The immediate effect of vaginal and caesarean delivery on anal sphincter measurements

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Abstract

Objective: This study evaluated the effects of vaginal and caesarean delivery on internal and external anal sphincter muscle thickness using translabial ultrasonography (TL-US).

Methods: This prospective cohort study enrolled nulliparous women who either had vaginal or caesarean deliveries. The thickness of the hypoechoic internal anal sphincter (IAS) and hyperechoic external anal sphincter (EAS) at the 12, 3, 6, and 9 o'clock positions at the distal level were measured before delivery and within 24–48 h after delivery.

Results: A total 105 consecutive women were enrolled in the study: 60 in the vaginal delivery group and 45 in the caesarean delivery group. The IAS muscle thickness at the 12 o'clock position in the vaginal delivery group was significantly thicker before compared with after delivery (mean ± SD: 2.31 ± 0.74 mm versus 1.81 ± 0.64 mm, respectively). The EAS muscle thickness at the 12 o'clock position in the vaginal delivery group was significantly thicker before compared with after delivery (mean ± SD: 2.42 ± 0.64 mm versus 1.97 ± 0.85, respectively).

Conclusions: There was significant muscle thinning of both the IAS and EAS at the 12 o'clock position after vaginal delivery, but not after caesarean delivery.

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Introduction

Faecal incontinence, defined as involuntary passage of stool or flatus, is a prevalent condition, estimated to affect 3–10% of women.[1,2] Third- and fourth-degree perineal lacerations during birth and instrumental deliveries have been found to be associated with an increased likelihood of faecal incontinence in women.[3,4]

The protective effect of caesarean section over uncomplicated vaginal delivery on faecal incontinence has not been shown.[1,5] In contrast, several studies have shown significantly reduced squeezing pressure on anal manometry after vaginal delivery but not after caesarean delivery.[6,7] A common hypothesis is that anal sphincter function would be better preserved with caesarean delivery.

The use of ultrasonography for the characterization of the anal sphincter complex has been shown to be reliable and sensitive.[8] Compared with endoanal ultrasonography, translabial ultrasonography (TL-US) using a vaginal probe is simple and accessible in almost every obstetric unit. A transvaginal probe was first used to evaluate the anal sphincter in 1994;[8] and the planes of the anal sphincter were defined using a transvaginal probe in female patients in 2005.[9] Although TL-US is used widely for the detection of sphincter defects after birth, the effect of the delivery method on the anal sphincter immediately after birth has not been studied.

This present study evaluated the effects of vaginal and caesarean delivery on internal and external anal sphincter measurements using TL-US with a vaginal probe in nulliparous women.

Patients and methods

Patient population

This prospective cohort study enrolled consecutive healthy nulliparous women at term pregnancy (gestational age of ≥37 weeks) who attended the Labour Unit, Etlik Zübeyde Hanim Women's Health Teaching and Research Hospital, Ankara, Turkey between August 2009 and December 2010 in order to give birth. Nulliparous women who underwent caesarean section as a result of obstetric or medical indications, without entering active labour, were recruited to the caesarean delivery group during the same time period. The exclusion criteria for the vaginal delivery group were: (i) women who were delivered with vacuum or forceps; (ii) women who developed third- or fourth-degree lacerations during delivery; (iii) women with sphincter interruption on postpartum TL-US, with muscle interruption being defined as a complete discontinuity in the muscle at a given location. The following demographic and clinical characteristics were recorded for each study participant: maternal age, body mass index, weight gain during pregnancy, gestational age of baby and birth weight of baby.

The study was approved by the Local Ethics Committee of Etlik Zübeyde Hanim Women's Health Teaching and Research Hospital (no. 06.07.09/174) and it conformed to the Declaration of Helsinki. All women were informed of the study's purpose and protocol and each study participant provided written informed consent.

