida women.

Descriptive analysis	Category	In rest	In contraction	In Valsalva
Vesicourethral position				
N	Nulliparous	12	12	12
	Primigravida	25	25	25
Missing	Nulliparous	0	0	0
	Primigravida	0	0	0
Mean	Nulliparous	1.88	1.76	2.06
	Primigravida	1.54	1.68	1.27
Median	Nulliparous	1.90	1.68	2.12
	Primigravida	1.50	1.70	1.20
Standard deviation	Nulliparous	0.158	0.320	0.261
	Primigravida	0.310	0.296	0.359
Minimum	Nulliparous	1.60	1.32	1.34
	Primigravida	1	1.20	0.600
Maximum	Nulliparous	2.14	2.45	2.30
	Primigravida	2.20	2.50	2.2
Hiatus area				
N	Nulliparous	12	12	12
	Primigravida	25	25	25
Missing	Nulliparous	0	0	0
	Primigravida	0	0	0
Mean	Nulliparous	15.5	14.9	17.8
	Primigravida	19.4	18.3	21.1
Median	Nulliparous	15.2	14.5	16.6
	Primigravida	20.5	18.5	21.5
Standard deviation	Nulliparous	2.65	3.14	3.3
	Primigravida	3.25	3.19	4.501
Minimum	Nulliparous	12.0	11.0	14.0
	Primigravida	14.8	14.8	15.0
Maximum	Nulliparous	21.4	19.7	23.6
	Primigravida	24.0	24.9	34.2
Levator ani thickness				
N	Nulliparous	12	12	12
	Primigravida	25	25	25
Missing	Nulliparous	0	0	0

Continued.

Descriptive analysis	Category	In rest	In contraction	In Valsalva
	Primigravida	0	0	0
Mean	Nulliparous	1.02	0.966	0.873
	Primigravida	1.08	1.16	0.928
Median	Nulliparous	1.0	0.975	0.885
	Primigravida	1.0	1.2	0.960
Standard deviation	Nulliparous	.0926	0.0604	0.0918
	Primigravida	0.185	0.181	0.120
Minimum	Nulliparous	0.800	0.850	0.650
	Primigravida	0.750	0.800	0.700
Maximum	Nulliparous	1.13	1.10	0.990
	Primigravida	1.60	1.60	1.2

The hiatal area is consistently larger in primigravida women across all three maneuvers. During rest, the average hiatal area is 19.4 for primigravidas compared with 15.5 for nulliparous women. This increase persists during contraction (18.3 vs. 14.9) and is greatest during the Valsalva maneuver (21.1 vs. 17.8). The wider hiatal area in pregnant women indicates a stretching of the pelvic floor connective tissues and muscles, which is one of the most important risk factors for pelvic organ prolapse.

Notably, the thickness of the levator ani muscle increases somewhat in primigravid women at rest (1.08 vs. 1.02) and considerably on contraction (1.16 vs. 0.966). This is contrary to what would be anticipated as thinning of a stretched muscle and is probably due to hypertrophy of the muscle or edema of the tissue secondary to the enhanced load of pregnancy. Nevertheless, the muscle does seem to thin during the Valsalva maneuver in both groups as anticipated, but the mean thickness is a touch greater in the primigravida group (0.928 compared to 0.873).

DISCUSSION

The present research examined the influences of the first and second singleton pregnancies on the anatomy of the pelvic floor using ultrasound measurements in three groups: nulliparous, primigravid (first singleton pregnancy), and secundigravid (second singleton pregnancy) women. The results showed a statistically significant difference in bladder neck mobility during contraction and Valsalva maneuvers between the secundigravid group and the other two groups. On the contrary, no relevant changes were noticed regarding the hiatal zone or the thickness of the levator ani muscle among the study groups.

