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Incidence and Predictors of Anal Incontinence after Obstetric Anal Sphincter Injury in Primiparous Women

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Abstract

Objective—To describe the incidence of fecal incontinence (FI) at 6, 12 and 24 weeks postpartum, anal incontinence (AI) and fecal urgency at 24 weeks and identify predictors of AI in women with obstetric anal sphincter injury (OASI).

Methods—Primiparous women sustaining OASIs were identified at 8 clinical sites. Third degree OASIs were characterized using World Health Organization (WHO) criteria, 3a (<50%) or 3b

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(>50%) tear through the sphincter. FI was defined as leakage of liquid/solid stool and/or mucus in the past month; AI was defined as leakage of liquid/solid stool and/or mucus and/or gas in the past month and was assessed at 6, 12 and 24 weeks postpartum using the Fecal Incontinence Severity Index. Logistic regression identified variables associated with AI.

Results—343 women participated: 297 subjects sustained a third degree OASI, 168 type 3a, 98 type 3b and 31 indeterminant; 45 had a fourth degree OASI. Overall FI incidence at 6, 12 and 24 weeks was 7% (23/326, 95% CI: 4%,10%), 4% (6/145, 95% CI: 2%,9%) and 9% (13/138, 95% CI: 5%,16%), respectively. At 24 weeks AI incidence was 24% (95% CI: 17%,32%) and fecal urgency 21% (95% CI: 15%,29%). No significant differences in FI and AI rates were noted by 3rd degree type or between groups with 3rd and 4th OASI. Flatal incontinence was greater in women sustaining a 4th degree tear (35% vs 16%, p=0.04). Caucasian race (AOR 4.64, 95% CI: 1.35-16.02) and shorter duration of second stage (AOR 1.47 per 30 minute decrease, 95% CI: 1.12-1.92) were associated with AI at 24 weeks.

Conclusions—Overall 24-week incidence of FI is 9% (95% CI: 5%,16%) and AI is 24% (95% CI: 17%,32%). In women with OASI, Caucasian race and shorter second stage labor were associated with postpartum AI.

Keywords

anal incontinence; fecal incontinence; fecal urgency; obstetric anal sphincter injury

Introduction

Although the onset of fecal incontinence (FI) or accidental bowel leakage (ABL) usually occurs many years after a woman gives birth, structural damage to the anal sphincter at the time of delivery is a well-recognized risk factor. Up to 50% or greater (depending on the definition) of patients with obstetrical anal sphincter injury (OASI) develop incontinence of stool and/or gas, thus making them an appropriate target for prevention and treatment strategies. [1-7]

Given the dearth of research on the efficacy of behavioral intervention as an adjuvant to post-partum repair of OASI, investigators in the Pelvic Floor Disorders Network designed the “Behavioral Therapy Of Obstetric Sphincter Tears” randomized clinical trial to evaluate the effectiveness of behavioral therapy, including pelvic floor muscle training, bowel control strategies, and bowel habit education compared to usual care for reducing FI symptoms. During this same period, classification of obstetric trauma (3rd or 4th degree lacerations) as a patient safety indicator was recommended by the National Quality Measures Clearinghouse and Agency for Healthcare Research and Quality in the United States. [8] Interestingly, FI incidence rates were lower than predicted and the trial was converted to an observational cohort. The aim of this cohort study was to describe the incidence of FI symptoms at 6, 12 and 24 weeks postpartum, and anal incontinence (AI) and fecal urgency at 24 weeks. In addition, variables associated with AI symptoms at 24 weeks were identified.

Materials and Methods

Study Design

The Behavioral Therapy of Obstetric Sphincter Tears (BOOST) study was originally designed as a multi-center, randomized trial of behavioral therapy for FI in primiparous women sustaining an OASI. At 6 weeks postpartum, participants with FI symptoms were to be randomized to behavioral therapy or usual care. Prior to initiation of the randomized trial, a feasibility period determined that numbers of primiparous women with OASI was sufficient at the clinical sites to perform the trial; however, after the trial was initiated, rates of FI were lower than predicted, and it was not feasible to complete the trial in a reasonable time-frame. In consultation with the Data and Safety Monitoring Board, we proceeded with a prospective cohort study, with the aim of describing the incidence of FI symptoms up to 24 weeks postpartum and the incidence of AI and fecal urgency at 24 weeks postpartum, and examining the relationship between risk factors, including the recommended World Health Organization (WHO) classification of obstetrical lacerations, and AI. [9] The study was conducted between July 2010 and June 2011 under institutional review board approval and with written informed consent at the 8 clinical sites of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development-sponsored Pelvic Floor Disorders Network (PFDN).

