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Obstetric Sphincter Injury Interacts with Diarrhea and Urgency to Increase the Risk of Fecal Incontinence in Women with IBS

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Abstract

Objectives—To confirm that fecal urgency and diarrhea are independent risk factors for fecal incontinence (FI), to identify obstetrical risk factors associated with FI in women with IBS (irritable bowel syndrome), and to determine whether obstetric anal sphincter injuries interact with diarrhea or urgency to explain the occurrence of FI.

Methods—The study is a supplement to a diary study of bowel symptoms in 164 female patients with IBS. Subjects completed daily bowel symptom diaries for 90 consecutive days and rated each bowel movement (BM) for stool consistency and presence of urgency, pain, and FI. All female participants from the parent study were invited to complete a telephone-administered 33-item bowel symptom and obstetric history questionnaire which included the Fecal Incontinence Severity Index (FISI).

Results—Out of 164 women in the parent study, 115 (70.1%) completed the interview. Seventy-four (45.1%) reported FI on their diary including 34 (29.6%) who reported at least one episode per month, 112 (97.4%) reported episodes of urgency, and 106 (92.2%) reported episodes of diarrhea. The mean FISI score was 13.9±9.7. Upon multivariable analysis, FI was significantly associated with parity (p=0.007), operative vaginal delivery (p=0.049), obstetrical sphincter lacerations (p=0.007), fecal urgency (p=0.005), diarrhea (p=0.008), and hysterectomy (p=0.004), but was not associated with episiotomy, pelvic organ prolapse, or urinary incontinence. The synergistic interactions of obstetric anal sphincter laceration with urgency (p=0.002) and diarrhea (p=0.004) were significant risk factors for FI.

Conclusion—Fecal urgency and diarrhea are independent risk factors for FI, and they interact with obstetric anal sphincter laceration to amplify the risk of FI.

Keywords

fecal incontinence; obstetric anal sphincter injury; diarrhea; urgency

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Introduction

Fecal incontinence (FI) is the recurrent uncontrolled passage of fecal material.[1] The best estimate of the prevalence of FI in the non-institutionalized adult population in the U.S, provided by the National Health and Nutrition Examination Survey of over 5000 Americans, was 8.9% of women and 7.7% of men. The biggest identified risk factor was age, with 15% of those older than 70 affected.[2] While not life-threatening, FI has a dramatically negative impact on quality of life and is a commonly cited reason for nursing home admission.[3-4] In addition, health-care costs of those with severe fecal incontinence are more than twice those of continent controls.[5]

The normal storage and evacuation of stool relies on complex neurologic and anatomic factors including normal intestinal tract motility, stool consistency, rectal compliance, anorectal sensation, and anal sphincter function. To what extent each of these factors contributes to the etiology of fecal incontinence has not yet been elucidated as multiple risk factors may coexist and some risk factors require physiological tests that are not feasible to perform in population based surveys. Current literature supports that rectal urgency and diarrhea are both risk factors for FI in community dwelling adults.[6-11] However, because urgency often accompanies diarrhea, it is not known whether these are independent risk factors.

While it is well established that obstetric anal sphincter injury increases the risk of developing FI in younger women[12-15], anatomic anal sphincter disruption has not been consistently identified as a major risk factor for FI in older patients[6] and certainly does not explain similar prevalence estimates of FI in men and women[2]. Similarly, it has been suggested that the majority of women with FI -- nearly 70% -- report that their symptoms began years after vaginal delivery and particularly after the age of 40.[16] It is possible that the onset of FI years after an obstetric injury could be explained by a synergistic interaction of obstetrical injury with frequent diarrhea or urgency. For example, subjects with sphincter injury may remain continent if their stools are formed but may be especially vulnerable when they experience diarrhea.

Patients with irritable bowel syndrome (IBS) present a unique opportunity for the evaluation of different, and potentially cumulative, risk factors for FI as all of these patients are affected, in some way, by abnormal intestinal tract motility. Approximately 23% to 46% of IBS patients in epidemiologic studies report FI[17-18]. Using data that we previously collected from 185 subjects with IBS who prospectively completed daily bowel diaries for a 3-month period, we had the opportunity to identify those with FI and investigate the differential impact of stool consistency, obstetric history, medical co-morbidities, and demographic variables on disease prevalence. Our study objectives were to confirm that fecal urgency and diarrhea are independent risk factors for FI, to identify obstetrical risk factors associated with FI in women with IBS, and to determine whether obstetric risk factors interact with diarrhea or urgency to explain the occurrence of FI.

Methods

This cohort study is a supplement to a completed study of bowel symptoms in 185 patients, including both men and women, with IBS[19].