Anal sphincter muscle thickness measurements

The hypoechoic internal anal sphincter (IAS) and hyperechoic external anal sphincter (EAS) thicknesses were measured at the 12, 3, 6 and 9 o'clock positions at the distal level as described previously.[9] The anal sphincters were first measured prior to delivery (prepartum): at the beginning of the labour for the vaginal delivery group (with cervical dilatation of ≤4 cm with regular contractions or with rupture of the membranes); and at the time of admission for the caesarean delivery group (Figure 1). The anal sphincter measurements were
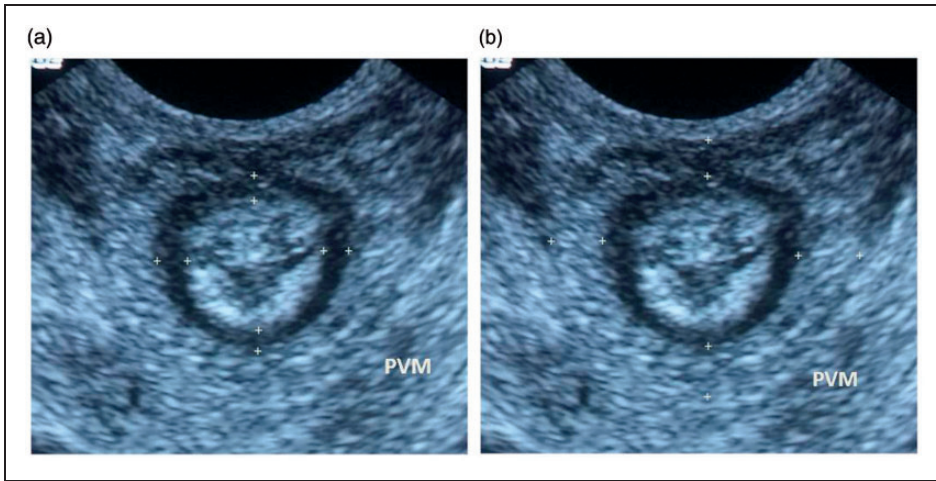
Figure 1. Representative images from translabial ultrasonography of the distal anal sphincter before delivery: (a) measurement of the internal anal sphincter on the axial plane between + and + at the 12, 3, 6 and 9 o'clock positions; and (b) measurement of the external anal sphincter on the axial plane between + and + at the 12, 3, 6 and 9 o'clock positions. PVM, pubovisceral muscle.
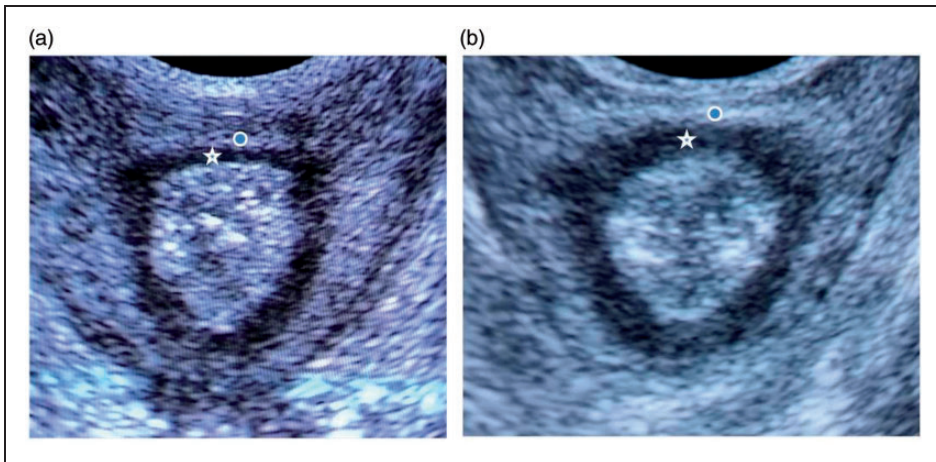

Figure 2. Representative images from translabial ultrasonography of the distal anal sphincter after delivery: (a) At the anterior region (12 o'clock position) showing the internal anal sphincter (★) and the external anal sphincter (●) on the axial plane after vaginal delivery; and (b) at the anterior region (12 o'clock position) showing the internal anal sphincter (★) and the external anal sphincter (●) on the axial plane after caesarean delivery.

repeated postpartum at 24–48 h after delivery for both groups (Figure 2).