Patient Population

Participants were primiparous women who were diagnosed with an OASI by the delivering physician and underwent anal sphincter repair at the time of singleton vaginal delivery. Sphincter tears were characterized at the time of delivery as <50% tear through the anal sphincter (modified WHO 3a), >50% (modified WHO 3b), or complete tear through the anal sphincter muscle (4th degree). [9] As the WHO 3c sub-classification (identification of internal sphincter tear) was not routinely performed, it was not included as a sub-classification. Each PFDN site held educational seminars with the obstetric services describing the WHO sphincter tear classification system in order that a standardized approach was performed across all sites. Women were eligible if they could provide informed consent, were ambulatory, had a singleton first pregnancy ≥ 28 weeks gestation, delivered vaginally, and sustained an OASI. Women were excluded if their delivery was prior to 28 weeks gestation, or they had a previous pregnancy ≥ 28 weeks, inflammatory bowel disease, pre-pregnancy ano-rectal surgery, pre-pregnancy FI, previously participated in a pharmacologic or behavioral study for FI, sustained a rectovaginal fistula, or had any neurological conditions predisposing them to FI (e.g., spinal cord injury or multiple sclerosis). Potential participants were identified by the Obstetrics Departments of the clinical sites and contacted while in the hospital during their postpartum stay, or approached via telephone or mail within 2 weeks of the delivery if they had consented to be contacted for a research study at the time of admission.

Study Measures

Baseline assessments included the collection of demographic information and medical record review for medical and gynecological history, antepartum and delivery information. Follow-up assessments were performed by telephone at 6, 12 and 24 weeks postpartum and

included the: Fecal Incontinence Severity Index (FISI) [10] to assess symptom severity of FI. The Modified Manchester Health Questionnaire (MMHQ) [11] to assess fecal urgency: “How often do you have a strong desire to move your bowels, which makes you rush to the toilet” was administered at 24 weeks to assess fecal urgency. The MMHQ which contains the FISI embedded within it, has been previously validated for telephone administration [11].

Study Outcomes

The primary outcome was the incidence of at least monthly FI symptoms at 6 and 12 weeks postpartum, defined as any involuntary leakage of mucus, liquid stool, or solid stool on the FISI. Secondary outcomes included: the incidence of FI symptoms at 24 weeks postpartum; the incidence of fecal urgency, defined as a response of “sometimes”, “often” or “always” to the first question of the Modified Manchester Health Questionnaire, at 24 weeks postpartum; the incidence of flatal incontinence, defined as any gas leakage, at 24 weeks postpartum; and the incidence of anal incontinence (AI), defined as leakage of mucus, liquid stool, solid stool, and/or gas at 24 weeks postpartum. Fecal urgency symptoms were also collected at 24 weeks.

Statistical Analysis

The original study was designed to enroll 236 subjects, providing 80% power with a two-sided Type I error of 5% to detect a relative between-group difference of 50% in prevalence of FI at 24 weeks post-partum (36% in the usual care group vs 18% in the behavioral intervention group), adjusting for a single interim analysis to stop for futility or benefit and 20% loss-to-follow-up (East 5.2, Cytel, Inc). The estimates of the prevalence of FI were obtained from a PFDN study the Childbirth and Pelvic Symptoms Study. [3] After 6 months of BOOST trial enrollment, the rate of FI in primiparous women sustaining an OASI was 8% at 6 weeks, as compared to the projected rate of 28%. At that time, the study was modified to a cohort design as it was judged to be infeasible to enroll and complete the intervention trial within a reasonable timeframe.