Parent study

Subjects were recruited by advertisement. Inclusion criteria were (a) a clinical diagnosis of IBS by a physician, (b) fulfillment of the Rome III criteria for IBS diagnosis (confirming clinical diagnosis), and (c) daily access to the internet. Exclusion criteria were a history of

Inflammatory bowel disease, celiac disease or lactose intolerance, daily use of IBS medications (e.g., lubiprostone, tegaserod, alosetron, or antidepressants), and current participation in pharmacologic trials. Subjects were permitted to use anti-diarrheal or laxative medications occasionally, but were asked to refrain from using these drugs as much as possible during the study. A total of 595 potential subjects were screened online, out of which 392 met study criteria and were invited to enroll through the mail. Two hundred and six (52.5%) subjects enrolled and started diary entries, however 7 subjects subsequently dropped out and 14were dropped by the investigators due to non-adherence with the symptom diary. Thus, a total of 185 subjects were included in the final analysis.

Before beginning their bowel symptom diary, subjects completed the Rome III Diagnostic Questionnaire[20], the IBS Severity Scale (IBS-SS scale)[21], the IBS Quality of Life questionnaire (IBS-QOL)[22], and the Brief Symptom Inventory 18 (BSI-18)[23] which is a psychological symptom questionnaire. During the 90-day diary recording period, subjects were asked to rate the stool consistency of each bowel movement (BM) on the 7-point Bristol Stool Scale[24] by referring to pictures and verbal descriptors in their diary book, and to report (yes/no) any associated symptoms of urgency, diarrhea, pain, or FI. Every night, the subjects transferred their diary ratings for the day to a secure website, where they also rated on a 0-10 scale their global 24-hour symptoms of abdominal pain, bloating, life stress, dissatisfaction with their BMs, and life interference from bowel symptoms, as well as their use of any medication during the day. If subjects did not complete the online diary on any day, they were reminded to do so by study staff the next day via e-mail. They could then enter their data for the previous day, but were not allowed to enter data for more than one retrospective day. Subjects were terminated from the study if they missed more than three days of diary recordings, and no data were used if they completed less than 21 consecutive days of diary recordings without interruption.

Supplemental Study

Among the 185 subjects in the parent study, 164 were female. Only the female subjects from the parent study were invited by email or postal mail to complete a telephone interview on their obstetric and medical history. The study was described to the subjects and they were invited to read the on-line consent form and provide consent if interested in participating in the supplemental study. Consenting subjects were then interviewed by telephone. Subjects who declined participation were not contacted further. Subjects who failed to respond were sent two additional mailings in the form of e-mail or postal mail. Subjects who failed to respond after three total mailings, were then telephoned up to two times. A maximum of five attempts were made to invite subjects to participate in the supplemental study. Subjects were offered $30 for study completion.

The interview questions included 33 items in the following areas: (a) Fecal Incontinence Severity Index[25] to confirm that cases had FI and controls did not, (b) details on the age and circumstances of onset of FI (for cases only), (c) information on prior treatments for FI (for cases), (d) obstetric history, (e) medical and surgical history, and (f) sexual function. A structured interview script was developed to ensure that the questionnaire was administered in a uniform fashion. The telephone interviews were conducted by one of seven physicians in the University of North Carolina Division of Female Pelvic Medicine and Reconstructive Surgery or by a trained research coordinator. The obstetric questions were developed by three of the urogynecologists on the research team. Specifically, subjects were asked how many times they had been pregnant, how many children they delivered, how many vaginal deliveries and cesarean deliveries they experienced, and their age at each delivery. They were then asked the details of each delivery including date, if a vacuum or forceps were used, if they had any perineal stitches placed immediately after delivery, if they had an episiotomy, if they had a third or fourth degree tear or were told by their provider that they

had an anal injury, and if they experienced FI immediately or within six months after delivery. Use of a vacuum or forceps was considered an operative vaginal delivery. An episiotomy was defined as a surgical incision on the perineum made by the delivering provider to aid in vaginal delivery. Anal sphincter injury was any partial or full thickness anal sphincter injury including third and fourth degree lacerations.

Subjects were also asked a series of questions regarding their medical and surgical history. Among the conditions queried, subjects were specifically asked if they had symptoms of pelvic organ prolapse (i.e., feeling or seeing a bulge in the vagina) or urinary incontinence at any frequency. They were also asked if they were ever diagnosed with either of these conditions by a medical provider. Subjects were considered to have the respective condition if they responded positively to the presence of symptoms or had a formal diagnosis.

FI was defined as present if at least one episode of accidental leakage of solid or liquid stool or mucous was recorded during the patient's 3-month diary. However, for analysis of risk factors we used a stricter definition of at least one episode per month on average. The severity of FI was measured by the Fecal Incontinence Severity Index[25], which is a retrospective questionnaire that assigns a patient-weighted score for each of 4 types of FI – solid, liquid, mucus, or gas leakage – based on the frequency of occurrence of each type and adds these weighted scores together to obtain an overall measure of FI severity. Diarrhea was defined by the Bristol Stool ratings of type 6 or 7 (loose or watery stool), and urgency was defined by a subjective judgment that urgency to defecate was present with a BM.

