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The Effects of Vaginal Delivery and Cesarean Section on Bladder Neck Mobility and Stress Urinary Incontinence

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Abstract: We investigated the effects of vaginal delivery (VD) and cesarean section (CS) on bladder neck (BN) mobility and genuine stress incontinence (GSI). Of the 230 patients included in the study, 95 had CS, 95 had VD and the remaining 40 continent nulliparous women served as controls. In both the CS and the VD groups 40 women had delivered once, 35 women twice and 20 women three times. Perineal ultrasonography was performed in all patients. Vaginal delivery affects BN mobility and its position more negatively than does CS, and increases its mobility in two directions. The CS group also has similar findings after the third delivery. The GSI rate was not significantly different between the CS and the VD groups, but the VD group had a higher percentage. Our study also shows that BN mobility is associated with GSI compared to the continent controls.

Keywords: Bladder neck mobility; Perineal ultrasonography; Urinary incontinence

Introduction

Genuine stress urinary incontinence (GSI) is a common cause of female incontinence and has traditionally been associated with pregnancy [1–3], vaginal delivery [4,5], previous incontinence surgery [6], inherent weakness of the connective tissue that supports the bladder neck [1] and the menopause [7]. The prevalence of stress incontinence increases with increasing parity, as shown in previous studies [4,5].

Recent studies of urethral neurophysiology [8–10], urethral pressure measurements [1,11], and evaluation of the pelvic floor and bladder neck (BN) [8,10,12] have shown that vaginal delivery is an important etiological factor in GSI. Bladder neck mobility is one of the important components of pelvic relaxation and increased mobility might indicate loss of urethral support [12]. For decades, radiological techniques such as lateral bead chain cystourethrography and videocystourethrography have been used as gold standards for the assessment of BN mobility. However, they require expensive equipment, contrast material and X-ray exposure. For the last decade ultrasonographical studies have been performed successfully for BN assessment in GSI.

The purpose of this study was to assess the effects of spontaneous VD and elective cesarean section delivery (CS) on the mobility and position of the BN and GSI, and to compare them with those obtained in nulliparous continent women using ultrasound.

Materials and Methods

Hospital records were reviewed and the women who had had a spontaneous vaginal delivery and elective CS at least 1 year ago were invited to the hospital. In the VD group, women who had a history of prolonged second stage and birthweight greater than 4000 g were excluded from the study, in order to homogenize the study groups and to eliminate the factors that might negatively affect the BN. We took the criteria of ACOG (1989) for the prolonged second stage of labor. Its limit is 2 hours in nulliparous and 1 hour in multiparous women; when

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conduction analgesia is used 1 hour is added to these values. Exclusion criteria also included primiparity without episiotomy, and any delivery by forceps or vacuum extraction. Only the patients delivered under optimal conditions were included in our study. Continent nulliparous women who attended the infertility department were considered as the control group.

Of the 230 patients included in the study, 95 had had CS, 95 VD, and the remaining 40 continent nulliparous women served as controls. In both the CS and the VD groups 40 women had delivered once, 35 women twice, and 20 women three times. The study was approved by the ethical committee of the hospital. All patients had given their informed consent.

General and gynecological examinations were performed on all women and an incontinence evaluation form filled in. In order to diagnose urinary incontinence the definitions of the International Continence Society were used. A stress test was performed on those patients who had involuntary loss of urine and considered it a social and hygienic problem. The stress test was performed first in the lithotomy position and, if urinary leakage was not demonstrated, next in the standing position, when the patients sense the fullness of their bladders. The patients were asked to cough several times and perform maximum straining several times repeatedly. The patients with urinary incontinence had multichannel urodynamic studies to eliminate detrusor instability. Those with urinary incontinence other than GSI, such as detrusor instability or mixed incontinence, and with intrinsic sphincter deficiencies, were excluded from the study.