Based on the 8% estimate of FI incidence at 6 weeks from the first 6 months of the BOOST data, we calculated that enrolling approximately 400 participants would provide a 95% Confidence Interval (CI) with a half width of 2.4% to estimate FI incidence. Assuming that the FI incidence among women with 3a or 3b tears was 10% and that 80% of participants had 3a or 3b tears, the sample size of 400 would have provided 80% or greater power to detect a difference in FI incidence between women with a 3a and 3b tears and those with 4th degree tears if the incidence among women with 4th degree tears was 23% or greater. Although the study was designed for approximately 400 participants, the PFDN stopped the study at the end of a Network grant cycle based on administrative and resource considerations; at the time the study was stopped, 343 eligible participants were enrolled. This sample size resulted in a confidence interval (CI) width approximately 10% greater than anticipated for descriptive analyses. Under the same assumptions originally used for the women with 3a and 3b tears, the FI incidence among women with 4th degree tears would need to be 24% or greater to have 80% power to detect a difference between women with 3a and 3b tears and those with 4th degree tears with a sample size of 343.

The incidences of FI at 6, 12 and 24 weeks postpartum and AI at 24 weeks were calculated, with associated 95% CIs. Fisher's exact test for categorical variables and t-test for continuous variables were used to compare the distribution of FI and AI incidence and of WHO OASI category (3rd degree vs. 4th degree tear) by demographic and antepartum and delivery characteristics. A multivariable logistic regression model predicting AI at 24 weeks was constructed based on results of the bivariate analysis. Using a basic rule of thumb for logistic regression, the number of predictors in the model was restricted to one independent variable per 10 women with AI. The predictors included in the model were selected based on clinical significance from among those associated with AI at the $p < 0.05$ level in bivariate analysis.

Results

A summary of participant flow in the cohort study is shown in Figure 1. The cohort study enrolled 343 women with a mean ($\pm$ SD) age of 28 ($\pm$ 5) years who delivered at 39 ± 1 weeks gestation. Fifty-six percent were Caucasian, 20% Latina, 10% African American, and 10% Asian. The overall episiotomy rate was 30% (101/343), of which 85% were midline. Third degree anal sphincter tears were reported in 297 women and were sub-classified as type 3a (N=168), 3b (N=98), indeterminate (N=31), (Table 2). Fourth degree tears occurred in 45 subjects.

Overall rates of FI at 6, 12 and 24 weeks after sphincter injury and repair were 7% (23/326, 95% CI: 4%,10%), 4% (6/145, 95% CI: 2%,9%) and 9% (13/138, 95% CI: 5%,16%), respectively. At 24 weeks AI incidence was 24% (33/138, 95% CI: 17%,32%) and fecal urgency 21% (29/138, 95% CI: 15%,29%). Overall, other bowel symptoms are also noted in Table 2. There were no significant group differences reported in incontinence or fecal urgency symptoms between women with 3a versus 3b OASI, therefore these two groups were then combined and AI, FI and fecal urgency rates were compared between women with 3a/3b injuries and women sustaining a 4th degree tear (Table 2). At 24 weeks postpartum, the only significant difference between women in the 3rd degree vs 4th degree groups was in flatal incontinence rates (16% vs 35%, respectively, $p=0.04$).

Bivariate analysis of patient characteristics at 24 weeks between women with 3rd and 4th degree OASI revealed no significant differences in socio-demographic, antepartum, intrapartum or infant characteristics except for stool softeners at discharge (234/274, 85% vs 41/42, 98%, $p=0.03$). However, bivariate analysis comparing women with and without AI at 24 weeks postpartum revealed that AI was significantly associated with race/ethnicity ($p=0.0096$), insurance status ($p=0.0002$), duration of second stage of labor ($p=0.025$) and episiotomy ($p=0.034$), (Table 3).

In multivariable analysis (Table 4), Caucasian race was associated with nearly a 5 fold increased odds of AI at 24 weeks (Adjusted Odds Ratio (AOR) 4.64, 95% Confidence Interval (CI): 1.35-16.02, $P=0.015$) and for each 30 minute decrease in duration of 2nd stage of labor the odds of AI symptoms increased by approximately 50% (AOR 1.47, 95% CI: 1.12-1.92, $P=0.004$). The association between episiotomy and AI neared but did not reach statistical significance at the $P < 0.05$ level (AOR 2.76, 95% CI: 0.94-8.14).