Both the parent study and this supplemental study were reviewed and approved by the Institutional Review Board for the Protection of Human Research Subjects prior to initiation of data collection. All subjects provided written informed consent.

Data analysis

Responses from the supplemental telephone interview were coded into a secure database with only the subject's identification number (assigned in the first study) to link the data to the subject. The data entries were reviewed for accuracy and the data was then merged with previously collected data from these subjects. Bivariate comparisons were performed using Student's t test and Chi-square analyses. Multivariate analysis was a performed on variables that were identified as statistically significant risk factors for the development of FI on bivariate analysis. The Tobit regression model was used for multivariate analysis as this model adjusts for the skewed distribution of FI (i.e., many subjects had no episodes of FI in their diary record).[26] To determine if there is an additive effect between obstetric anal sphincter laceration and gastrointestinal symptoms on the development of FI, the interaction between obstetric anal sphincter injury and urgency as well as obstetric anal sphincter injury and diarrhea were assessed. No other interactions were tested. Data were analyzed using SPSS Statistics 18.0 (SPSS, Somers, NY, USA). A p-value < 0.05 was considered significant. Results from the original parent study were previously published.[19] Data from the supplemental cohort will be presented here.

Results

In the parent study we collected daily diaries on bowel symptoms including fecal incontinence episodes for an average of 73 consecutive days (median 86 days, range 21-106 days). One hundred and sixty-four (88.6%) of the subjects were female, and 74 (45.1%) of the females in the parent study reported FI episodes on their symptom diaries. One hundred and fifteen women (70.1% participation rate) completed the supplemental telephone interview. Of the 49 non-participators two declined participation, two were unable to be contacted and 45 were non-responders.

Fifty-five of the 115 women completing the supplemental interview (47.8%) reported FI at least once during their diary period, and 34 (29.6%) reported an average of at least one episode per month. The average frequency of FI episodes per month was 2.0 ± 7.2, and the average FISI score was 13.9 ± 9.7. When compared to participants, non-participants reported a similar prevalence of FI: 20 (40.8%) non-participants reported FI at least once during their diary period (p=0.409) and 11 (22.4%) reported an average of at least one episode per month (p=0.350).

Demographic characteristics among women with and without FI were similar in this supplemental study population (Table 1). The mean participant age was 40.3 years old with a range of 21 to 72 years. There was no difference in age among women with and without FI, and the mean age of symptom onset was 34.2 ± 12.4 years old. The majority of the women were Caucasian (110, 95.7%), but 3 (2.6%) were African American, and 1 (<1%) was a Native American. Seventy-four (65%) of the subjects were married, 25 (22%) were single, and 15 (13%) were divorced or widowed. There was no difference in prevalence of FI with regards to marital status. This population was highly educated as 34 (30%) completed graduate or professional school, 52 (45%) were college graduates, 22 (19%) had some college education, and 6 (5%) completed high school. Education level had no effect on the prevalence of FI. The entire supplemental study population was overweight with BMI being similar among women with and without FI.

Urinary incontinence was reported by 60 women (52.6%), but urinary incontinence was unrelated to the presence of FI. Only six women (5.2%) were diagnosed with pelvic organ prolapse which had no effect on FI in this population. Twenty-four (20.9%) of the women reported having a hysterectomy, and this was significantly more common in women with FI compared to women without FI (p=0.004) (Table 2).

The majority of the women had been pregnant at least one time (67, 58.3%) and most of these women had had vaginal deliveries (55, 82.1%). Only 9 (13.4%) of parous women had cesarean deliveries. The mean age of first delivery was 25 ± 6.6 years. Episiotomy was reported by 49.5% (47/95) of respondents, operative vaginal delivery was reported by 20.0% (19/95) of respondents, and obstetrical anal sphincter laceration was reported by 24.5% (23/94) of respondents. Tobit linear regression analysis of all 115 women in the supplemental study population revealed that operative vaginal delivery was more prevalent among women with FI, and obstetric anal sphincter laceration was an independent risk factor for FI (Table 2). However, episiotomy was not a risk factor for FI.

One or more episodes of urgency was reported by 112 subjects (97.4%), and one or more episodes of diarrhea was reported by 106 (92.2%). The mean number of urgency episodes was 28.0 ± 26.1, and diarrhea episodes was 12.3 ± 16.0. Fecal urgency and diarrhea were both independent risk factors for FI (Table 2).

