Influence of the duration of the second stage of labor on the likelihood of obstetric anal sphincter injury

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Abstract (247)

Background: Duration of the second stage of labor has been suggested as an independent risk factor for clinically detectable obstetric anal sphincter injury in low-risk nulliparous women.

Methods: A retrospective 5-year cohort study in a UK obstetrics center including high-risk delivery unit and low-risk birthing center. 4831 nulliparous women with vertex-presenting, single, live-born infants at term were included. The cohort was stratified according to spontaneous or instrumental delivery. Binary logistic regression models were used to examine the association between duration of second stage and sphincter injury.

Results: 325 of 4831 women (6.7%) sustained sphincter injuries. In spontaneously delivering women, there was no association between duration of the second stage and the likelihood of sustaining sphincter injuries. Factors associated with increased likelihood of sustaining sphincter injury included older maternal age, higher birthweight and Southeast Asian ethnicity. By contrast, for women undergoing instrumental delivery, a longer second stage was associated with an increased sphincter injury risk of 6% per 15 minutes in the second stage of labor prior to delivery.

Conclusions: For spontaneous vaginal deliveries, duration of the second stage of labor is not an independent risk factor for obstetric anal sphincter injuries. The association between prolonged second stage and sphincter injury for instrumental deliveries is likely explained by the risk posed by the use of the instruments themselves or by delay in initiating instrumental assistance. Attempts to modify the duration of the second stage for prevention of sphincter injuries are unlikely to be beneficial and may be detrimental.

Keywords: obstetric anal sphincter injury; second stage of labor, vaginal delivery

Introduction

Obstetric anal sphincter injury (OASIS) is a common birth complication, which carries long-term health implications for women including problems with continence (1, 2), pain (3), dyspareunia (4) and psychological trauma (5). In the UK, the rate of OASIS in primiparous women delivering vaginally has increased three-fold from 1.8% to 5.9% between 2000 and 2012 (6). The rising trend may be partly due to the changing demographics of the obstetric population, but it may also be attributable to wider awareness of standardized perineal assessment and tear recognition at delivery.

Understanding the risk factors for OASIS as clearly as possible is important for identifying interventions that might help to lower increasing rates. Many established risk factors for OASIS, such as birthweight (7) and ethnicity (8) are not modifiable. However, intra-partum factors, such as duration of the second stage of labor, are especially important, as they may be modifiable if recognized. Both second stage lasting >2 hours (7, 9, 10) and rapid second stage (11) have been suggested as risk factors. Yet the relationship between OASIS risk and the duration of the second stage is complex and highly susceptible to confounding (12). Prolonged second stage is an indication for instrumental delivery (13), which in turn confers a higher risk of OASIS, particularly when forceps are used (7, 10). Moreover, there may be other potential confounding relationships, such as a prolonged second stage when birthweight is high or when the mother is older.

Previous work has identified multiple risk factors for OASIS (7, 10) but has not specifically attempted to isolate the contribution of the duration of the second stage from the risk associated with instrumental delivery (6, 11, 14). The objective of our study is to determine

whether there is an association between second stage duration and risk of OASIS that is independent of the association with other confounding variables.

Methods

Study population

A cohort of all nulliparous women with vertex-presenting, single, live-born infants at term (37–42 completed weeks of gestation), who underwent vaginal delivery (spontaneous or instrumental) within a 5-year period in a single tertiary obstetrics center in the UK was identified. The influence of previous deliveries, particularly where previous OASIS has occurred, on the subsequent risk of OASIS is complex (15, 16), as is the relationship with subsequent anal continence (17). Thus, to avoid potential confounding by parity, only nulliparous women were included in our sample. Data were obtained from the hospital's electronic maternity data-recording system. Data regarding the pregnancy, labor, and delivery were recorded by midwives shortly after the birth. Deliveries that occurred outside the high-risk delivery unit or the low-risk midwifery led birthing unit (either unplanned delivery elsewhere or planned home birth) were not included.

Variables

The perineum was inspected by the delivering midwife or obstetrician shortly after delivery. In cases where the degree of injury was in doubt, a second opinion was sought, as is routine practice in our center. Perineal trauma was classified according to the system adopted by the Royal College of Obstetricians and Gynaecologists UK and the International Consultation on Incontinence (18, 19).