Discussion

The overall anal incontinence incidence rate in this well characterized prospective cohort of primiparous women sustaining an OASI was found to be 24%, consistent with what has been noted previously [12, 13]; fecal incontinence incidence rates were found to be 4-9% at 6 to 24 weeks postpartum, similar to what has been reported in the general literature [12,13] but lower than what we had noted in our previous work despite the same definition of FI.[3] Although we used current literature to inform the design of the randomized trial in women sustaining an OASI, we believe that there may have been changes in secular trends regarding the management of the second stage of labor. We had observed a higher rate of FI at 6 weeks postpartum in our first study and had utilized that rate to power the original trial [3]. It is also important to note that rates of both FI and AI do appear to change over time after a first delivery. These data continue to support the hypothesis that higher FI rates seen with aging may result from continued deterioration of the anal sphincter complex when age-related neuropathic changes or muscle atrophy may occur. [14] Because AI has a significant impact on quality of life [15], powering a trial for the effect on AI rather than just FI should be considered in the design of future intervention trials.

With regard to the potential for differences in symptoms of women sustaining 3a/3b sphincter tears, we hypothesized that muscle contracture effects during healing after sphincter tears less than 50% would favor apposition of the torn anal sphincter, while muscle contracture forces during the healing of a >50% laceration would favor continued separation of the external anal sphincter, perhaps leading to differences in FI symptoms. We confirmed that FI and AI incidence rates for both 3rd degree OASI types were significantly lower than that of 4th degree OASI. This finding is consistent with our previous study [3] and other literature. [16] However, we found no differences in FI and AI rates between 3a and 3b sphincter laceration types as we hypothesized, suggesting that when identified and repaired, the amount of muscle torn may not be a critical factor. It may also be possible that these differences may not be noted until greater than 6 months from delivery and healing.

White race has been previously shown to be associated with an increased risk of sphincter tears and FI compared to non-Hispanic black race. [17,18] However, we had previously noted that in both groups with sphincter tear, white women were more likely to develop FI than black women. [19] While not a modifiable variable, studies are needed to more fully understand the anatomic and physiologic basis for this difference as well as potential socio-economic perceptions that may lead to differential reporting rates by patients. Other studies targeting potential systematic differences in delivery characteristics or interventions should be considered.

We found that a shorter second stage of labor increased the risk of AI. The risk of anal/fecal incontinence associated with length of labor is not totally understood. In one randomized trial of delayed pushing versus immediate pushing, where there was a significant ($p<0.001$) decrease in the length of second stage (median [range], 120 [57-255] vs 60 [0-148] minutes, respectively), there was no significant difference in the proportion of women with postpartum fecal continence. [20] In a retrospective study, 360 primiparous women were queried regarding anal incontinence symptoms and those with a prolonged second stage of

