The second stage of labor and stress urinary incontinence

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OBJECTIVE: This study was undertaken to investigate the potential association between prolonged second stage of labor and stress urinary incontinence.

STUDY DESIGN: A retrospective, population-based study was performed. A random, case-controlled sample of 85 cases and 88 controls was identified by means of a standard computerized patient database. Subjects were identified by International Classification of Diseases, Ninth Revision codes, and medical records were reviewed. The median follow-up time from delivery was 7.8 years for cases and 7.2 years for controls. Multiple logistic regression was performed to test for an association between stress urinary incontinence and variables of interest.

RESULTS: The data suggest that for all women who labored the length of the second stage of labor for the first delivery was not associated with stress urinary incontinence (odds ratio, 1.07; P = .42; 95% confidence interval, 0.9-1.3). However, forceps delivery was associated with a significant increase in stress urinary incontinence risk (odds ratio, 10.4; P = .04; 95% confidence interval, 1.2-93.4).

CONCLUSION: Length of second stage of labor was not associated with stress urinary incontinence. However, the odds of having a later diagnosis of stress urinary incontinence was 10 times higher for women who underwent forceps delivery. (Am J Obstet Gynecol 2001;184:1571-5.)

Key words: Stress incontinence, labor, forceps

Urinary incontinence affects millions of women worldwide, and it has been shown that women have an 11.1% lifetime risk of needing surgery for prolapse or incontinence. The estimated prevalence of urinary incontinence among women aged 65 years and older is between 30% and 60%. Accordingly, health care costs for incontinence procedures have become substantial. Less is known about the prevalence of stress urinary incontinence (SUI) among women between the ages of 30 to 50 years, but it is reported to be between 10% and 25%. Some important risk factors for incontinence have been elucidated, such as smoking, obesity, and certain neurologic disorders. However, an important question in women’s health care is whether or not vaginal delivery is an independent risk factor for the development of SUI and other pelvic floor disorders, such as prolapse. By studying women’s labor and delivery experiences, we may better identify characteristics of this process that could predict women who will have SUI in the future. Given that it is expensive and difficult to treat these disorders and that many women are disabled and depressed as a result of their incontinence, women may best be served by learning to prevent these disorders. It is with this interest in mind that this study was conducted.

The authors designed a retrospective, population-based, case-controlled study to investigate the association between length of second stage of labor and the subsequent onset of SUI. Specifically, we investigated the length of first and second stage of labor, infant birth weight, route of delivery, episiotomy and laceration during the first birth, and subsequent development of SUI.

Material and methods

The study was conducted at Group Health Cooperative (GHC) of Puget Sound, a managed care organization with over 500,000 enrollees in western Washington State. GHC maintains a somewhat unique and extensive archive of automated data files that include enrollment history, billing records that include International Classification of Diseases, Ninth Edition (ICD-9) and Current Procedural Terminology, Version 4 codes for both inpatient and outpatient visits, pharmacy records, and laboratory data. Discharging physician records inpatient discharge diagnoses. These are recorded as a primary diagnosis and as an unlimited number of secondary discharge diagnoses. Trained medical records specialists then code these diagnoses for database entry. The primary diagnosis and up to 10 secondary discharge diagnoses may be coded. Coders are instructed to give highest priority to conditions that...
are “complications or comorbidities” of the primary diagnosis when >10 secondary diagnoses are recorded. Outpatient codes are recorded by providers on a precoded checklist at the end of the patient encounter. The institutional review boards at GHC and the University of Washington approved all methods.

Subjects. All women who had given birth at GHC between 1982 and 1986 and who were continuously enrolled until 1998 were identified with the patient computerized data file. From this cohort, a random sample of women with SUI was selected using Current Procedural Terminology procedure codes for surgeries specific for SUI and outpatient ICD-9 codes specific for urinary incontinence. These specific codes included the following: 51840 Burch, 51885 Sling, 51845 and 57289 Pereyra, 51841 Complex Urethropexy, 625.6 SUI, 788.3 Incontinence, and 788.33 Mixed Incontinence. Women who did not meet these ICD-9 codes were eligible for the control group. Eligible controls were matched to cases according to age at reference date (within 5 years), length of GHC enrollment (to within 5 years), and length of time between the first birth and date of diagnosis or reference date (within 2 years) and were then randomly selected from the eligible control pool in an approximate 1:1 ratio.