Characteristics of the maternal-fetal dyad were extracted from the Protos database, including maternal age (at time of delivery), body mass index (BMI) at first trimester prenatal booking, ethnicity and birthweight. Birthweight was recorded to the nearest gram. Variables related to the delivery were also obtained from the database, including whether epidural analgesia was used prior to the delivery, whether shoulder dystocia occurred, the length of time between diagnosis of second stage and the time of delivery (time in second stage), and the place of delivery (high-risk delivery unit or low risk midwife led unit). Gestational age was recorded to the nearest week. Instrumental deliveries were conducted with both forceps and ventouse. Ventouse devices available in the unit included posterior metal cup, silastic cup and Kiwi Omnicup.

Restrictive use of episiotomy is practiced in our center, with all those performing deliveries trained exclusively in the use of mediolateral episiotomy. The use of episiotomy in our center is in keeping with UK national guidance on intrapartum care (20) and is typical of a UK institution.

Statistical analyses

Group-wise comparisons were carried out using Student's t-test for continuous numerical data and Chi squared tests for categorical data. Binary logistic regression was used to model the relationship between sustaining OASIS and time in second stage, with birthweight, maternal age, maternal BMI, place of delivery, shoulder dystocia, ethnicity, and use of epidural analgesia included as covariates. These covariates were selected on the basis of clinical relevance, and we used the Bayesian Information Criterion to optimize model fit as far as possible. The frequency of mediolateral episiotomy in our cohort is low (<5%), and its inclusion did not improve the model fit or change the magnitude or statistical significance of

any other model coefficient. To account for the interaction between mode of delivery and duration of the second stage, and also for any other synergistic relationships between mode of delivery and other covariates in the model, the cohort was stratified according to method of delivery (spontaneous versus instrumental). Findings were considered statistically significant at an alpha level of 0.05. All analyses were conducted using the R statistical software package version 2.14.1.

Data were collected as part of a service evaluation project for the obstetrics center. There were no human or animal subjects, and individual medical records were not accessed. No patient identifiable information was available to the authors. Institutional Review Board approval was therefore not required.

Results

Group-wise comparisons between spontaneous and instrumental deliveries

The distribution of perineal trauma in our study population is shown in Table 1. 325 out of 4831 women (6.7%) sustained OASIS. The majority of OASIS were classified as IIIa (<50% of the external sphincter involved) tears (84.5%). The overall rate of fourth degree perineal damage was 0.3%.

Incidence of OASIS was compared according to the characteristics of the maternal-fetal dyad and the delivery type (Table 2). Women who sustained OASIS at spontaneous delivery were older (mean 29.5 years v. 28.2 years, $p<0.001$), but there was no difference for women undergoing instrumental delivery. Birthweight was also significantly higher among spontaneously delivering women who sustained OASIS (mean 3370g v. 3535g, $p<0.001$) but

not among women who had instrumental delivery. There was no significant difference in BMI in either group. Women of Southeast Asian or black ethnicity delivering spontaneously were significantly more likely to sustain OASIS than Caucasian women ($p<0.001$). The rates were 14.4% in Southeast Asian women and 12.2% in women of black African origin versus 6.0% of Caucasian women. This difference was not apparent in the instrumental delivery group. In women who underwent instrumental delivery, average length of the second stage was longer in women who sustained OASIS (mean 147.4 minutes v. 127.6 minutes, $p<0.05$). No such difference exists for spontaneously delivering women. In both spontaneously delivering and instrumental delivery groups, the rates of OASIS were higher where no epidural analgesia was used ($p<0.001$). The overall rate of shoulder dystocia in our population was 1.4%, and women who experienced this complication at spontaneous delivery were more likely to sustain OASIS ($p<0.05$).

Figure 1 shows the distribution of second stage lengths, arranged in 15-minute intervals. Absolute numbers of women delivering within each interval are shown, with pale grey bars representing women who did not sustain OASIS, compared to the dark grey bars representing those who did. The ratio between the pale and dark grey areas thus represents the rate of OASIS in each interval. The rate of OASIS increases with increased time in second stage across the whole population ($p<0.05$, Figure 1a). In spontaneously delivering women, 1185 of 3853 deliveries (30.8%) occurred within 30 minutes of the diagnosis of second stage, and a further 1025 (26.6%) between 30 minutes and 1 hour (Figure 1b). For spontaneous vaginal deliveries there was no difference in OASIS rates across different lengths of second stage. By contrast, only 211 of 978 (21.6%) of instrumental deliveries occurred within the first hour of the second stage (Figure 1c). For instrumental deliveries, OASIS rates increased with time in second stage ($p<0.05$).