labor (n=197, >90 minutes) were compared to those with a short second stage (n=163, <30 min). With a response rate of 51%, flatal incontinence was noted in 9.1% of subjects in the prolonged second stage group compared to 15.6% in the shorter second stage group (p=0.18). Similarly, fecal incontinence symptoms were noted in 2.3% of the prolonged second stage group and 5.2%, in the shortened second stage, (p=0.45), suggesting that prolonged second stage was not associated with fecal incontinence symptoms. However, rates of fecal and flatal incontinence were consistently higher in women with a shortened second stage of labor, albeit not to a statistically significant degree. [21] A pathophysiologic rationale for this exists in that there may be greater expulsive force on the pelvic floor over a shorter period of time with a shorter second stage of labor, decreasing the chance for stretch/relaxation and increasing the risk of tissue rupture and other injury. [22] Alternatively, subjects with a much longer second stage of labor who may have been at a risk for anal incontinence were excluded by having a cesarean section for a second stage arrest. A Eunice Kennedy Shriver National Institute of Child Health and Human Development sponsored trial (NCT02137200, <http://clinicaltrials.gov>) has started that will *a priori* address the effects of active versus passive management of second stage labor on both objective and subjective pelvic floor outcomes and may provide some insight into these important sequelae. Study limitations include a lower than anticipated rate of fecal incontinence which limited our ability to detect clinical and demographic factors significantly associated with FI. We also did not subcategorize 3c lacerations because complete disruptions of the external anal sphincter associated with internal anal sphincter disruption in the absence of a 4th degree laceration are extremely uncommon and not typically identified in the US. [23] We also did not believe that providers could reliably identify internal anal sphincter (IAS) disruption without a 4th degree tear. Finally, we had a moderate loss to follow up attributed to transition from a randomized trial to a cohort design requiring permission from the local site review boards to re-contact and re-consent participants as well as loss of participants due to follow-up time windows expiring before a participant could be re-consented. Specifically, trial recruitment began in July 2010 and was monitored closely. After 201 subjects had enrolled, we recognized that the number of women who had experienced OASIS and reported FI was lower than expected. Thus, in January, 2011, we amended the original RCT protocol to add a research call to the subject at 12 weeks post-partum to assess the presence of FI. However, the timeline of the RCT was proving prolonged and on February 23, 2011, the protocol was transitioned from an RCT to cohort study; by that time a total of 236 women were enrolled. Per local IRB requirements, most women enrolled under the RCT could not be re-contacted at the 12 and 24 week cohort study time points. While this resulted in a high degree of missing data, such missingness due to administrative reasons would not be expected to bias the results. Study strengths include increased external validity of findings with recruitment from 8 clinical sites, well-characterized definitions of FI, AI and fecal urgency with noted differences in AI rates and risk factors and a standardized approach to the classification of OASI.

Overall 24-week incidence of FI is 9% and AI is 24% in a robust sample of US primiparous women. More information is needed regarding the longer-term effect of length of labor and racial differences affecting the development of accidental bowel leakage.

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Summary Statement

Obstetric anal sphincter injuries are associated with incident AI symptoms with little difference in FI symptoms between WHO 3a and 3b laceration sub-types.

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Figure 1. Consort Diagram of Participant Status

* The 12 and 24 week calls were not included in the original RCT design. Participants who consented to the study under the original protocol were only followed beyond 6 weeks if their consent allowed for further contact.

Table 1
BOOST Fecal Incontinence Survey Participant Characteristics

Characteristics	Overall n=343 ^a	WHO 3 rd Degree Tear n=297	WHO 4 th Degree Tear n=45
Age, (mean $\pm$ SD)	28 $\pm$ 5	28 $\pm$ 5	28 $\pm$ 5
MISSING (n)	0	0	0
Race/Ethnicity, n (%)			
White	193 (56)	166 (56)	26 (58)
Black/African American	35 (10)	30 (10)	5 (11)
Asian	34 (10)	31 (11)	3 (7)
Latina	68 (20)	57 (19)	11 (24)
Other	13 (4)	13 (4)	0 (0)
MISSING (n)	0	0	0
Insurance, n (%)			
Private only	215 (64)	186 (64)	28 (62)
Medicare or Medicaid	51 (15)	46 (16)	5 (11)
Other only	71 (21)	59 (20)	12 (27)
MISSING (n)	6	6	0
Marital Status, n (%)			
Single	74 (21)	71 (24)	3 (7)
Married	239 (70)	203 (68)	35 (78)
Living as married	26 (7)	20 (7)	6 (13)
Divorced	2 (1)	2 (1)	0 (0)
Other	2 (1)	1 (0)	1 (2)
MISSING (n)	0	0	0
Obstetric Characteristics			
Gestational Age (weeks), (mean $\pm$ SD)	39 $\pm$ 1	39 $\pm$ 1	39 $\pm$ 1
MISSING (n)	0	0	0
Pre-pregnancy Weight (lb), (mean $\pm$ SD)	144 $\pm$ 37	144 $\pm$ 37	147 $\pm$ 37
MISSING (n)	65	55	10
Pre-delivery Weight (lb), (mean $\pm$ SD)	178 $\pm$ 35	178 $\pm$ 36	180 $\pm$ 34
MISSING (n)	11	8	3
Duration 2 nd stage of labor (min), (mean $\pm$ SD)	148 $\pm$ 387	141 $\pm$ 341	198 $\pm$ 622
MISSING (n)	35	28	6
Labor augmentation, n (%)			
☐ Yes	174 (52)	154 (53)	20 (47)
☐ No	160 (48)	136 (47)	23 (53)
MISSING (n)	9	7	2