The interactions of obstetric anal sphincter laceration and urgency (β=0.26, p=0.002) and obstetric anal sphincter laceration and diarrhea (β=0.50, p=0.004) were both significant (Table 3). As shown in Figure 1, the history of an obstetric anal sphincter laceration combined with fecal urgency increased the risk of FI by nearly two-fold when compared to the presence of urgency alone. Similarly, the interaction of obstetric anal sphincter injury and diarrhea more than doubled the risk of FI than diarrhea alone (Figure 2). Figures 1 and 2 show one sphincter laceration case with unusually high rates of FI episodes (67 per month) and unusually high rates of urgency (106 per month) and diarrhea (40 per month). We reviewed the diary data from this subject and confirmed that these data points are accurate; specifically, there was variability in the consistency of incontinent stools from day to day and variation in the presence of urgency and diarrhea from BM to BM. All reports of these

symptoms were acquired by internet on the day they occurred. Moreover, the diary data were consistent with retrospective questionnaire data. However when data from this particular subject were excluded from the analysis, the interactions between obstetric anal sphincter injury and fecal urgency or diarrhea were no longer significant.

Discussion

Our study evaluated risk factors for FI by analyzing women with IBS who by definition all have abnormal intestinal tract motility. Consistent with prior studies that reported a prevalence of FI among patients with IBS of 23-46%[17-18], we found that 47% of women in our sample reported at least one instance of FI in a 90-day period and 29% reported an average of at least one episode per month. The average frequency of FI in this group was 2.0 times per month. Urgency and diarrhea were also frequent occurrences in this sample: the average number of BMs accompanied by urgency was 28.0 per month and the average number of BMs accompanied by diarrhea (loose or watery stools) was 12.3 per month. Obstetrical risk factors were frequent in this cohort as well. Thus, this sample of IBS women was well suited to examine the associations between gastrointestinal and obstetrical risk factors for FI.

Diarrhea is a well-established risk factor for FI[2], but two recent studies reported for the first time that urgency may be an independent and possibly stronger risk factor than diarrhea[7, 11]. These are important observations because they identify a new risk factor which could be targeted for prevention and treatment of FI. However, urgency and diarrhea frequently occur together and are sometimes regarded as different aspects of the same physiological process. Moreover, the fact that these two studies come from the same institution and are based on surveys in the same geographic region suggested a need for independent confirmation. Our study shows that urgency is an independent risk factor for FI; when adjustment is made for loose or watery stools, there is still a significantly increased risk of FI.

The second aim of our study was to reassess possible obstetric risk factors for FI. Previous studies show that there is an increased incidence of FI during the immediate post-partum period in women who sustain an obstetric laceration[27], but population-based studies which include subjects of all ages have usually failed to find a significant association; instead, there is a similar overall prevalence of FI in men and women[2]. The fact that most women with FI identified in population-based surveys have an age of onset which is delayed by many years after their last childbirth has also been cited as evidence that obstetric injuries may not be common causes of FI. However, a limitation of many of these population-based studies was that the questions used to ascertain obstetrical risk factors were limited to the number of vaginal deliveries[2] or they were questions that women may have had difficulty answering because they required recall after a lapse of many years[2, 6]. A strength of our study was that the questions on obstetric risk factors, although retrospective, were designed by urogynecologists. More importantly a structured interview script was used to ensure uniform delivery of the telephone questionnaire. These differences in methodology may account for the fact that we observed a significant association between number of vaginal deliveries, operative vaginal deliveries, and anal sphincter lacerations. Also, our results may differ from previous studies because we analyzed these obstetric variables in a specific population of women with IBS who have a higher prevalence of fecal incontinence than the general population.[17-18]

Our study was designed to test the hypothesis that there is a significant interaction between obstetric sphincter lacerations and diarrhea or urgency; this hypothesized interaction could account for the delayed onset of FI following obstetrical injuries. Previous studies which have examined these two categories of risk factors simultaneously have followed a

traditional epidemiological analytical approach in which multivariate regression is used to ascertain whether gastrointestinal and obstetrical risk factors are independently associated with FI. We chose to test for synergistic interactions by entering the product of sphincter laceration and diarrhea frequency (or frequency of urgency) as an independent variable in the regression analysis. By doing so we were able to show that there is a synergistic interaction between urgency and sphincter laceration even after adjusting for diarrhea, and there is also a synergistic interaction between diarrhea and sphincter laceration even after adjusting for urgency. The existence of this synergism between sphincter laceration and diarrhea or urgency provides a testable hypothesis to account for the late onset of FI after obstetrical sphincter laceration, and it has important clinical implications; it permits more precise estimates of the risk of FI in individual patients and may lead to better targeted interventions. For example, in fecally incontinent patients with a history of sphincter laceration, greater emphasis may be placed on medical therapy for diarrhea and urgency rather than surgical repair of the sphincters as this conservative approach may provide adequate control of FI. Alternatively, medical therapy provided concurrently with sphincteroplasty may improve outcomes.

