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Research article

Can we predict obstetric anal sphincter injury?☆

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ABSTRACT

Objective: The aim of the study was to identify primiparous pregnant women with a higher risk for obstetric anal sphincter injuries (OASIS) based on obstetric characteristics (risk factors).
Study design: In the retrospective case control study primiparous women were examined using endoanal ultrasonography (EUS) for OASIS identification 6–12 weeks after delivery. Obstetric characteristics for OASIS were collected from the mothers' medical records. The univariate analysis of maternal (age at delivery, maternal height, weight, BMI), infant (length, weight and head circumference) and birth (pregnancy duration, labour and delivery duration, episiotomy, vacuum extraction and oxytocin augmentation) risk factors, Pearson correlations and information gain were carried out. The cut-off values for the aforementioned risk factors divided the patients into groups with higher and lower risk of OASIS.
Results: The data of 84 primiparous women with OASIS, and 58 without, were analysed. Those newborns born to women in the OASIS group were heavier ($P < 0.05$), with the cut-off at 3420 g (72% probability of OASIS), had a larger head circumference ($P < 0.001$), cut-off at 36 cm (84% probability of OASIS), and were longer ($P < 0.05$), cut-off at 50.5 cm (74% probability of OASIS). The maternal age and body mass index (BMI) were risk factors for OASIS ($P < 0.05$ and $P < 0.05$, respectively) with a probability of 83% in women younger than 27.5 years and a 78% probability if BMI was higher than 28 kg/m^2. The incidence of OASIS was not higher in women with episiotomy or vacuum extraction, but it was higher in oxytocin augmentation ($P < 0.031$).
Conclusion: The findings can assist in identification of pregnant women with a higher risk of OASIS who require special attention at delivery to prevent it. In high risk women EUS is indicated to identify and treat possible OASIS as early as possible in order to prevent anal incontinence.

Introduction

The most devastating complication of anal sphincter injury is anal incontinence, defined as an involuntary loss of flatus, liquid or solid stool, which is a serious social and hygienic problem [1]. The most common risk factor for late-onset anal incontinence is a third-degree tear that occurs during vaginal delivery [2]. Clinically undiagnosed tears are associated with subsequent late-onset anal incontinence in 77% of affected patients [3]. Perineal injury during vaginal delivery can remain unrecognized until the presence of persistent anorectal complaints. Such complaints have an important negative impact on the quality of life, as well as on the decision for the type of delivery in future pregnancies [4]. In order to prevent the overlooking of obstetric anal sphincter injuries (OASIS), endoanal endosonography (EUS) can be used. It allows the diagnosis of clinically undiagnosed tears. The incidence of clinically diagnosed OASIS in Slovenia is according to Europeristat (2010) 0.2% [5]. In the recent study the occult tears were detected by ultrasonography in 11, 5% [6]. According to the literature EUS is the gold standard for detection of OASIS and it is far superior to a clinical examination [7].

The most commonly used classification of anal sphincter injury is described by Sultan: 3a – the injury of less than half of the external anal sphincter, 3b – the injury of more than half of the external sphincter and 3c – the injury of the external and internal anal sphincter, 4 – the injury of the anal sphincter and mucosa of the anus [8]. However, the literature still lacks an appropriate classification of risk factors that would help predict the possibility

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of OASIS during obstetric care [9]. The aim of the study was to identify primiparous pregnant women with a higher risk for OASIS based on possible obstetric risk factors. We chose to evaluate maternal, newborn, labour and delivery possible risk factors. The information provided from this study can assist in the identification of pregnant women at a higher risk of OASIS with the aim of minimizing the incidence of anal incontinence due to delivery.

Materials and methods

The retrospective case control study was conducted at the Division of Gynaecology and Obstetrics, University Medical Centre Ljubljana, Slovenia. This study followed the institutional requirements and was evaluated and approved by the Republic of Slovenia National Medical Ethics Committee (NMEC). Informed consent was signed by all participants in the study. The study took place from January 2010–December 2015. We retrospectively analysed the data of two groups. The first group was composed of 78 patients who had clinically-diagnosed OASIS and fulfilled the inclusion criteria for the study, which were: primiparity, singleton delivery in cephalic presentation, without anal pathology before delivery. All the patients who gave birth at the University medical centre Ljubljana with clinically diagnosed OASIS and who agreed to have EUS were included in the study. The clinical diagnosis of OASIS was made immediately after the delivery in the delivery room by endoanal digital palpation and visual examination of the injured perineum. The second group were 64 parturients after first delivery that did not have clinically detected OASIS, but fulfilled the inclusion criteria and consented to participate in the study. All the parturients delivered at the University Medical Centre Ljubljana.

The EUS examination in both groups was performed 6–12 weeks after delivery.

Out of sixty four women without clinically detected OASIS, six had OASIS diagnosed with EUS. According to findings of the EUS examination the women were divided in the test group with an ultrasonographically proven OASIS and control group without an ultrasonographically proven OASIS.