Characteristics	Overall n=343 ^a	WHO 3 rd Degree Tear n=297	WHO 4 th Degree Tear n=45
Forceps, n (%)			
☐ Yes	64 (19)	52 (18)	11 (26)
☐ No	267 (81)	235 (82)	32 (74)
MISSING (n)	12	10	2
Vacuum, n (%)			
☐ Yes	68 (21)	61 (21)	7 (17)
☐ No	262 (79)	226 (79)	35 (83)
MISSING (n)	13	10	3
Shoulder Dystocia, n (%)			
☐ Yes	21 (6)	18 (6)	3 (7)
☐ No	308 (94)	268 (94)	39 (93)
MISSING (n)	14	11	3
Episiotomy, n (%)			
☐ Yes	101 (30)	84 (28)	16 (36)
☐ No	241 (70)	212 (72)	29 (64)
MISSING (n)	1	1	0
Type of episiotomy, n (%)			
Mediolateral	10 (10)	9 (11)	1 (7)
Midline	84 (85)	70 (84)	13 (86)
Unknown	5 (5)	4 (5)	1 (7)
MISSING (n)	2	1	1
Labor induced, n (%)			
☐ Yes	110 (32)	90 (31)	19 (43)
☐ No	230 (68)	205 (69)	25 (57)
MISSING (n)	3	2	1
Infant Characteristics			
Head circumference (cm), (mean $\pm$ SD)	35 $\pm$ 2	35 $\pm$ 2	35 $\pm$ 4
MISSING (n)	18	14	4
Weight (g), (mean $\pm$ SD)	3484 $\pm$ 493	3,477 $\pm$ 491	3,534 $\pm$ 515
MISSING (n)	6	4	2
Sphincter Tear Characteristics			
Characteristic Anal Sphincter Repair	Overall	WHO 3 rd Degree Tear	WHO 4 th Degree Tear n=45
		3a n=168 3b n=98	
Type sphincter repair, n (%)			
Overlapping	24 (7)	10 (6) 11 (11)	3 (7)

Characteristics	Overall n=343 ^a	WHO 3 rd Degree Tear n=297	WHO 4 th Degree Tear n=45	
End to end	243 (72)	117 (70)	73 (75)	33 (75)
Unknown	72 (21)	40 (24)	13 (14)	8 (18)
MISSING (n)	4	1	1	1
Suture used for sphincter repair, n (%)				
Chronic	89 (26)	45 (27)	19 (20)	16 (37)
Synthetic absorbable	197 (58)	96 (57)	68 (70)	19 (43)
Synthetic delayed absorbable	14 (4)	6 (4)	4 (4)	4 (9)
Other	2 (1)	2 (1)	0 (0)	0 (0)
Unknown	38 (11)	18 (11)	6 (6)	5 (11)
MISSING (n)	3	1	1	1
Stool softeners at discharge, n (%)				
☐ Yes	275 (87)	132 (86)	77 (83)	41 (98)
☐ No	41 (13)	21 (14)	16 (17)	1 (2)
MISSING (n)	27	15	5	3

^aOne participant missing value for degree of anal sphincter tear field.