Contrary to some of the literature, our study shows that there are no relevant changes in the hiatal zone or mobility of the bladder neck in the third trimester of first or second pregnancy. Yet we noticed statistically significant alteration in the levator ani muscle in both second gravid and primigravid patients during the third trimester, especially during contraction and Valsalva maneuvers. This indicates a direct effect of pregnancy on the function of the levator ani muscle.[4]

Our findings are in concordance with some prior evidence, including Luo et al that discovered that multiparous women have stronger symptoms and structural alterations in the pelvic floor during pregnancy than nulliparous women.[5] This is seen in our data as well, with women having multiple pregnancies having greater anatomical changes in their pelvic floor. A most significant result of our research is the higher prevalence of urinary complaints in patients who are secundigravid when compared to their primigravid and nulliparous peers. This seems to have a direct correlation with the greater bladder neck mobility that was seen in these females during their second and third trimesters. These findings together indicate that more pregnancies result in more pronounced changes in pelvic organ support and function of the pelvic floor muscles, and further research is necessary to fully examine and confirm this association.

Pregnancy and labor are established individual, high-risk causes of pelvic floor defects, with reported rates varying between 10% and 58%.[6-8] Growing fetal weight, most notably in the third trimester, places immense tension on surrounding structures of the pelvis that can be injurious to adjacent neurovascular structures.[9] Additionally, hormonal changes during gestation and labor make their own contribution to alterations in the pelvic floor. Although repeat pregnancies can cause additional damage, the tissues in the pelvic floor compensate through a cascade of remodeling mechanisms.[10] When these changes associated with pregnancy and delivery are not completely reversed after childbirth, however, women can develop pelvic organ prolapse (POP) and stress urinary incontinence (SUI), both of which can profoundly affect their social life, in addition to their mental and physical health.[11,12]

The levator ani muscle (LAM) is distinct from other skeletal muscles, as it has a persistent basal tone that is only consciously inhibited during micturition, defecation, and the Valsalva maneuver.[13] The LAM is subjected to a significant stretch during vaginal delivery, stretching to approximately 3.3 times its resting state to enable the passage of a term infant.[13-15] This sustained tonicity, in addition to its capacity to rapidly contract in response to an acutely rising intra-abdominal pressure (as with coughing or sneezing), is important to prevent both stress urinary incontinence (SUI) and pelvic organ prolapse (POP).[16,17]

The first vaginal birth is especially linked to extensive damage to the LAM and the surrounding pelvic floor, leading to a long-term decline in pelvic floor muscle strength and to an enlarged vaginal hiatus. When such injuries do not heal adequately after delivery, this importantly elevates the risk of subsequent pelvic organ prolapse. Eventually, pregnancy and childbirth can trigger enduring morphological and functional alterations of the LAM. A greater vaginal hiatus is one of the most important signs of weakened pelvic floor support, thus predisposing the patient to developing pelvic organ prolapse.[18,19]

Compared to that, our results in the second gravid patients revealed changes of more severity. Bladder neck mobility was also higher in the third trimester compared to the second, and this difference was statistically significant with contraction. In addition, morphological changes in LAM were also statistically significant in the third trimester over the second, which signifies more effect on pelvic support by a second pregnancy.[20,21]

Our research on primigravid patients found no statistically significant differences in total pelvic floor measurements between the second and third trimesters. Bladder neck mobility did improve in the third trimester compared to the second trimester, but this was not found to be statistically significant. In the same way, no significant changes in levator ani muscle (LAM) morphology occurred during this time.

In spite of these variations, our research uncovered no significant variation in the hiatal area when women with a first singleton pregnancy are compared to those with a second. This is the same as was previously reported, implying that although other structures of the pelvic floor might have more extreme changes with repeated pregnancies, the hiatal area might be less affected.[22]

Limitations

The limitation was that the sample size was small. Also, we had not taken patient who had first LSCS delivery. Same patient was not analysed in second and third trimester. Similarly same patient was not taken for first and second pregnancy. All the patients were Indian so our result may not apply to other ethnic groups.

CONCLUSION

This study demonstrates that pelvic floor changes, including increased bladder neck mobility and descent, anorectal junction descent, and hiatal area enlargement, begin during pregnancy and progress with gestational age. While bladder neck mobility increases significantly with parity, the hiatal area does not show a similar increase with a higher number of pregnancies. The translabial ultrasound, as a non-invasive, accessible, and well-accepted imaging modality, is highly effective for dynamically evaluating these changes, with its real-time quantitative analysis proving beneficial for patient education and proactive postpartum care. These findings, while insightful, require further validation through studies with larger sample sizes to solidify their clinical implications.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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