The ultrasound examination and possible obstetric characteristics (risk factors) for anal sphincter injury were collected from the medical records; those were maternal (age at delivery, maternal height, weight, BMI), infant (length, weight and head circumference) and labour (pregnancy duration, labour and delivery duration, episiotomy, vacuum extraction and oxytocin augmentation) risk factors.

In all women a three dimensional (3D) EUS was performed with a BK 2050 probe (BK Medical, Sandhoften, Denmark), which has a high multi frequency (6–16 MHz) and a 360 ° rotational mechanical capability.

The probe was inserted into the anal canal and the anal sphincter was examined from the proximal part where the external anal sphincter forms a complete ring to the most distal part, where the internal anal sphincter terminates. The continuity of the anal sphincter ring was checked. The ultrasound image of the potential injury of the anal sphincter was made and its depth was measured. As the sphincter is circular, the injury was recorded according to the clock (Twelve o'clock being anterior and six posterior). This is illustrated in Fig. 1.

The width of the injury of the circular sphincter was not taken into the statistical analysis because all of the clinically detected injured sphincters were repaired either end-to-end or over-lap with 3.0 absorbable polyglycolic sutures by the obstetrics and gynecology specialist.

The depth of the injury was also measured and classified according to Sultan's classification [8].

For the analysis we did not distinguish between patients based on the injury type, rather they were all regarded as patients from the OASIS group.

Numeric variables are presented with the mean, standard deviation, range, and median; descriptive variables are presented with the absolute number and proportion. The risk factors were evaluated using univariate, multivariate analysis. Pearson correlation and information gain (i.e. Kullback-Leibler divergence) were described. Chi-square test for association between two categorical variables was used. The statistical significance was set at a P-value of <0.05 in all analyses. The program used for statistics was Microsoft office Excel 2007 (Microsoft, Redmond, Washington, USA) and SPSS Version 22.0 (IBM Corp., Armonk, NY, USA). For determining the cut- off values WEKA 3.8.0. (University of Waikato, Hamilton, New Zealand), Orange 2.7 (University of Ljubljana, Ljubljana, Slovenia) and RapidMiner 7.0 (RapidMiner, Boston, Massachusetts, USA) were used. In order to determine the optimal cut-off values for the numeric parameters, Bayes supervised discretization algorithms of continuous parameters were employed [10]. Using a bottom-up approach and dynamic programming we selected the intervals that maximized the information gain of the discretized parameter. According to the population size, we decided to use only two intervals for discretization. As a result, for each parameter we calculated the

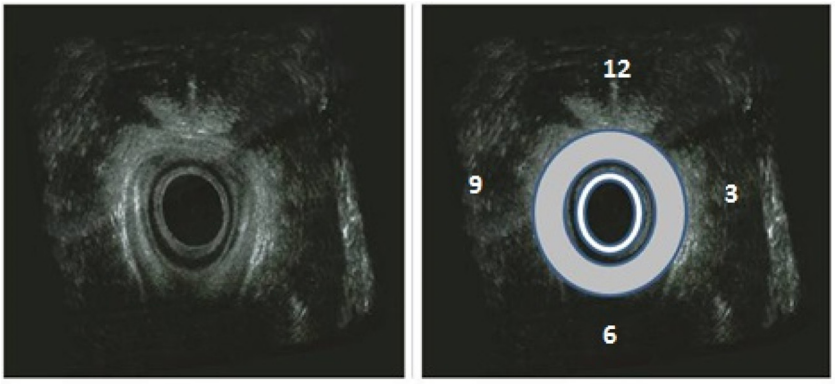

Fig. 1. An example of the EUS assessment. On the left, the anatomy of the anal sphincter is visible and on the right the external anal sphincter is colored light gray. The mucosa is colored white. The internal anal sphincter is seen between external anal sphincter (gray circle) and mucosa (white circle). Location, depth and width of the injury can be described according to the clock.

Table 1
Maternal, obstetric and neonatal variables and their correlation with OASIS (Correl. – Pearson correlation, P – P value, N – number of patients for which the particular parameter was available, μ – mean value and σ – standard deviation), *the time of labour and delivery started when contractions were 5 min apart till complete expulsion of the newborn.

Group			Control group		OASIS group	
Parameter	Correl.	P	N	$\mu \pm \sigma$	N	$\mu \pm \sigma$
Mother's age (years)	−0.191	0.019	58	31.8 ± 3.5	84	30.2 ± 4.2
Mother's weight (kg)	0.144	0.087	58	73.5 ± 11.7	82	78 ± 13.1
Mother's height (cm)	−0.095	0.270	58	168.3 ± 6.2	82	166.9 ± 5.9
Mother's BMI (kg/m2)	0.198	0.019	58	25.9 ± 3.7	82	28 ± 4.3
Pregnancy duration (days)	0.153	0.079	54	275.9 ± 10.2	82	279 ± 9.8
Newborn's weight (g)	0.250	0.002	58	3350.1 ± 393.9	84	3574.6 ± 450.9
Newborn's length (cm)	0.238	0.009	41	51.1 ± 1.8	71	52 ± 1.8
Head circumference (cm)	0.275	0.001	58	34.6 ± 1.4	83	35.3 ± 1.4
Labour and delivery* (h)	−0.072	0.443	54	6.1 ± 3.4	82	6 ± 2.8

optimal cut-off value (CI = 95%), thus obtaining two intervals for which the probability of the patient suffering OASIS during childbirth is considerably different. In order to verify the cut-off values, we also used Fayyad and Irani's method [11] by selecting to use exactly two intervals (i.e. one split point) for each parameter.