Table 2

Fecal and Anal Incontinence Incident Rates

6 Weeks	b Overall n=326	3a n=165	3b n=97	c p-value	4 n=45	d p-value
Solid/Liquid stool, or Mucus, % (n) 95% CI	7 (23) 4, 10	6 (10) 3, 11	6 (6) 2, 13	1.0	11 (5) 4, 24	0.21
Liquid Only, % (n), 95% CI	3 (11), 1, 6					
Solid Only, % (n), 95% CI	1 (2), 0, 2					
Mucus Only, % (n), 95% CI	2 (7), 1, 4					
Liquid And Solid Only, % (n), 95% CI	0 (1), 0, 2					
Liquid And Mucus Only, % (n), 95% CI	0 (1), 0, 2					
Solid And Mucus Only, % (n), 95% CI	0 (1), 0, 2					
12 weeks						
Solid/Liquid stool, or Mucus, % (n) 95% CI	n=145 4 (6) 2, 9	n=77 6 (5) 2, 15	n=43 0 (0)	0.16	n=19 5 (1) 0, 26	0.58
Liquid Only, %	0					
Solid Only, % (n), 95% CI	1 (2), 0, 5					
Mucus Only, % (n), 95% CI	1 (2), 0, 5					
Liquid And Solid Only, %	0					
Liquid And Mucus Only, % (n), 95% CI	1 (1), 0, 4					
Solid And Mucus Only, %	0					
All 3, % (n), 95% CI	1 (1) 0, 4					
24 Weeks						
Solid/Liquid stool, or Mucus, % (n) 95% CI	n=138 9 (13) 5, 16	n=76 11 (8) 5, 20	n=34 9 (3) 2, 24	1.0	n=23 9 (2) 1, 28	1.0
Liquid Only, % (n), 95% CI	4 (6), 2, 9					
Solid Only, % (n), 95% CI	2 (3), 0, 6					
Mucus Only, % (n), 95% CI	1 (2), 0, 5					
Liquid And Solid Only, % (n), 95% CI	1 (1), 0, 4					
All 3, % (n), 95% CI	1 (1) 0, 4					
Flatal incontinence: Any gas leakage, % (n) 95% CI	19 (26) 13, 26	17 (13) 9, 27	15 (5) 5, 31	1.0	35 (8) 16, 57	0.04
Anal Incontinence: Solid/liquid stool, gas, % (n) 95% CI	24 (33) 17, 32	25 (19) 16, 36	18 (6) 7, 35	0.47	35 (8) 16, 57	0.19
Liquid Only, % (n), 95% CI	2 (3), 0, 6					
Solid Only, % (n), 95% CI	1 (2), 0, 5					
Mucus Only, % (n), 95% CI	1 (2), 0, 5					

6 Weeks	<i>b</i> Overall n=326	3a n=165	3b n=97	<i>c</i> p-value	4 n=45	<i>d</i> p-value
Gas Only, % (n), 95% CI	14 (20), 9,21					
Liquid And Gas Only, % (n), 95% CI	2 (3), 0,6					
Solid And Gas Only, % (n), 95% CI	1 (1), 0,4					
Liquid, Solid, And Gas Only, % (n), 95% CI	1 (1), 0,4					
All 4, % (n), 95% CI	1 (1) 0,4					
Fecal Urgency: Sometimes/Often/Always, % (n) 95% CI	21 (29) 15, 29	25 (19) 16, 36	21 (7) 9, 38	0.81	13 (3) 3, 34	0.41

b Indeterminate 3rd degree tears included in the overall n's

c Fisher's exact test p-value for FI, AI, flatal incontinence and fecal urgency between 3a and 3b sphincter tear types; indeterminate 3rd degree tears excluded

d p-value for FI, AI, flatal incontinence and fecal urgency between combined 3a/3b sphincter tears and 4th degree sphincter tear; indeterminate 3rd degree tears included

Table 3
Bivariate Analysis of Anal Incontinence at 24 Weeks

Characteristics	Anal Incontinence (YES) n=33	Anal Incontinence (NO) n=105	p-value ^e
Degree Tear, n (%)			0.1923
3 rd	25 (76%)	89 (86%)	
4 th	8 (24%)	15 (14%)	
MISSING (n)	0	1	
Age, (mean $\pm$ SD)	29 $\pm$ 4	28 $\pm$ 5	0.3535
MISSING (n)	0	0	
Race/Ethnicity, n (%)			0.0096 ^f
White	28 (85%)	61 (58%)	
Black/African American	1 (3%)	10 (9%)	
Asian	3 (9%)	5 (5%)	
Latina	1 (3%)	24 (23%)	
Other	0 (0%)	5 (5%)	
MISSING (n)	0	0	
Insurance, n (%)			0.0002 ^f
Private only	32 (97%)	67 (64%)	
Medicare or Medicaid	1 (3%)	11 (11%)	
Other only	0 (0%)	26 (25%)	
MISSING (n)	0	1	
Marital Status, n (%)			0.0463 ^f
Single	2 (6%)	17 (16%)	
Married	31 (94%)	78 (75%)	
Living as married	0 (%)	10 (9%)	
Divorced	0 (%)	0 (0%)	
Other	0 (%)	0 (0%)	
MISSING (n)	0	0	
Pre-pregnancy Weight (lb), (mean $\pm$ SD)	158 $\pm$ 44	144 $\pm$ 43	0.1431
MISSING (n)	6	25	
Gestational Age (weeks), (mean $\pm$ SD)	39 $\pm$ 2	40 $\pm$ 1	0.0913
MISSING (n)	0	0	
Pre-delivery Weight (lb), (mean $\pm$ SD)	185 $\pm$ 41	178 $\pm$ 39	0.4005
MISSING (n)	3	1	
Duration 2 nd stage of labor (min), (mean $\pm$ SD)	77 $\pm$ 60	119 $\pm$ 85	0.0254
MISSING (n)	10	25	