Specific inclusion and exclusion criteria were outlined at the start of the study. Women who had given birth at the GHC before 1982 were not included because the necessary databases were not in existence at this time. Eligibility criteria for the study group included continuous enrollment at GHC until 1998, first birth at GHC, and absence of diseases associated with urinary incontinence (multiple sclerosis, motor neuron disorders, history of stroke, and connective tissue disorders including systemic lupus erythematosus, systemic sclerosis, and dermatomyositis). First birth was an inclusion criterion because our hypothesis, which was supported by the literature, was that the greatest degree of trauma occurs with the first birth and in turn influences all subsequent deliveries. Controls were eligible if they met the following criteria: continuous enrollment at GHC until 1998, first birth at GHC, absence of diseases associated with urinary incontinence (see previous list), absence of Current Procedural Terminology or ICD-9 codes for incontinence in the database, and finally, absence of SUI on careful chart review.

We identified 43,288 mother-baby pairs with the computerized database. Of these, 26,326 had their first birth at GHC. Of that group, 56 patients underwent surgery specific for SUI, and an additional 296 patients had outpatient ICD-9 codes for SUI. From this group of 296 patients who were found by outpatient codes, 4 were ineligible because of ineligibility codes including multiple sclerosis, previous stroke, dermatomyositis, and systemic lupus erythematosus, and 57 were not continuously enrolled. From this group of 291 patients, all 56 surgical patients and 97 of the nonsurgical patients were included in the study. Because the resources were allocated on the basis of the original power calculation, only 97 of the 296 patients who had outpatient codes for incontinence were reviewed. The 97 patients who were reviewed were randomly selected by means of the SAS (SAS, version 6, 1st ed; SAS Institute Inc, Cary, NC) random number generator. Of the 153 charts reviewed, 68 were ineligible and 85 were eligible.

Controls were identified in a similar fashion. First, 25,950 potential controls were selected using automated data; from these 25,950 potential controls, 5 potential controls were matched to each case according to age, time between birth and reference date (which was the diagnosis date), and time of enrollment. Each set of 5 controls was randomly ordered, and controls were reviewed until a match had been found for each case. There were 278 potential matches for the surgical cases and 560 matches for the nonsurgical cases. From this group, 138 charts were reviewed; 50 were ineligible, and 88 were eligible.

Reasons for ineligibility included first birth not at GHC (40 cases, 35 controls); miscoded incontinence codes (20 potential cases without SUI; 4 cases with another form of incontinence, which was primarily urge incontinence; and 14 controls with evidence of SUI at chart review); and missing data (4 cases, 3 controls). This accounted for the 68 ineligible cases and 50 ineligible controls.

The original birth records for each woman’s first and subsequent births were evaluated. The times for first and second stage of labor were recorded from the original record, as well as the birth weight, mode of delivery, gestational age at delivery, epidural use, and information on laceration or episiotomy occurrence. The first stage of labor was defined as the time from the onset of labor until complete dilatation. The second stage of labor was defined as the time from complete dilatation to delivery of the infant. The reference date was the equivalent of the date of diagnosis for the control population.

The characteristics of cases and controls were analyzed with descriptive statistics, with the Student t test for continuous variables, and the χ² test for categoric variables. Length of second stage of labor was categorized into 30-minute increments. The association between length of second stage of labor and SUI was evaluated using logistic regression. Univariate analyses were performed on all potential confounding variables of this association, such as birth weight, gestational age, lacerations and episiotomies, mode of delivery, and age of the patient at delivery. There were 141 subjects who labored of the 173 total study population. These 141 subjects were included in the final model because we hypothesized that labor was an independent risk factor for SUI. Sixteen case-control pairs were excluded because they underwent a cesarean delivery without labor.
Results