It is prudent to consider that our finding of a synergistic interaction between obstetric anal sphincter laceration and urgency or diarrhea is based on data from the entire supplemental study population of 115 subjects. This population includes a subject with unusually high rates of episodes of FI, urgency, and diarrhea. When this subject was excluded from data analysis, the synergistic interaction was no longer significant. We believe it would be erroneous to exclude this subject from data analysis when considering the clinical implications of this data, as the accuracy of the diary entries was checked, and the subject's high rate of FI was independently confirmed by retrospective questionnaire. Evaluation of a larger sample of subjects is required to determine the true effect of this particular individual.

We did not find that episiotomy, urinary incontinence, or BMI were significant risk factors for FI in this study, although these have been identified as risk factors in some previous studies. A possible explanation for this is that our study was relatively small and lacked statistical power to test subtle associations. Our sample size was constrained by the fact that this was a supplemental study. While the sample size was adequate for the parent study, it was small for a risk analysis.

A strength of our study was the use of prospective diary data to identify and define FI, urgency, and diarrhea within our study population. All of the subjects maintained a daily diary for an average of 73 consecutive days specifically noting the presence of FI and noting whether urgency or diarrhea were associated with each bowel movement. This enabled us to clearly define our primary outcome, FI, while minimizing subject recall bias. To take full advantage of this prospective data from a 90-day diary, we chose to use the continuous variable, FI episodes per month, rather than the binary variable of presence or absence of FI, as our primary outcome variable. Similarly, we chose to use the Tobit regression model for data analysis which adjusts for the skewed distribution of FI (i.e., the fact that many subjects had no episodes of FI in their diary record). Of note, linear regression gave results similar to Tobit regression and confirms the significance of interactions between obstetric anal sphincter injury and fecal urgency or diarrhea.

A major limitation of our study is the retrospective attainment of data on obstetric risk factors. The subjects were asked to recall the number of pregnancies they experienced, the mode of delivery, and whether they had an episiotomy or 3rd or 4th degree perineal laceration. While it would be reasonable to expect that the majority of subjects would accurately recall the number of pregnancies they have had and whether they had a vaginal or cesarean delivery, subjects may not accurately recall whether they had a perineal injury or

may infer that they had an injury based on their level of discomfort or other symptoms related to the delivery. Similarly, subjects with FI might attempt to identify causes of their symptoms and overestimate the degree of their perineal injury. Elkadry et. al. demonstrated that 60% mothers have imperfect recall of obstetric events within a short post-partum interval of ten weeks.[28] Specifically, the authors found that women overestimated anal sphincter injury and underreported episiotomy. Thus, our finding that anal sphincter injury (i.e., 3rd or 4th degree lacerations) but not episiotomy was associated with FI symptoms may be based on flawed maternal recall. Our study would be strengthened by verification of obstetric details from delivery records. Unfortunately, this data was not available as the subjects were initially recruited through national advertisement and consequently received care from institutions throughout the country.

Our study was also limited by the fact that the interviewer was not blinded to the current FI status of the subject as the FISI was included in the administered questionnaire. However, the use of a structured interview script and standardized definitions of FI and obstetric risk factors likely minimized the impact of this potential bias. Also, the number of episodes of FI used in the data analysis was obtained from the 90-day diaries previously completed by each subject in the parent study[19]. The interviewers in the current study were blinded to this information and thus were not influenced by this data during questionnaire administration.

Our study utilizes a unique population of women with IBS to examine risk factors for FI. The advantage of studying this group is that it is enriched with respect to the prevalence of FI and gastrointestinal symptoms. However, this also limits the generalizability of our findings. Our study should be replicated in a large sample of women who are not selected based on the presence of IBS symptoms.

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References

1. Whitehead WE, Wald A, Diamant NE, Enck P, Pemberton JH, Rao SS. Functional disorders of the anus and rectum. Gut. 1999; 45(2):II55–9. [PubMed: 10457046]
2. Whitehead WE, Borrud L, Goode PS, et al. Fecal incontinence in US adults: epidemiology and risk factors. Gastroenterology. 2009; 137:512–7. 7 e1–2. [PubMed: 19410574]
3. Pares D, Vial M, Bohle B, et al. Prevalence of Fecal Incontinence and Analysis of Its Impact on Quality of Life and Mental Health. Colorectal Dis. 2010
4. Grover M, Busby-Whitehead J, Palmer Rn MH, et al. Survey of geriatricians on the effect of fecal incontinence on nursing home referral. J Am GeriatrSoc. 2010; 58:1058–62.
5. Dunivan GC, Heymen S, Palsson OS, et al. Fecal incontinence in primary care: prevalence, diagnosis, and health care utilization. Am J Obstet Gynecol. 2010; 202:493 e1–6. [PubMed: 20223447]
6. Bharucha AE, Zinsmeister AR, Locke GR, et al. Risk factors for fecal incontinence: a population-based study in women. Am J Gastroenterol. 2006; 101:1305–12. [PubMed: 16771954]
7. Bharucha AE, Seide BM, Zinsmeister AR, Melton LJ 3rd. Relation of bowel habits to fecal incontinence in women. Am J Gastroenterol. 2008; 103:1470–5. [PubMed: 18510612]
8. Kalantar JS, Howell S, Talley NJ. Prevalence of faecal incontinence and associated risk factors; an underdiagnosed problem in the Australian community? Med J Aust. 2002; 176:54–7. [PubMed: 11936284]