Regression analyses stratified by mode of delivery

For nulliparous women undergoing spontaneous vaginal delivery there was no association between the length of the second stage and the risk of OASIS (Table 3). A higher risk of OASIS was associated with increased birthweight (OR 1.11 per 100g increase (95% CI 1.08-1.15), $p<0.001$), higher maternal age (OR 1.04 (95% CI 1.01–1.07), $p<0.01$), not having epidural analgesia (OR 1.80 (95% CI 1.22-2.69), $p<0.001$), and Southeast Asian ethnicity (OR 2.73 (95% CI 1.57–4.55), $p<0.001$). There was also an association with increased risk in the black population ($p<0.1$), but this was not statistically significant. Higher BMI was associated with a decreased risk of OASIS (OR 0.96 (95% CI 0.92–0.99), $p<0.05$). However, as our study population was predominantly within normal BMI range (73.2% with a BMI of <25, and only 27.8% with a BMI≥25), there may not be a protective effect of BMI above the normal range. There was no difference in OASIS rates for women undergoing spontaneous vaginal delivery on the delivery unit versus the midwifery led unit. There was also an increased risk of OASIS in women who experienced shoulder dystocia at delivery (OR 2.34 (95% CI 0.83–5.66), $p<0.1$), but this association was not statistically significant.

For women who underwent instrumental delivery, a higher risk of OASIS was associated with a longer duration of second stage (OR 1.06 per 15 minute increase (95% CI 1.01-1.11), $p<0.01$) (Table 3). There was an increased risk of OASIS where no epidural analgesia was used (OR 2.55 (95% CI 1.54-4.29), $p<0.001$). For women who underwent instrumental delivery, there was no influence of maternal age, maternal BMI, ethnicity or birthweight on OASIS risk.

Discussion

In a cohort of spontaneously delivering nulliparous women, we found no association between duration of the second stage of labor and the likelihood of sustaining OASIS. This implies that interventions to limit the length of the second stage (for example intervening with the use of instruments or syntocinon) for the specific purpose of reducing OASIS risk are likely to be ineffective and potentially counter-productive. By contrast, for women who underwent instrumental delivery, a longer second stage was associated with increased risk of OASIS. The magnitude of this risk was a 6% increase for every 15 minutes in the second stage of labor prior to delivery. This increase may seem marginal, but in the context of a second stage that lasts for several hours, the cumulative risk would be substantial. Therefore, decisions about whether or not instrumental assistance is necessary should not be delayed, and if a need for instrumental delivery in the second stage is identified (for example suspected fetal distress or maternal exhaustion), it is advantageous from the point of view of minimizing OASIS risk to proceed as quickly as is safely possible.

The results obtained from stratifying according to mode of delivery imply that the relationship previously postulated between the length of second stage and OASIS is due to the complex interaction between mode of delivery and the length of the second stage. Other interactions, including with maternal age and birthweight may also contribute to the complexity of the relationship between delivery type and OASIS risk. We demonstrate that where instrumental delivery is undertaken in the context of a longer second stage of labor, OASIS risk appears to be increased. It is important that obstetricians undertaking instrumental delivery after a long second stage are aware that an extra risk of OASIS may exist for these deliveries. Furthermore, our results suggest that the decision to undertake instrumental deliveries should

made as promptly as possible, as delay could further prolong second stage, leading to increased likelihood of OASIS.

The major strength of our study is that we are able to isolate the contribution of duration of the second stage to OASIS risk. By stratifying a nulliparous population according to mode of delivery, we remove the potentially confounding influences of previous OASIS and previous birth. Moreover, nulliparous women are a particularly important population in which to clarify the contribution of second stage duration, since they are among the most at risk of both sustaining OASIS and experiencing longer second stage. The influence of the length of the second stage in multiparous women is likely to be more complex as it is influenced by previous mode of delivery and is a target for future research.

The influence of epidural analgesia on the likelihood of OASIS has been a source of controversy, with some studies finding increased rates with epidural analgesia (21), whereas other studies have found decreased rates (22), as we do here. In our population of spontaneously delivering women, there was no detrimental effect of epidural analgesia. On the contrary, our findings suggest a protective influence of epidural, which may be related to increased control of fetal head delivery due to reduced maternal pain and distress (23). Control of fetal head during delivery to reduce perineal damage is an area of current controversy, with a recent systematic review of ‘hands on’ rather than ‘hands off (poised)’ technique demonstrating no benefit in reducing the OASIS rate (24). There may, however, be a significant benefit of warm compresses to the perineum or massage in reducing perineal trauma rates (24).