Cases and controls were similar with regard to age at diagnosis, body mass index at diagnosis, race, and time between first birth and reference date. Participants were, for the most part, white (n = 152), reflecting the underlying population structure of the greater Puget Sound area. In addition, cases and controls were virtually indistinguishable with regard to birth characteristics including birth weight, gestational age at delivery, third- and fourth-degree episiotomies or lacerations, epidural use, and smoking (Table I). The median time between the first birth and the date of diagnosis or the reference date was 7.8 years for cases and 7.2 years for controls (1.0-21.0 and 0.6-20.8, respectively). Few subjects had a history of asthma (n = 7), chronic urinary tract infection (n = 3), chronic obstructive pulmonary disease (n = 0), constipation (n = 2), or diabetes (n = 3), and these characteristics were evenly distributed between cases and controls.

There were no significant differences in birth characteristics of cases and controls, apart from birth weight. Mean birth weight was 3573 g for cases and 3395 g for controls (P = .05). However, subjects with extreme weights drove this difference. When the smallest three and largest three values were removed, the difference was no longer statistically significant. Furthermore, in multivariate analysis, birth weight was not independently associated with risk of SUI and was not maintained in the model. The mean gestational age was 39.7 weeks for cases and 39.4 weeks for controls, with a range of 29 to 43 weeks for cases and 31 to 43 weeks for controls (P = .5). Among this population, 22% of the study group had third- and fourth-degree episiotomies and lacerations compared with 17% of controls (Table I). Epidural anesthesia was more common among cases (35.4%) compared with controls (20.7%), suggesting colinearity with operative vaginal deliveries (Table II). Parity was evenly matched; 55.3% of cases and 48.9% of controls were para 2 at reference date. Parity is known to be associated with age, and, because cases and controls were matched for age, we were unable to evaluate parity as a potential risk factor for SUI.

Information on all subsequent deliveries for each patient was obtained. For women who underwent a cesarean with their first delivery, 67% of controls and 43% of cases had a repeat cesarean with their second delivery. In 86% of subjects (88% of cases and 84% of controls), the labor for the first birth was the longest and most traumatic in comparison with all subsequent births. This is in keeping with the literature that states that the first birth is likely to be the most traumatic and often determines the route of delivery for all subsequent pregnancies.11, 12

In this population, 16 case-control pairs underwent cesarean delivery without labor. A χ² analysis was performed evaluating cesarean delivery without labor against normal vaginal deliveries. Women who underwent cesarean delivery without labor (ie, elective cesarean delivery) were less likely to develop SUI later in life, although this was not statistically significant (odds ratio, 0.49; P = .3; 95% confidence interval, 0.14-1.65).

Further analysis was performed after removal of the 16 case-control pairs who did not labor. After removal of these women, the mean duration of the first and second stage of labor was calculated for the first birth. The mean duration of the first stage of labor was 13.5 hours for cases and 11.4 hours for controls (P = .5). The mean duration of the second stage of labor was 94 minutes for cases and 85 minutes for controls (P = .4). The odds ratio for the association of SUI and duration of second stage of labor was calculated by means of logistic regression, and no significant association was found. The odds ratio associated with