9. Melville JL, Fan MY, Newton K, Fenner D. Fecal incontinence in US women: a population-based study. Am J Obstet Gynecol. 2005; 193:2071–6. [PubMed: 16325618]
10. Quander CR, Morris MC, Melson J, Bienias JL, Evans DA. Prevalence of and factors associated with fecal incontinence in a large community study of older individuals. Am J Gastroenterol. 2005; 100:905–9. [PubMed: 15784039]
11. Rey E, Choung RS, Schleck CD, Zinsmeister AR, Locke GR III, Talley NJ. Onset and Risk Factors for Fecal Incontinence in a US Community. Am J Gastroenterol. 2010; 105:412–9. [PubMed: 19844202]
12. Eason E, Labrecque M, Marcoux S, Mondor M. Anal incontinence after childbirth. CMAJ. 2002; 166:326–30. [PubMed: 11868640]
13. Zetterstrom J, Lopez A, Anzen B, Norman M, Holmstrom B, Mellgren A. Anal sphincter tears at vaginal delivery: risk factors and clinical outcome of primary repair. Obstet Gynecol. 1999; 94:21–8. [PubMed: 10389712]
14. Fenner DE, Genberg B, Brahma P, Marek L, DeLancey JO. Fecal and urinary incontinence after vaginal delivery with anal sphincter disruption in an obstetrics unit in the United States. Am J Obstet Gynecol. 2003; 189:1543–9. discussion 9-50. [PubMed: 14710059]
15. Varma A, Gunn J, Gardiner A, Lindow SW, Duthie GS. Obstetric anal sphincter injury: prospective evaluation of incidence. Dis Colon Rectum. 1999; 42:1537–43. [PubMed: 10613471]
16. Bharucha AE, Zinsmeister AR, Locke GR, et al. Prevalence and burden of fecal incontinence: a population-based study in women. Gastroenterology. 2005; 129:42–9. [PubMed: 16012933]
17. Longstreth GF, Wolde-Tsadik G. Irritable bowel-type symptoms in HMO examinees. Prevalence, demographics, and clinical correlates. Dig Dis Sci. 1993; 38:1581–9. [PubMed: 8359067]
18. Varma MG, Brown JS, Creasman JM, et al. Fecal incontinence in females older than aged 40 years: who is at risk? Dis Colon Rectum. 2006; 49:841–51. [PubMed: 16741640]
19. Palsson OS, Baggish JS, Turner MJ, Whitehead WE. IBS patients show frequent fluctuations between loose/watery and hard/lumpy stools: Implications for treatment. Am J Gastroenterol. 2011
20. Drossman DA, Dumitrascu DL. Rome III: New standard for functional gastrointestinal disorders. J Gastrointestin Liver Dis. 2006; 15:237–41. [PubMed: 17013448]
21. Francis CY, Morris J, Whorwell PJ. The irritable bowel severity scoring system: a simple method of monitoring irritable bowel syndrome and its progress. Aliment Pharmacol Ther. 1997; 11:395–402. [PubMed: 9146781]
22. Patrick DL, Drossman DA, Frederick IO, DiCesare J, Puder KL. Quality of life in persons with irritable bowel syndrome: development and validation of a new measure. Dig Dis Sci. 1998; 43:400–11. [PubMed: 9512138]
23. Derogatis, LR. Administration, scoring, and procedures manual. NCS Pearson Inc; 2000. Brief Symptom Inventory 18.
24. Lewis SJ, Heaton KW. Stool form scale as a useful guide to intestinal transit time. Scand J Gastroenterol. 1997; 32:920–4. [PubMed: 9299672]
25. Rockwood TH, Church JM, Fleshman JW, et al. Patient and surgeon ranking of the severity of symptoms associated with fecal incontinence: the fecal incontinence severity index. Dis Colon Rectum. 1999; 42:1525–32. [PubMed: 10613469]
26. McDonald JF, Moffitt RA. The Uses of Tobit Analysis. The Review of Economics and Statistics. 1980; 62:318–21.
27. Burgio KL, Borello-France D, Richter HE, et al. Risk factors for fecal and urinary incontinence after childbirth: the childbirth and pelvic symptoms study. AmJGastroenterol. 2007; 102:1998–2004.
28. Elkadry E, Kenton K, White P, Creech S, Brubaker L. Do mothers remember key events during labor? Am J Obstet Gynecol. 2003; 189:195–200. [PubMed: 12861162]