Examinations were performed in the lithotomy position. A single operator (D.K.) performed the TL-US examinations, both prepartum and postpartum. Ultrasound was performed using an GE LOGIQ™ P5 ultrasound machine (GE Healthcare, Milwaukee,

Table 1. Demographic and clinical characteristics of healthy nulliparous women ($n = 97$) who underwent either vaginal or caesarean delivery in this prospective cohort study.

Characteristic	Vaginal delivery group $n = 52$	Caesarean delivery group $n = 45$
Maternal age, years	24.6 ± 5.2	25.8 ± 6.5
Body mass index, kg/m^2	27.3 ± 3.0	28.7 ± 2.9
Weight gain, kg	13.4 ± 4.1	15.1 ± 5.8
Gestational age of baby, weeks	39.2 ± 1.2	39.4 ± 1.3
Birth weight of baby, g	3281 ± 313	3325 ± 478

Data presented as mean $\pm$ SD.
No significant between-group differences ($P \geq 0.05$); independent samples t-test.

WI, USA) equipped with a 5–8 MHz transvaginal probe. The vaginal probe was first placed translabially to get a longitudinal view of the anal canal. Then the transducer was rotated 90° and an axial image of the distal anal sphincters was obtained at the level of the mucosal star sign.[9] Measurements in the transverse plane included: (i) IAS measurements (hypoechoic part from side to side); and (ii) EAS measurements (only circular hyperechoic muscular fibres of the EAS from side to side). The hammock-like muscle fibres of the pubovisceral muscle were not included, which could be seen passing posteriorly in some patients at this level (Figure 1a & 1b).

Statistical analyses

Previous research and a prior pilot study conducted in our clinic revealed a difference of 0.5 mm with a standard deviation of 1.3, which was the baseline hypothesis for the difference between measurements before and after delivery for each sphincter position.[10] Using these values with a significance level of $P < 0.05$, 95% confidence interval and 80% power, the minimum sample size was calculated to be 42 for each group.

All statistical analyses were performed using the SPSS® statistical package, version 17.0 (SPSS Inc., Chicago, IL, USA) for Windows®. Categorical variables are presented as percentages and continuous variables are presented as mean $\pm$ SD. The normality of the variables was tested using the Kolmogorov–Smirnov test. For statistical analysis, independent samples t-test was used to compare the two groups. Paired-samples t-test was used to compare two sets of measurements prepartum and postpartum. A P-value < 0.05 was considered statistically significant.

Results

A total of 105 consecutive nulliparous women with term pregnancy, 60 in the vaginal delivery group and 45 in the caesarean delivery group, were enrolled in the study. In the vaginal delivery group, one woman who experienced third- or fourth-degree lacerations during delivery and seven women with sphincter interruption on postpartum TL-US were excluded from the analysis, which left 52 patients in the vaginal delivery group.

The demographic and clinical characteristics of the two groups are presented in Table 1. There were no significant differences between the vaginal and caesarean delivery groups in terms of maternal age, body mass index, weight gain during pregnancy, gestational age of the baby and birth weight of the baby. All patients in the vaginal delivery group had a mediolateral episiotomy.

Table 2. Measurements of the internal anal sphincter muscle thickness before and after delivery in healthy nulliparous women ($n = 97$) who underwent either vaginal or caesarean delivery.

Position	Vaginal delivery group $n = 52$			Caesarean delivery group $n = 45$		
	Before	After	Statistical significance[a]	Before	After	Statistical significance[a]
12 o'clock, mm	2.31 ± 0.74	1.81 ± 0.64	P = 0.009	2.46 ± 0.80	2.14 ± 1.33	NS
3 o'clock, mm	2.48 ± 0.54	2.35 ± 0.69	NS	2.32 ± 0.74	2.28 ± 0.60	NS
6 o'clock, mm	2.37 ± 0.57	2.30 ± 0.82	NS	2.33 ± 0.58	2.27 ± 0.74	NS
9 o'clock, mm	2.71 ± 0.60	2.40 ± 0.77	NS	2.54 ± 0.70	2.52 ± 0.73	NS

Data presented as mean ± SD.
[a]Paired-samples *t*-test was used to compare the measurements before and after delivery.
NS, no significant difference between before and after delivery ($P \geq 0.05$).