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cases (n = 85)</th>
<th>Controls (n = 88)</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y) (mean, range)</td>
<td>39.7 (22.6-52.9)</td>
<td>39.6 (25.1-49.0)</td>
<td>P = .9</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>23.8 (±4.6)</td>
<td>22.7 (±4.1)</td>
<td>P = .2</td>
</tr>
<tr>
<td>Race (% white)</td>
<td>87.1</td>
<td>88.6</td>
<td>P = .9</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>11.9</td>
<td>11.4</td>
<td>P = .9</td>
</tr>
<tr>
<td>Years between first birth and diagnosis or reference date</td>
<td>7.8</td>
<td>7.2</td>
<td>P = .8</td>
</tr>
<tr>
<td>Birth weight (g)</td>
<td>3573 (±596)</td>
<td>3395 (±597)</td>
<td>P = .05</td>
</tr>
<tr>
<td>Gestational age at delivery (wk)</td>
<td>39.7 (±1.9)</td>
<td>39.4 (±2.4)</td>
<td>P = .5</td>
</tr>
<tr>
<td>Episiotomy or laceration (% 3 or 4 only)</td>
<td>21.2</td>
<td>17.0</td>
<td>P = .5</td>
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<table>
<thead>
<tr>
<th>Labor characteristics</th>
<th>Cases (confidence interval) (n = 70)</th>
<th>Controls (confidence interval) (n = 71)</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of first stage of labor (hr, mean)</td>
<td>13.5 (±25.8)</td>
<td>11.4 (±8.6)</td>
<td>P = .5</td>
</tr>
<tr>
<td>Duration of second stage of labor (min, mean)</td>
<td>94.0 (±64.9)</td>
<td>85.0 (±64.1)</td>
<td>P = .4</td>
</tr>
<tr>
<td>Epidural use (%)</td>
<td>35.4</td>
<td>20.7</td>
<td>P = .03</td>
</tr>
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</table>
Although the study by Skoner et al used controls, the diagnoses by chart review, and matching of cases to controls. There was also a trend toward protection associated with a 10-fold increase in the odds of the development of SUI. There was no significant difference in mode of delivery between cases and controls with one exception; 10.7% of the cases underwent a forceps delivery compared with only 1.1% of controls (odds ratio, 10.4; 95% confidence interval reflects the imprecision of this result. In addition, the incidence of forceps delivery in our population was low (1.1%-10%), but still within the 2% to 4% range reported nationally. However, the increase in incidence of SUI associated with forceps delivery is in contrast to the findings of Groutz et al but is similar to the findings of other studies. The increase in incidence of SUI may be related to the fact that in forceps delivery the head is brought down more quickly than in normal labor, stretching and injuring nerves and connective tissue elements of the pelvic floor. Some experts think that avoiding operative deliveries and allowing passive descent in the second stage of labor may decrease the incidence of SUI related to birth trauma. In addition, earlier studies have shown evidence of nerve damage that is worsened by operative vaginal deliveries.

The vacuum deliveries were equally distributed between cases and controls in our study and were not associated with SUI. The reason for this discrepancy is unclear. However, it is possible that there was an insufficient number of operative deliveries to detect a meaningful difference and that forceps delivery may cause more damage to the perineum as compared with vacuum delivery. Literature supports the fact that forceps delivery is associated with fecal incontinence and occult rectal sphincter defects. In this same study, Sultan et al found this association only with forceps delivery and not with vacuum delivery. Likewise, in a study by Snooks et al, the pelvic floor musculature was evaluated with electromyography studies that were performed on women between 48 and 72 hours after birth, 2 months after birth, and, in some, 6 months after birth. Findings from this study showed that there was pudendal nerve damage with forceps delivery and less damage with cesarean deliveries.

A 30-minute increment in duration of second stage of labor, adjusted for age and duration of enrollment at GHC, was 1.10. After adjusting for other factors, including mode of delivery, age in years, and duration of GHC enrollment, the risk for SUI associated with duration of second stage of labor was 1.10 (95% confidence interval, 0.90-1.28; \( P = .5 \)) (Table III). Other potentially confounding variables that were examined include birth weight, length of the first stage of labor, body mass index, epidural use, and age.

Overall, there was no significant difference in mode of delivery between cases and controls with one exception; 10.7% of the cases underwent a forceps delivery compared with only 1.1% of controls (odds ratio, 10.4; 95% confidence interval, 1.17-93.4; \( P = .04 \)).

**Comment**

In this population-based, case-control study of relatively young women, length of second stage of labor was not associated with SUI. However, forceps delivery was associated with a 10-fold increase in the odds of the development of SUI. There was also a trend toward protection from SUI with cesarean delivery without labor.

The specific strengths of this study included a continuously enrolled population, computerized databases that provided uniform case ascertainment, validation of all diagnoses by chart review, and matching of cases to controls. Although the study by Skoner et al used controls, the patients were interviewed over the telephone after the fact, and there was no matching of cases to controls. In addition, this study, like the study of Persson et al, had a significantly longer follow-up period from the birth event to the later development of SUI. The other reported studies have mailed out questionnaires or interviewed patients after the fact to obtain a longer follow-up period. Most of the studies, however, interviewed patients immediately post partum or soon thereafter. Although 20% to 35% of women who were 3 months post partum still showed evidence of SUI, most of these cases are transient and improve or resolve over time, with only 3% of patients still with SUI at 1 year post partum.