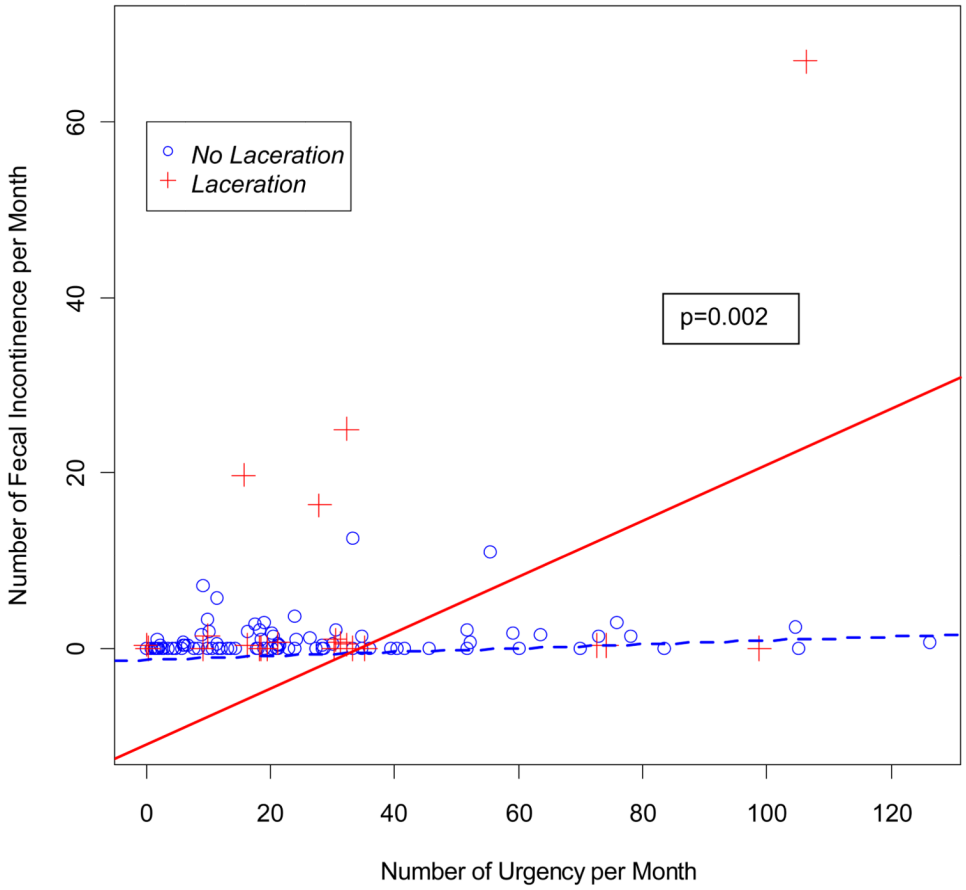

Figure 1. Interaction of obstetric anal sphincter laceration and fecal urgency

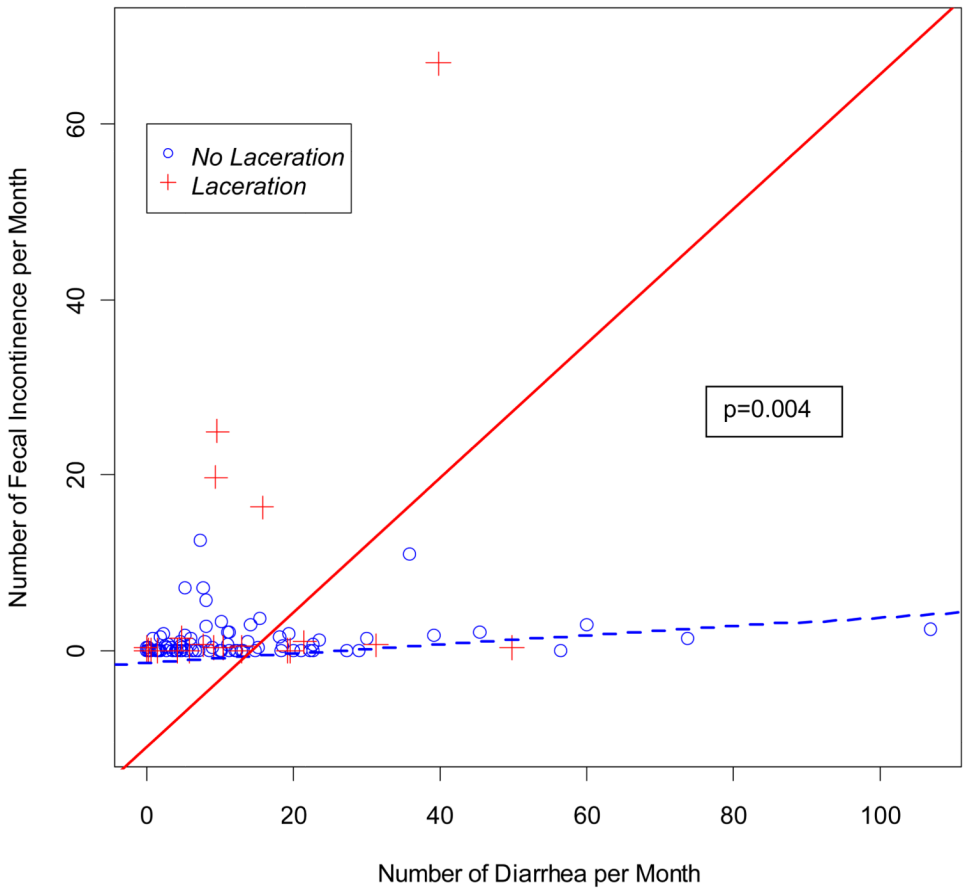

Figure 2. Interaction of obstetric anal sphincter laceration and diarrhea

Table 1
Demographic Characteristics of the Sample

		Fecal Incontinence†		
	Total	**Yes**	**No**	**p-value§**
Total # of Participants	115 (100%)	34 (29.6%)	81 (70.4%)	
Age, mean (SD)	40.3 (12.5)	42.9 (12.0)	39.2 (12.6)	0.191
Marital status				
Married	74 (64.9%)	21 (63.6%)	53 (65.4%)	0.27
Single, Divorced, Widowed	40 (35.1%)	12 (36.4%)	28 (34.6%)	
Education				
College Graduate	86 (75.4%)	22 (66.7%)	64 (79.0%)	0.60
High School Graduate	28 (24.6%)	11 (33.3%)	17 (21.0%)	
BMI, mean (SD)	26.3 (6.6)	27.4 (6.9)	25.9 (6.5)	0.20

SD = Standard Deviation

† Fecal incontinence is defined as having at least one episode of accidental leakage of solid or liquid stool or mucous monthly.

§ Significance is based on Tobit regression with the number of fecal incontinence per month as the primary outcome. The Tobit regression model adjusts for the skewed distribution of FI as many subjects had no episodes of FI in their diary record.

Table 2

Tobit regression of non-obstetric, obstetric, and gastrointestinal risk factors for FI

Non-obstetric risk factors			
	β Coefficient	**95% CI**	**p Value**
POP Symptoms	−8.2	−22.4, 6.0	0.26
Urinary Incontinence	3.4	−1.4, 8.3	0.16
Hysterectomy	7.9	2.5, 13.2	0.004
Obstetric risk factors			
Parity	3.5	−1.4, 8.4	0.16
# of times pregnant	2.1	0.6, 3.6	0.007
Operative Vaginal Delivery	5.9	0.01, 11.8	0.049
Episiotomy	1.9	−2.9, 6.7	0.43
Obstetric Anal Sphincter Laceration	7.5	2.0, 12.9	0.007
