

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

3

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19

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22

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40 **Abstract (247)**

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

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

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

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

62

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

64 **Introduction**

65

66 Obstetric anal sphincter injury (OASIS) is a common birth complication, which carries long-
67 term health implications for women including problems with continence (1, 2), pain (3),
68 dyspareunia (4) and psychological trauma (5). In the UK, the rate of OASIS in primiparous
69 women delivering vaginally has increased three-fold from 1.8% to 5.9% between 2000 and
70 2012 (6). The rising trend may be partly due to the changing demographics of the obstetric
71 population, but it may also be attributable to wider awareness of standardized perineal
72 assessment and tear recognition at delivery.

73

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

85

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

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

91

92 **Methods**

93

94 *Study population*

95 A cohort of all nulliparous women with vertex-presenting, single, live-born infants at term
96 (37–42 completed weeks of gestation), who underwent vaginal delivery (spontaneous or
97 instrumental) within a 5-year period in a single tertiary obstetrics center in the UK was
98 identified. The influence of previous deliveries, particularly where previous OASIS has
99 occurred, on the subsequent risk of OASIS is complex (15, 16), as is the relationship with
100 subsequent anal continence (17). Thus, to avoid potential confounding by parity, only
101 nulliparous women were included in our sample. Data were obtained from the hospital's
102 electronic maternity data-recording system. Data regarding the pregnancy, labor, and delivery
103 were recorded by midwives shortly after the birth. Deliveries that occurred outside the high-
104 risk delivery unit or the low-risk midwifery led birthing unit (either unplanned delivery
105 elsewhere or planned home birth) were not included.

106

107 *Variables*

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

113

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

124

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

129

130 *Statistical analyses*

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

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

145

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

150

151 **Results**

152

153 *Group-wise comparisons between spontaneous and instrumental deliveries*

154 The distribution of perineal trauma in our study population is shown in Table 1. 325 out of
155 4831 women (6.7%) sustained OASIS. The majority of OASIS were classified as IIIa (<50%
156 of the external sphincter involved) tears (84.5%). The overall rate of fourth degree perineal
157 damage was 0.3%.

158

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

164 not among women who had instrumental delivery. There was no significant difference in BMI
165 in either group. Women of Southeast Asian or black ethnicity delivering spontaneously were
166 significantly more likely to sustain OASIS than Caucasian women ($p<0.001$). The rates were
167 14.4% in Southeast Asian women and 12.2% in women of black African origin versus 6.0%
168 of Caucasian women. This difference was not apparent in the instrumental delivery group. In
169 women who underwent instrumental delivery, average length of the second stage was longer
170 in women who sustained OASIS (mean 147.4 minutes v. 127.6 minutes, $p<0.05$). No such
171 difference exists for spontaneously delivering women. In both spontaneously delivering and
172 instrumental delivery groups, the rates of OASIS were higher where no epidural analgesia
173 was used ($p<0.001$). The overall rate of shoulder dystocia in our population was 1.4%, and
174 women who experienced this complication at spontaneous delivery were more likely to
175 sustain OASIS ($p<0.05$).

176
177 Figure 1 shows the distribution of second stage lengths, arranged in 15-minute intervals.
178 Absolute numbers of women delivering within each interval are shown, with pale grey bars
179 representing women who did not sustain OASIS, compared to the dark grey bars representing
180 those who did. The ratio between the pale and dark grey areas thus represents the rate of
181 OASIS in each interval. The rate of OASIS increases with increased time in second stage
182 across the whole population ($p<0.05$, Figure 1a). In spontaneously delivering women, 1185 of
183 3853 deliveries (30.8%) occurred within 30 minutes of the diagnosis of second stage, and a
184 further 1025 (26.6%) between 30 minutes and 1 hour (Figure 1b). For spontaneous vaginal
185 deliveries there was no difference in OASIS rates across different lengths of second stage. By
186 contrast, only 211 of 978 (21.6%) of instrumental deliveries occurred within the first hour of
187 the second stage (Figure 1c). For instrumental deliveries, OASIS rates increased with time in
188 second stage ($p<0.05$).

189

190 *Regression analyses stratified by mode of delivery*

191 For nulliparous women undergoing spontaneous vaginal delivery there was no association
192 between the length of the second stage and the risk of OASIS (Table 3). A higher risk of
193 OASIS was associated with increased birthweight (OR 1.11 per 100g increase (95% CI 1.08-
194 1.15), $p<0.001$), higher maternal age (OR 1.04 (95% CI 1.01–1.07), $p<0.01$), not having
195 epidural analgesia (OR 1.80 (95% CI 1.22-2.69), $p<0.001$), and Southeast Asian ethnicity
196 (OR 2.73 (95% CI 1.57–4.55), $p<0.001$). There was also an association with increased risk in
197 the black population ($p<0.1$), but this was not statistically significant. Higher BMI was
198 associated with a decreased risk of OASIS (OR 0.96 (95% CI 0.92–0.99), $p<0.05$). However,
199 as our study population was predominantly within normal BMI range (73.2% with a BMI of
200 <25 , and only 27.8% with a BMI ≥ 25), there may not be a protective effect of BMI above the
201 normal range. There was no difference in OASIS rates for women undergoing spontaneous
202 vaginal delivery on the delivery unit versus the midwifery led unit. There was also an
203 increased risk of OASIS in women who experienced shoulder dystocia at delivery (OR 2.34
204 (95% CI 0.83–5.66), $p<0.1$), but this association was not statistically significant.

205

206 For women who underwent instrumental delivery, a higher risk of OASIS was associated with
207 a longer duration of second stage (OR 1.06 per 15 minute increase (95% CI 1.01-1.11),
208 $p<0.01$) (Table 3). There was an increased risk of OASIS where no epidural analgesia was
209 used (OR 2.55 (95% CI 1.54-4.29), $p<0.001$). For women who underwent instrumental
210 delivery, there was no influence of maternal age, maternal BMI, ethnicity or birthweight on
211 OASIS risk.

212

213 **Discussion**

214

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

228

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

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

240

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

249

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

261

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

271

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

278

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

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

291

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

307

308

309 **Authorship contributions**

310 CA, AA and AP conceived of and designed the study. CA collected and analyzed the data.

311 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% |

415

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 |

423

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

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430

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

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| <i>Variable</i> | <i>Spontaneous delivery</i> | <i>Instrumental delivery</i> |
|---|-----------------------------|------------------------------|
| | <i>OR (95% CI)</i> | <i>OR (95% CI)</i> |
| 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)*** |

435

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

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

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440

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

443 1A) Number of parturients delivering without OASIS (light grey bars) and number of
444 parturients delivering with OASIS (dark grey bars). n=4831

445 1B) Number of parturients delivering spontaneously without OASIS (light grey bars) and
446 number of parturients spontaneously delivering with OASIS (dark grey bars). n=3853

447 1C) Number of parturients delivering via instrumental delivery without OASIS (light grey
448 bars) and number of parturients delivering via instrumental delivery with OASIS (dark grey
449 bars). n=978, y axis scale changed.

450