Table 3. Measurements of the external anal sphincter muscle thickness before and after delivery in healthy nulliparous women ($n = 97$) who underwent either vaginal or caesarean delivery.

Position	Vaginal delivery group $n = 52$			Caesarean delivery group $n = 45$		
	Before	After	Statistical significance[a]	Before	After	Statistical significance[a]
12 o'clock, mm	2.42 ± 0.64	1.97 ± 0.85	P = 0.03	2.40 ± 0.76	2.23 ± 0.82	NS
3 o'clock, mm	2.93 ± 1.07	2.87 ± 0.99	NS	2.97 ± 0.62	2.60 ± 0.86	NS
6 o'clock, mm	3.10 ± 0.90	2.84 ± 0.94	NS	3.05 ± 0.84	2.92 ± 0.93	NS
9 o'clock, mm	3.17 ± 0.85	3.06 ± 1.04	NS	3.20 ± 0.76	3.02 ± 0.77	NS

Data presented as mean ± SD.
[a]Paired-samples *t*-test was used to compare the measurements before and after delivery.
NS, no significant difference between before and after delivery ($P \geq 0.05$).

Measurements of the IAS muscle thickness before and after delivery in both groups are presented in Table 2. The IAS muscle thickness at the 12 o'clock position in the vaginal delivery group was significantly thicker before delivery compared with after delivery ($P = 0.009$). The IAS muscle thickness measurements at the other three anal positions did not differ significantly between before and after the delivery in the vaginal delivery group. The IAS muscle thickness measurements at all four anal positions did not differ significantly between before and after the delivery in the caesarean delivery group.

Measurements of the EAS muscle thickness before and after the delivery in both groups are presented in Table 3. The EAS muscle thickness at the 12 o'clock position in the vaginal delivery group was significantly thicker before delivery compared with after delivery ($P = 0.03$). The EAS muscle thickness measurements at the other three anal positions did not differ significantly between before and after the delivery in the vaginal delivery group. The EAS muscle

thickness measurements at all four anal positions did not differ significantly between before and after the delivery in the caesarean delivery group.

Discussion

Faecal incontinence has been shown to be related to occult sphincter injury during birth.[6,11,12] In addition to anal sphincter interruption, attenuation of both the internal or external sphincter may have a negative impact on sphincter function.[13] This study demonstrated that in the vaginal delivery group, both the internal and external sphincter muscles were thinner at the anterior region (12 o'clock position) after delivery compared with before the delivery. The present study did not detect any differences between the measurements of both the internal and external sphincter muscle thicknesses taken before and after caesarean delivery.

This is the first study to examine the anal sphincter before delivery and then again within 24–48 h after delivery. This present study undertook TL-US imaging before and after delivery in vaginal and caesarean delivery groups in order to be able to compare the impact of delivery type on anal sphincter anatomy. Normal muscle thickness values for anal sphincters at the end of pregnancy and immediately after delivery are lacking. The IAS muscle thickness ranged from 1.81 to 2.40 mm after vaginal delivery and from 2.14 to 2.52 mm after caesarean delivery. The EAS muscle thickness ranged from 1.97 mm to 3.06 mm after vaginal delivery and from 2.23 to 3.02 mm after caesarean delivery.