Characteristics	Anal Incontinence (YES) n=33	Anal Incontinence (NO) n=105	p-value ^e
Duration 2 nd stage of labor (unit=half hour), (mean $\pm$ SD)	2.6 $\pm$ 2.0	4.0 $\pm$ 2.8	0.0254
MISSING (n)	10	25	
Labor augmentation, n (%)			0.8357
☐ Yes	14 (47%)	52 (51%)	
☐ No	16 (53%)	50 (49%)	
MISSING (n)	3	3	
Forceps, n (%)			0.7966
☐ Yes	5 (17%)	19 (20%)	
☐ No	25 (83%)	78 (80%)	
MISSING (n)	3	8	
Vacuum, n (%)			0.4631
☐ Yes	8 (27%)	20 (21%)	
☐ No	22 (73%)	77 (79%)	
MISSING (n)	3	8	
Shoulder Dystocia, n (%)			0.7072
☐ Yes	3 (11%)	8 (8%)	
☐ No	25 (89%)	90 (92%)	
MISSING (n)	5	7	
Episiotomy, n (%)			0.0339 ^f
☐ Yes	17 (53%)	32 (30%)	
☐ No	15 (47%)	73 (70%)	
MISSING (n)	1	0	
Labor induced, n (%)			0.8155
☐ Yes	7 (23%)	29 (28%)	
☐ No	23 (77%)	76 (72%)	
MISSING (n)	3	0	
Type sphincter repair, n (%)			0.0078 ^f
Overlapping	3 (10%)	5 (5%)	
End to end	12 (39%)	71 (69%)	
Unknown	16 (51%)	27 (26%)	
MISSING (n)	2	2	
Suture used for sphincter repair, n (%)			0.2050
Chronic	6 (19%)	29 (28%)	
Synthetic absorbable	15 (48%)	56 (54%)	
Synthetic delayed absorbable	2 (7%)	1 (1%)	
Other	0 (0%)	2 (2%)	
Unknown	8 (26%)	16 (15%)	

Characteristics	Anal Incontinence (YES) n=33	Anal Incontinence (NO) n=105	p-value ^e
MISSING (n)	2	2	
Stool softeners at discharge, n (%)			0.4013
☐ Yes	18 (72%)	75 (82%)	
☐ No	7 (28%)	17 (18%)	
MISSING (n)	8	13	
Head circumference (cm), (mean $\pm$ SD)	35 $\pm$ 2	35 $\pm$ 3	0.3657
MISSING (n)	6	7	0.6607
Weight (g), (mean $\pm$ SD)	3528 $\pm$ 541	3572 $\pm$ 468	
MISSING (n)	3	3	

^e Fisher's exact test for categorical variables and t-test for continuous variables

^f Indicates significance at alpha=0.05

Table 4
Multivariable Analysis of Anal Incontinence Symptoms and Risk Factors

Variable	Adjusted Odds Ratio	95% Confidence Interval	p-value
Episiotomy			
No	1.000 (reference)	0.94-8.14	0.07
Yes	2.76		
Primary Race			
Non-White	1.000 (reference)	1.35-16.02	0.015
White	4.64		
Duration 2 nd Stage of Labor (unit=30 minute decrease)	1.47	1.12-1.92	0.004