Perineal ultrasonography was performed to assess the position and mobility of the bladder neck in all patients. We used a Hitachi EUB 315 ultrasound machine with a 3.5 MHz curvilinear transducer covered with a sterile glove, which was placed on the sagittal axis of the perineum following sterile gel application in the supine position. The women whose BN and symphysis pubis could be easily determined were evaluated without catheterization after they had drunk sufficient water to sense the fullness of their bladders [14]. A 14 Fr Foley catheter was inserted transurethrally in patients whose BN or symphysis pubis could not be clearly determined. The catheter balloon and the bladder were filled with 0.9% NaCl solution, 5 ml and 300 ml, respectively [15,16]. The image was frozen and placed on one side of the screen as soon as the symphysis pubis, the bladder, the bladder neck and the urethra were all visualized. The measurements were made using the *x-y* coordinate system [14]. The *x* axis was constructed by drawing a straight line through the center of the symphysis pubis. The *y* axis was constructed perpendicular to the *x* axis at the tip of the symphysis pubis. The *Dxr* was defined as the distance between the bladder neck and the *y* axis, and *Dyr* was defined as the distance between the bladder neck and the *x* axis. Next, the patient was asked to perform Valsalva maneuvers several times, and the image was frozen and placed on the other half of the screen. The greatest bladder neck mobility during Valsalva was taken as the stress value. Both distances were measured again (*Dys*, *Dxs*). Downwards mobility of the BN (downwards displacement: ΔDy) was calculated by subtracting *ys* from *yr* (in women where the BN was found below the *x* axis, the two values were added instead of being subtracted). The backwards mobility (backwards displacement: ΔDx) was found in the same manner (Fig. 1). All measurements were performed by the same operator (FD). Statistical analysis was performed using SPSS for Windows 5.0. Numerical

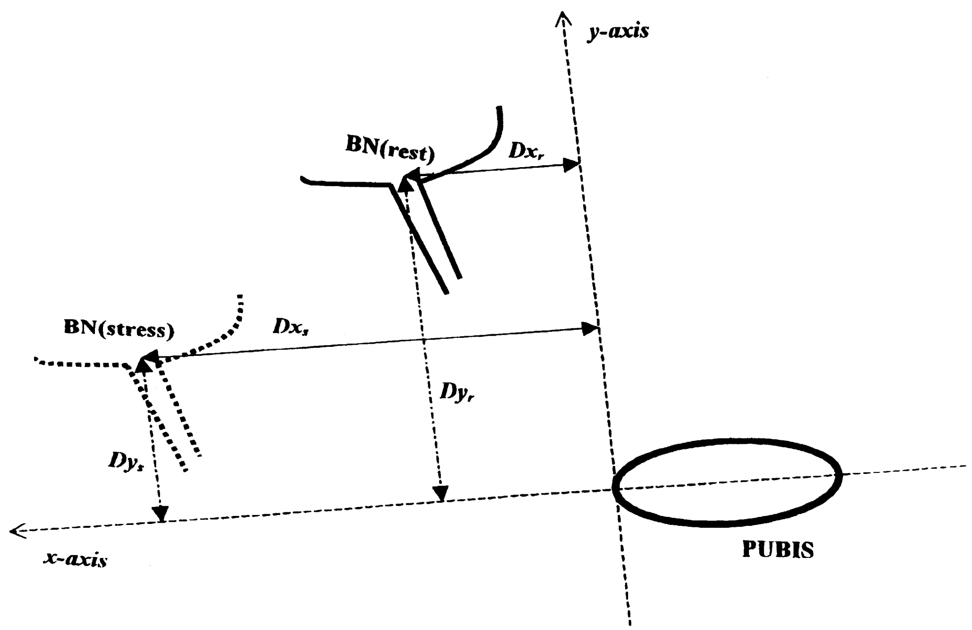

Fig. 1. Evaluation of bladder neck location on perineal ultrasound relative to reference coordinate system.

data were analyzed with Student's *t*-test, the Mann–Whitney *U* test, and categorical data with the χ^2 test. Relationships between the presence of GSI and BN mobility (ΔDy) with maternal age, delivery mode and number of deliveries were evaluated separately by logistic regression analysis. A *P* value equal to or less than 0.05 was considered significant.

Results

A total of 230 patients were included in the study. Three women were excluded because of having detrusor instability (2 had had CS, 1 had had VD). Of the 230 women, included, 95 had had CS, 95 VD, and the remaining 40 continent nulliparous women were regarded as controls. All of the cesarean sections were performed under elective conditions. In the CS and the VD groups, 40 women had delivered once, 35 twice, and 20 three times. The ages, weights and BN position values at rest and during Valsalva in both groups are shown in Table 1. The number of CS and VD did not affect the resting position of BN. The BN positions of the women who had cesarean section once (CS-1) and twice (CS-2) are similar to those of nulliparous controls. However, during stress the position (*Dys*) and downwards mobility of BN (ΔDy) in women who had three cesarean sections (CS-3) were different from nulliparous controls. The BN positions during stress (*Dxs*, *Dys*) and two-directional mobility of BN (ΔDx, ΔDy) in women who had delivered vaginally twice (VD-2) and in women delivering vaginally three times (VD-3) were significantly different from nulliparous women. In the women who delivered vaginally once (VD-1), only *Dys* was different from nulliparous. The BN moved further downwards and backwards during stress in the VD group with increasing parity. However, the CS-3 and VD-3 groups were significantly older than the nulliparous group. No relationship was found between GSI and maternal age, delivery mode or number of deliveries by logistic regression analysis. We found a significant relationship between the mean + 1 SD value of ΔDy of the continent parous group (14.9 + 6.7 = 21.6 mm) and delivery mode ($P = 0.04$) and number of deliveries ($P = 0.0009$), but could find no significant relationship between this value and age ($P = 0.9$).