Study limitations included low power for the evaluation of secondary outcomes such as operative vaginal delivery and cesarean delivery with and without labor, inability to evaluate parity as a risk factor for SUI because of the case and control selection methods, and a still suboptimal duration of follow-up. The study design limited us to a 16-year window between the birth and the diagnosis of SUI; thus subjects were relatively young, and the prevalence of incontinence was proportionately low.

In this study, although we did find a significant association between forceps delivery and SUI, the confidence interval reflects the imprecision of this result. In addition, the incidence of forceps delivery in our population was low (1.1%-10%), but still within the 2% to 4% range reported nationally. However, the increase in incidence of SUI associated with forceps delivery is in contrast to the findings of Groutz et al but is similar to the findings of other studies. The increase in incidence of SUI may be related to the fact that in forceps delivery the head is brought down more quickly than in normal labor, stretching and injuring nerves and connective tissue elements of the pelvic floor. Some experts think that avoiding operative deliveries and allowing passive descent in the second stage of labor may decrease the incidence of SUI related to birth trauma. In addition, earlier studies have shown evidence of nerve damage that is worsened by operative vaginal deliveries.

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In an earlier study by Snooks et al and in several studies by Smith et al, pudendal nerve latency was noted in women who had SUI compared with controls who did not have SUI. One could speculate that if damage is occurring to the

### Table III. Multivariate association between SUI* and characteristics of labor*

<table>
<thead>
<tr>
<th>Labor characteristic</th>
<th>Odds ratio</th>
<th>Confidence interval</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second stage of labor</td>
<td>1.10†</td>
<td>0.90-1.28</td>
<td>( P = .4 )</td>
</tr>
<tr>
<td>Forceps delivery</td>
<td>10.43</td>
<td>1.17-93.42</td>
<td>( P = .04 )</td>
</tr>
<tr>
<td>Vacuum delivery</td>
<td>0.81</td>
<td>0.26-2.48</td>
<td>( P = .7 )</td>
</tr>
<tr>
<td>Laceration or episiotomy (% 3 or 4 only)</td>
<td>1.15</td>
<td>0.43-3.00</td>
<td>( P = .8 )</td>
</tr>
</tbody>
</table>

*Adjusted for age in years and duration of GHC enrollment.
†Odds ratio represents the difference associated with a 30-minute increment in duration of second stage of labor.
branches of the pudendal nerve innervating the external anal sphincter and thus leading to fecal incontinence then it is very likely that occult damage is occurring to the periurethral branches of the same nerve and thus contributing to SUI. From the literature to date, it does not seem unreasonable to hypothesize that forceps delivery causes more compression, stretching, and tearing of the nerves that are responsible for maintaining continence.

In direct contrast to our findings, Persson et al. did not find an association between operative vaginal delivery and SUI. However, these authors did not analyze the data separating vacuum from forceps deliveries (Persson J. Personal communication). One can safely assume that the risk factor of operative delivery, which they reported, applies to vacuum deliveries only, because a forceps delivery is a rare event in this population.

Conversely, one could speculate that interventions that avoid contact of the fetal head with the pelvic floor and thus avoid pelvic floor damage may protect against SUI. Some authors have, in fact, found support for the hypothesis that cesarean deliveries are protective against pelvic floor damage and the subsequent onset of SUI. The current study supports the idea that cesarean delivery may be protective against SUI.

This study differs from several previous studies on SUI because of the young age of the study subjects (mean age, 39.5 y). The prevalence of urinary incontinence in our population was approximately 10%. This is similar to the rates quoted in the literature. The follow-up study by Snooks et al. suggests that the damage caused with delivery may worsen over time, thus leading to a higher incidence of incontinence with increasing age.

SUI is a common, embarrassing, and often debilitating problem for women. The findings of our study suggest that obstetric factors are associated with SUI in younger women. Studies with longer follow-up and larger sample sizes are needed to adequately explore the obstetric factors associated with incontinence in women of all ages.

REFERENCES

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