A further complicating issue is that we cannot assess the relative contributions of the passive and the active second stage to the likelihood of sustaining OASIS using our data. Additionally, labor augmentation data were not available to us. Our study was performed within a center where restrictive use of medio-laternal episiotomy is practiced, as is typical in the UK setting. Given that previous studies have revealed that mid-line episiotomy is a risk factor for OASIS (14), and that risk is reduced where mediolateral episiotomy is given with a larger angle from the midline (25), the findings from our cohort may not be generalizable to populations where more liberal or midline episiotomy is practiced, or where other aspects of the conduct of vaginal deliveries are significantly different.

In common with our findings, other studies have also found OASIS to be more likely in parturients of Southeast Asian ethnicity (6, 8, 26, 27). It has been suggested that this difference may correspond to anatomical variation in the perineal anatomy between ethnicities (8). In particular, shorter length of the perineal body may be a risk factor (28), although it is not certain that the perineal body is more likely to be short in women of Asian origin (29).

Despite the lack of correlation between longer second stage of labor and OASIS in spontaneously delivering women, a long second stage may still be detrimental to the pelvic floor in the long term. Prolonged labor increases the risk of pubovisceral muscle avulsion (30), which may be associated with later pelvic floor dysfunction and pelvic organ prolapse. Furthermore, not all OASIS are clinically detectable at the time of delivery (31). We have limited our analysis to those injuries that were detectable by the obstetrician or midwife at the time of delivery. However this does not exclude the possibility of occult sphincter injuries that may cause longer-term morbidity, but which would only be picked up using endo-anal

ultrasound. Use of routine endo-anal ultrasound after vaginal delivery is not routine in our center, although some evidence exists that this might improve outcomes (32). Occult injury remains a possibility even in the context of very careful perineal inspection, particularly as injuries may be masked by intact tissue (33).

Our conclusion that duration of second stage is not an independent risk factor for OASIS in women undergoing spontaneous vaginal delivery, has two important implications for intrapartum care. Firstly, for clinicians, our results imply that intrapartum interventions to shorten the duration of the second stage for the specific purpose of reducing OASIS rates would be unlikely to benefit women. The second implication of the study derives from the fact that OASIS rates are an increasingly valuable indicator of maternity unit performance (34) for standard-setting purposes. However, there are two major issues with using a unit's OASIS rates in this way. The first is the paradox associated with data collection for studies of OASIS - that improved education and recognition of OASIS results in an apparent increase in incidence, (6, 34). It is therefore difficult to compare tear rates between units, as those with a higher reported rate could have better OASIS awareness. The second is that independent risk factors for OASIS must be defined as accurately as possible to prevent unreliable conclusions regarding unit performance. Our study adds to the ability to establish accurate individualized risk-based models by characterizing the relationship between the duration of the second stage and risk of OASIS for both spontaneous vaginal deliveries and instrumental deliveries.

Authorship contributions

CA, AA and AP conceived of and designed the study. CA collected and analyzed the data. CA, AA and AP interpreted the data and wrote the manuscript.

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413 **Table 1:** Distribution of all perineal trauma in nulliparous women undergoing spontaneous

414 vaginal delivery

Tear Type	Number of parturients (4831)	Rate
None	1196	24.8%
First (Injury to the perineal skin only)	544	11.3%
Second (Injury to perineum involving perineal muscles but not involving the anal sphincter)	2766	57.3%
Third (Injury to perineum involving the anal sphincter complex):		
a (Less than 50% of external anal sphincter thickness torn)	262	5.3%
b (More than 50% of external anal sphincter thickness torn)	37	0.8%
c (Both external and internal anal sphincter torn)	11	0.2%
Fourth (Injury to perineum involving the anal sphincter complex and anal epithelium)	15	0.3%

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416 N = 4831. Tears are classified according to the system adopted by the Royal College of