The positions and mobilities of the bladder neck in continent and incontinent parous women are shown in Table 2. There was no significant difference in terms of age and weight between the GSI cases and controls. In GSI cases, the BN was lower at rest and was displaced both downwards and backwards during stress. Although there was no significant difference in GSI rate between the CS and the VD groups, the rate was higher in the VD group (3.2% versus 8.4%) (Table 3).

Table 1. The age, weight and BN positions at rest and during Valsalva of patients in all groups compared to those in nulliparous controls (mean ± 1 SD) (*P* value is expressed as *<0.05)

	Age	Weight	Dy_r	Dy_s	ΔDy	Dx_r	Dx_s	ΔDx
CS-1 (*n* = 40)	28.3 ± 6.0	66.2 ± 11.3	25.1 ± 3.9	11.3 ± 6.9	13.8 ± 5.0	−4.2 ± 4.9	1.4 ± 4.5	5.6 ± 3.0
CS-2 (*n* = 35)	29.7 ± 6.6	64.5 ± 11.9	24.7 ± 3.5	11.1 ± 7.3	13.7 ± 6.2	−3.3 ± 4.9	2.2 ± 5.3	5.5 ± 3.8
CS-3 (*n* = 20)	31.6 ± 2.7*	65.9 ± 9.5	24.4 ± 5.5	8.9 ± 10.1*	15.5 ± 8.4*	−3.3 ± 5.6	3.2 ± 4.1	6.5 ± 6.4
VD-1 (*n* = 40)	28.6 ± 4.6	65.5 ± 7.8	23.7 ± 5.0	10.0 ± 6.8*	13.7 ± 4.7	−4.4 ± 5.6	2.7 ± 6.6	7.1 ± 4.1
VD-2 (*n* = 35)	29.5 ± 5.8	66.8 ± 10.7	23.8 ± 5.4	6.4 ± 8.7*	17.4 ± 7.8*	−3.8 ± 5.5	4.1 ± 4.4*	7.9 ± 6.2*
VD-3 (*n* = 20)	32.4 ± 3.6*	67.5 ± 8.9	22.3 ± 5.9	2.7 ± 10.4*	19.6 ± 9.7*	−2.2 ± 5.6	5.6 ± 4.7*	7.8 ± 4.5*
Nulliparous (*n* = 40)	26.7 ± 4.1	61.7 ± 6.8	25.6 ± 3.6	15.8 ± 5.8	9.8 ± 5.0	−5.1 ± 5.5	−0.3 ± 5.1	4.8 ± 3.2

Table 2. The comparison of age, weight and BN values between women with GSI and continent parous women (mean ± 1 SD)

	Age	Weight	Dy_r	Dy_s	ΔDy	Dx_r	Dx_s	ΔDx
GSI(+) (*n* = 11)	31.4 ± 5.2	67.3 ± 12.3	20.7 ± 6.0*	−0.9 ± 7.2*	21.6 ± 5.0*	−2.0 ± 5.4	4.5 ± 5.7	6.5 ± 5.6
GSI(−) (*n* = 179)	29.6 ± 5.5	65.9 ± 10.0	24.3 ± 4.6	9.5 ± 8.0	14.9 ± 6.7	−3.8 ± 5.3	2.9 ± 5.2	6.6 ± 4.4
P	NS	NS	<0.05	<0.01	<0.001	NS	NS	NS

GSI, Women with genuine stress incontinence; NS, Not significant (*P* value as *>0.05).

Table 3. The GSI rates of the vaginal delivery and cesaran section groups

	Cesarean section (*n* = 95)			Vaginal delivery (*n* = 95)		
	CS-1 (*n* = 40)	CS-2 (*n* = 35)	CS-3 (*n* = 20)	VD-1 (*n* = 40)	VD-2 (*n* = 35)	VD-3 (*n* = 20)
GSI *n* (%)	1 (2.5)	1 (2.9)	1 (5.0)	2 (5.0)	4 (11.4)	2 (10.0)
Total GSI *n* (%)		3 (3.2)			8 (8.4)	

Discussion

Ultrasound evaluations, which are cheap, easy, simple, real-time and non-invasive, give accurate information about the mobility and position of the BN. Perineal ultrasonography, which has several advantages, such as non-displacement of the probe during stress, greater comfort, and giving a better topographical view, is superior to other ultrasound methods such as transvaginal and transrectal ultrasonography [12,14–18].