Previous research has waited at least 6 weeks after birth before measuring anal sphincter muscles,[6] but this present study aimed to detect occult sphincter injury early and exclude these women before healing had been accomplished. However, the present results may have been affected by early inflammation secondary to delivery. A previous study evaluated normal TL-US anal sphincter complex measurements of women at 6 months after both vaginal and caesarean deliveries.[10] The study showed that IAS measurements at the 12 o'clock position, both proximally and distally, were significantly thicker for caesarean delivery patients compared with vaginal delivery patients.[10]

The present IES data were found to be similar to previously published values,[9,10,14] but the EAS measurements were thinner than previous measurements made in both prepartum and postpartum patients.[10,14] For example, the EAS thickness measurements ranged from 5.6 to 6.6 mm in pregnant women examined using endoanal utrasonography.[14] The difference in EAS thickness between studies probably depends on the imaging technique used, because the method used in the present study only measured the circular hyperechoic muscle fibres of the EAS from side to side and it did not include the hammock-like muscle fibres of the pubovisceral muscle, which could be seen passing posteriorly in some patients at this level. The present EAS thickness values were similar to those previously measured using magnetic resonance imaging.[15]

The anal sphincter is composed of an involuntary inner smooth-muscle component (the internal anal sphincter) and a voluntary striated muscle component (the external anal sphincter). The most common cause of sphincter damage is vaginal delivery,[2,4] therefore most of the patients who need anal sphincter investigations are women. Endoanal ultrasound is currently the gold standard for sphincter evaluation, but vaginal ultrasound has many advantages in women.[16] The use of transvaginal ultrasound probes is available in almost every obstetrics and gynaecology unit and physicians are familiar and experienced with the vaginal approach. The anus is undisturbed by the insertion of a vaginal probe, so examination of the anal sphincters can be

done without deformity from a probe within the canal. This allows the thickness of the internal sphincter and the subepithelial tissues to be measured in their true resting state. The internal sphincter has been found to be a little thicker when a vaginal probe is used rather than when it is measured using endoanal ultrasonography.[8] Although doubts have been raised about the ability of transvaginal scanning to accurately detect sphincter damage, results of both prospective and retrospective studies support the use of transvaginal ultrasonography as a reliable method for evaluating the anal sphincter, equivalent in accuracy to the endoanal technique.[9,17,18]

Proximal thinning after vaginal birth can be defined as sphincter asymmetry and it may be a sign of partial damage. However, it has been suggested that sphincter thinning or asymmetry, particularly at the 12 o'clock position, is not a product of birth injury or the mode of delivery.[19] Even though the anterior (12 o'clock position) sphincter muscles were thinner compared with the other three positions before delivery in the present study, further significant sphincter thinning of both the IAS and EAS at the 12 o'clock position after delivery was only seen in the vaginal delivery group. One of the key benefits of the present study was the fact that the same patients were scanned before and after delivery.

In the vaginal delivery group ($n = 60$) in the present study, one woman (1.7%) experienced third- or fourth-degree lacerations during delivery and seven women (11.7%) experienced occult sphincter interruption as detected on postpartum TL-US. These eight women were excluded from these analyses. There are very conflicting results in the literature regarding the detection rate of postpartum occult sphincter injury as measured by ultrasonography.[20,21] A previous study reported that 28% (42 of 150) of nulliparous women were diagnosed as having occult sphincter tears as measured

by anal endosonography immediately after vaginal birth,[11] but a subsequent study by the same authors reported a lower rate of 5.6% (21 of 376).[12]

This present study had several limitations. First, the study included only nulliparous women. This may have increased the need for episiotomy during delivery and the potential effect of episiotomy on anal sphincter measurements after delivery has not been eliminated. However, the presence of a significant difference only at the 12 o'clock position was similar to a previous study performed after 6 months of delivery,[10] which suggests that the effect of episiotomy may have been negligible. Secondly, this study used 2D ultrasonography to measure only the distal IAS and EAS. Larger studies that use 3D ultrasonography to evaluate multiple planes of the anal sphincter are recommended.

In conclusion, this present study demonstrated significant muscle thinning of both the IAS and EAS at the 12 o'clock position after vaginal delivery, but not after caesarean delivery, as determined by TL-US. These findings may show that the anal sphincter is better preserved during caesarean delivery compared with vaginal delivery.

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