417 Obstetricians and Gynaecologists and the International Consultation on Incontinence.

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420 **Table 2**: Sample characteristics stratified by mode of delivery and whether or not OASIS
421 occurred.
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Characteristic	**All patients (4831)**	**Spontaneous vaginal delivery (3853)**		**Instrumental delivery (978)**	
		No sphincter injury (3603)	*Sphincter injury (250)*	*No sphincter injury (903)*	*Sphincter injury (75)*
Maternal Age (mean)	28.6	28.2	29.5***	29.4	30.3
Maternal BMI (mean)	23.9	23.9	23.5	24.1	23.7
Birthweight (g) (mean)	3389	3370	3535***	3421	3444
Gestation (weeks) (mean)	39.7	39.6	39.8	39.7	39.9
Duration of second stage (minutes) (mean)	78.1	64.8	68.2	127.6	147.4*
Est. blood loss (ml) (mean)	380.1	346.5	544.1**	453.9	560.7**
Ethnicity					
Caucasian	4235	3163	203***	793	64
Southeast Asian	253	173	29	45	5
Black	60	43	6	10	1
Chinese	103	79	4	18	1
Other/Unknown	180	134	5	37	4
Epidural					
Yes	2823	934	43***	513	27
No	1518	2201	176	390	48
Unknown	490	457	28	0	0
Place of delivery					
Delivery Unit	3857	2678	190	903	75
Midwife-led	953	893	57	0	0
Unknown	21	21	0	0	0
Shoulder dystocia					

Yes	4729	47	7*	43	4
No	102	3545	240	860	71

N = 4831. Data are summarized by the mean for continuous variables and n for categorical variables. Student's t-test was used for continuous numerical data and Chi squared analysis for categorical data. * $p<0.05$, ** $p<0.01$, ***$p<0.001$

Table 3: Binary logistic regression of characteristics affecting the likelihood of OASIS in spontaneous vaginal deliveries and instrumental deliveries.

Variable	*Spontaneous delivery OR (95% CI)*	*Instrumental delivery OR (95% CI)*
Duration of second stage (per 15 minutes)	1.00 (0.95 - 1.05)	1.06 (1.01 - 1.11)**
Birthweight (per 100g)	1.11 (1.08 – 1.15)***	1.00 (0.99 – 1.00)
Maternal age	1.04 (1.01 – 1.07)**	1.02 (0.97 – 1.06)
Maternal BMI	0.96 (0.92 - 0.99)*	0.99 (0.99 – 1.00)
Ethnicity – Caucasian	Ref	Ref
Ethnicity – Southeast Asian	2.73 (1.56 – 4.55)***	1.53 (0.50 – 3.85)
Ethnicity – black	2.45 (0.81 – 6.01)†	1.71 (0.10 – 9.79)
Ethnicity – Chinese	0.79 (0.19 – 2.20)	0.77 (0.04 – 4.20)
Ethnicity – other	0.81 (0.24 – 2.00)	1.91 (0.54 – 5.34)
Place – Delivery unit	Ref	NA
Place – Midwifery-led	0.76 (0.52 – 1.09)	NA
Shoulder dystocia – yes	2.34 (0.83 - 5.66) †	0.94 (0.26 – 2.59)
Shoulder dystocia – no	Ref	Ref
Epidural analgesia – yes	Ref	Ref
Epidural analgesia – no	1.80 (1.22 – 2.69)***	2.55 (1.54 – 4.29)***

N = 3853 for spontaneous deliveries. N = 978 for instrumental deliveries. Model coefficients are expressed as odds ratio and 95% confidence intervals (CI).