Snooks et al. [8] measured the position of the perineum relative to the ischial tuberosities on straining and found an abnormal degree of perineal descent in all women who had delivered vaginally, but in none of the controls or the women who had delivered by cesarean section. Pescher et al. [12] performed perineal ultrasonography on the women before and after childbirth and showed that VD altered urethral support in more than 50%. Bladder neck mobility during stress was increased after childbirth, and the BN was lower at rest in women who had had a VD than in those who had elective CS or who were nulliparous. These findings are similar to ours, except for the position of the BN at rest in the VD group. Conversely, Meyer et al. [18] performed perineal ultrasonography and found that VD did not alter the position of the BN at rest, which was similar to that in primiparous, multiparous and nulliparous control groups. They found no significant difference in two-directional BN mobility (downwards and backwards) between parous and nulliparous women, even in those with previous forceps deliveries. However, in the present study the two-directional BN mobility of the VD-2 and VD-3 groups were significantly different from the nulliparous group, similar to the findings of Pescher et al. [12]. We compared the positions and mobility of BN between parous and nulliparous women, as did Meyer et al. [18], but it would have been better to compare the positions and mobility of BN before and after delivery in the same women, as did Peschers et al. [12].

Stanton et al. [12] reported that stress incontinence rarely appeared after childbirth, if it had not already occurred during pregnancy. Many authors reported similar findings [1,3,19]. In contrast to this, Meyer et al. [20] stated that women who had been continent during pregnancy experienced stress urinary incontinence de novo after delivery. In agreement with Meyer et al. [20], we found that primiparous women who had been continent before the VD had a GSI rate of 2.5% (Table 3). We found no significant difference in GSI rate between the CS and the VD groups, but the VD group had a higher percentage (3.2% versus 8.4%). This difference may be due to the increased bladder neck mobility in cases delivered vaginally.

In the present study the low rate of GSI may be a function of the study group and the criteria for urinary incontinence used by the International Continence Society [13]. We excluded women who had had a prolonged second stage of labor, delivered a macrosomic baby, had an instrumented delivery, or a delivery without episiotomy in the vaginal delivery group. Various investigatons, such as ultrasound of the bladder neck [12,18], neurophysiological studies [8–10], urodynamic studies and survey studies [4,19] examining the relationship between obstetric factors and the risk of subsequent incontinence have produced conflicting results. It is suggested that continence status would be negatively affected by instrumented delivery [1,8,9,18], by birthweight [9,10] and by a prolonged second stage of labor [8–19]. Other studies suggested that instrumented delivery [4,10], birthweight [11] and episiotomy had no negative effect. Wilson et al. [19] found a little difference in urinary incontinence between elective cesarean section and those carried out in the second stage of labor. Sultan et al. [10] reported that women who had had CS after the onset of labor could also be at risk of developing pudendal nerve damage, whereas those who had had an elective CS were not. Because our CS group had had their cesarean section in elective conditions, the GSI rate was also low.

Holst and Wilson [5] reported that incontinence was more common in parous than in nulliparous women, and was most common in those who had had 4 or more children. Wilson et al. [19] found a similar prevalence of incontinence between women who had had VD and who had had a third or fourth CS. In agreement with Wilson et al. [19], we found increased BN mobility in women who had had a third cesarean section, but not after a first or a second. Sultan et al. [10], in their neurophysiological study during pregnancy and the puerperium, demonstrated that first VD in particular caused pudendal nerve damage, but elective CS did not. Jolleys [4] reported a linear increase in incontinence with increasing parity. There seemed to be no difference in the prevalence of incontinence after vaginal delivery compared to forceps delivery or cesarean section. We did not notice a linear increase in incontinence with increasing parity (Table 3), but we found weakening of the urethral support (hypermobility of the bladder neck) with increasing parity (Table 1).

As a result, vaginal delivery under optimum conditions affects BN mobility and its position more negatively than does CS, and increases its mobility in two directions. The CS group also had similar findings after a third delivery. GSI rate was not significantly different between the CS and the VD groups, but the VD group had a higher percentage. Our study also shows that BN mobility is associated with GSI compared to continent controls. In order to determine the effect of VD and CS on pelvic floor and urinary incontinence, randomized prospective and comparative studies which include anatomical, urodynamic and neurophysiological components in large series should be performed in the future.

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EDITORIAL COMMENT: The effects of vaginal delivery on pelvic function are the focus of increasing research. The identification of women at risk remains a challenge. In addition, the magnitude and specifics of these risks have not been clarified. The international aspect of this article should cause comparison and contrast with obstetric practice around the world. The startling difference in obstetric practice and the high rates of elective cesarean section warrant an evidence based approach to obstetric management.