Gastrointestinal risk factor			
# of Urgency Episodes per Month	0.12	0.04, 0.20	0.005
# of Diarrhea Episodes per Month	0.18	0.05, 0.32	0.008

Table 3

Interaction of obstetric anal sphincter laceration and urgency or diarrhea on development of fecal incontinence symptoms.

	β Coefficient	95% CI	p-value
Interaction of obstetric anal sphincter laceration and urgency			
Crude analysis			
Obstetric Anal Sphincter Laceration	−1.5	−9.1, 6.0	0.69
# of Urgency Episodes per Month	0.045	−0.041, 0.13	0.30
Interaction of laceration and urgency	0.24	0.07, 0.41	0.005
Adjusted analysis*			
Obstetric Anal Sphincter Laceration	−3.3	−10.9, 4.2	0.39
# of Urgency Episodes per Month	−0.06	−0.17, 0.06	0.34
# of Diarrhea Episodes per Month	0.16	0.01, 0.32	0.04
Interaction of laceration and urgency†	0.26	0.09, 0.42	0.002
Interaction of obstetric anal sphincter laceration and diarrhea			
Crude analysis			
Obstetric Anal Sphincter Laceration	−0.1	−7.4, 7.1	0.97
# of Diarrhea Episodes per Month	0.10	−0.02, 0.23	0.11
Interaction of laceration and diarrhea	0.52	0.16, 0.88	0.005
Adjusted analysis§			
Obstetric Anal Sphincter Laceration	−1.9	−9.2, 5.4	0.61
# of Diarrhea Episodes per Month	0.08	−0.08, 0.24	0.32
# of Urgency Episodes per Month	0.01	−0.09, 0.11	0.85
Interaction of laceration and diarrhea¶	0.50	0.15, 0.84	0.004

*adjusted for diarrhea, age, hysterectomy, # of times pregnant, and operative vaginal delivery.

†interaction between obstetric anal sphincter laceration and urgency episodes.

§adjusted for urgency, age, hysterectomy, # of times pregnant, and operative vaginal delivery.

¶interaction between obstetric anal sphincter laceration and diarrhea episodes.