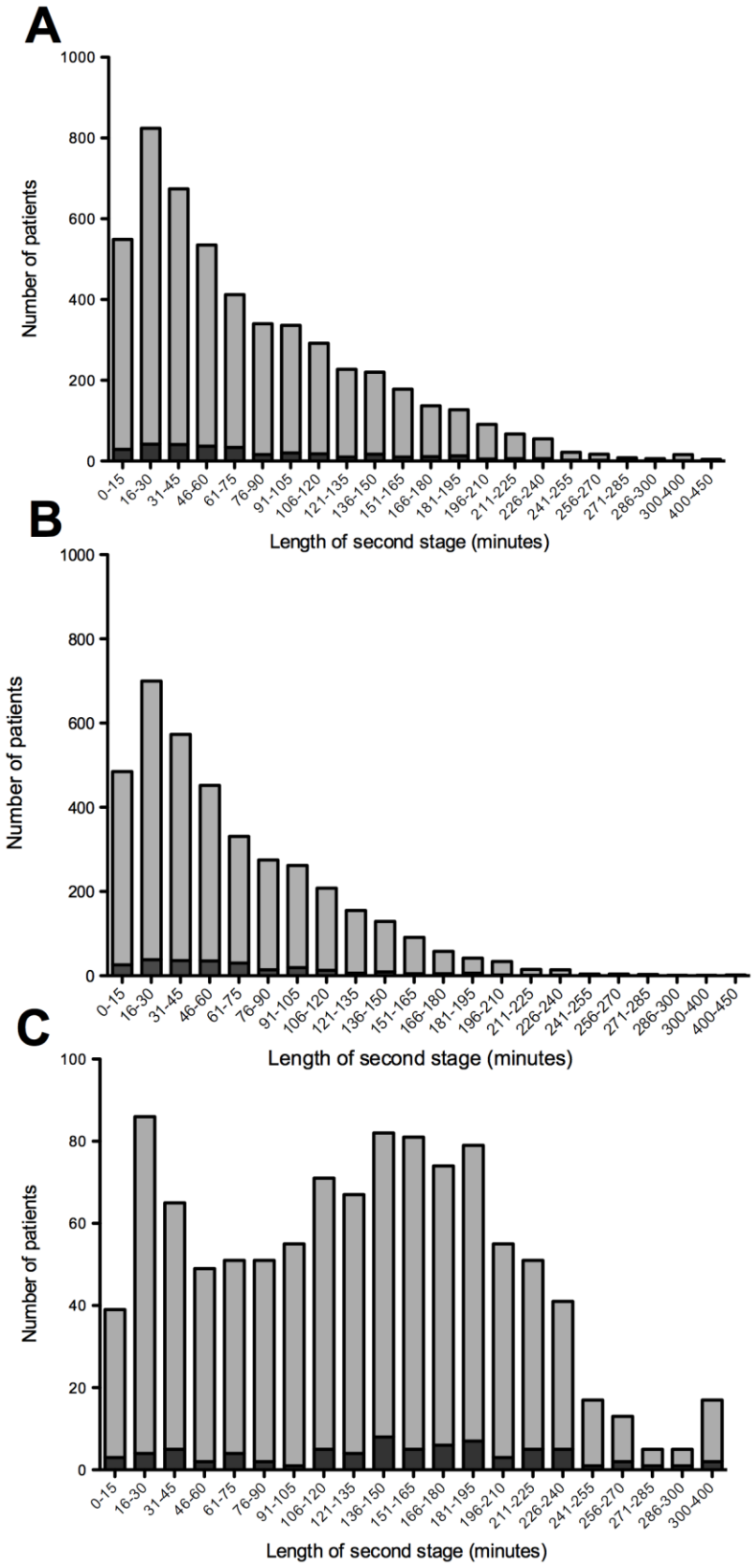
† $p<0.1$, * $p<0.05$, ** $p<0.01$, ***$p<0.001$

Figure 1: OASIS likelihood with varying duration of second stage. Second stage length is divided into 15-minute intervals.

1A) Number of parturients delivering without OASIS (light grey bars) and number of parturients delivering with OASIS (dark grey bars). n=4831

1B) Number of parturients delivering spontaneously without OASIS (light grey bars) and number of parturients spontaneously delivering with OASIS (dark grey bars). n=3853

1C) Number of parturients delivering via instrumental delivery without OASIS (light grey bars) and number of parturients delivering via instrumental delivery with OASIS (dark grey bars). n=978, y axis scale changed.


A
Number of patients
1000
800
600
400
200
0
0-15
16-30
31-45
46-60
61-75
76-90
91-105
106-120
121-135
136-150
151-165
166-180
181-195
196-210
211-225
226-240
241-255
256-270
271-285
286-300
300-400
400-450
Length of second stage (minutes)
B
Number of patients
1000
800
600
400
200
0
0-15
16-30
31-45
46-60
61-75
76-90
91-105
106-120
121-135
136-150
151-165
166-180
181-195
196-210
211-225
226-240
241-255
256-270
271-285
286-300
300-400
400-450
Length of second stage (minutes)
C
Number of patients
100
80
60
40
20
0
0-15
16-30
31-45
46-60
61-75
76-90
91-105
106-120
121-135
136-150
151-165
166-180
181-195
196-210
211-225
226-240
241-255
256-270
271-285
286-300
300-400
Length of second stage (minutes)

451