Results

The EUS proven OASIS group at the end consisted of 84 women (study group) and the control group (without the EUS proven OASIS) consisted of 58 women.

Out of sixty four women without clinically detected OASIS six (9%) had OASIS diagnosed with EUS, and it shows statistically significant difference (chi-square is 6.295, P = 0.012) between clinical examination and EUS examination.

The characteristics of the study group and the control group are described in Table 1. The number of women per injury type was: 3a – 42, 3b – 28 and 3c – 6. For 8 patients, the injury was rated as third degree, but the subtype could not be measured due to the extensive repair.

Results of the univariate and multivariate analyses of the risk factors: maternal (age at delivery, maternal height, weight, BMI), infant (length, weight and head circumference) and labour (pregnancy duration, labour and delivery duration) are presented in Tables 1 and 2.

There were no women who had forceps extraction and shoulder dystocia in a newborn. Three patients had epidural analgesia. All the patients delivered in Lithotomy position.

For significant numerical parameters, the cut-off values were calculated, as presented in Table 3. The start values in interval 1 are the minimum values, whereas the end values of interval 2 are the maximum values of the corresponding parameter based on the studied population. The higher the information gain (column IG in Table 3), the more valuable the particular parameter is in relation to predicting whether the patient suffered OASIS or not.

For the nominal obstetric parameters that were available for the patients in medical records, we calculated the statistics shown in Table 4.

Discussion

To our knowledge, similar studies that have already been published do not use EUS as diagnostic tool for OASIS. At this time, EUS is the most accurate tool for evaluation of anal sphincter anatomy [7]. We also showed significant difference between clinical and EUS detection of OASIS ($P < 0.05$).

There are not many studies about the influence of maternal age on the incidence of OASIS. Existing studies on this topic disagree on whether maternal age influences the risk of perineal injury or not [12].

Omih's and Lindow's epidemiological research [13] showed that increasing maternal age was an independent risk factor for perineal trauma, but they concluded that overall in multiparous women, advancing maternal age is an independent determinant for the risk of sustaining perineal trauma. In the primiparous group they did not find any differences due to a low incidence of anal sphincter injury.

We found that younger age has a significant impact ($P < 0.05$) on OASIS. According to our study data, the incidence of OASIS was surprisingly less common in older than in younger primiparous patients (53% vs. 83%). Most of the injuries occurred in patients that were younger than 27.5 years. Unlike Omih and Lindow [13], our group was more uniform, including only primiparous women.

We managed to show a statistical correlation ($P < 0.05$) between elevated maternal BMI and the occurrence of perineal injury. In contrast to our study, Schwartz et al.'s research about ethnical groups and risk factors for OASIS [14] failed to confirm a direct link between BMI and OASIS. They were also studying the relative feto-maternal disproportion (newborn's weight and maternal BMI) which appeared to be a stronger predictor of the OASIS. In the Swedish epidemiological study done by Lindholm and Altman [15], overweight and obese patients had less perineal injuries than patients with BMI $< 25\ kg/m^2$. The reason for the result could be that in overweight and obese patients injuries are much harder to detect clinically, which was the method of identification of OASIS in their study. We showed that the injury occurred in 78% of the patients with a BMI more than $28.3\ kg/m^2$, and in 48% of patients with a lower BMI.

Table 2
Risk factors for anal sphincter injury: Multivariate logistic analysis.

Risk factor	Logistic regression OR [95%OR]	Logistic regression P-value
Maternal age	0.49 [0.26–0.91]	0.023
Newborn's head circumference	1.82 [1.12–2.96]	0.015

Table 3
Cut-off values for the most significant parameters; Parameter, Information gain; Interval the range of values for a particular parameter; OASIS and Control columns – number and the percentage of all the patients for which a particular parameter was in the range.

		Interval 1			Interval 2		
Parameter	Information gain	Interval	OASIS group N (%)	Control group N (%)	Interval	OASIS group N (%)	Control group N (%)
Maternal age	0.043	[21,27.5]	20 (83%)	4 (17%)	[27.5, 41]	61 (53%)	54 (47%)
Maternal weight	0.025	[55,85]	59 (54%)	51 (46%)	[85,130]	22 (76%)	7 (24%)
Maternal height	0.021	[152,160]	8 (38%)	13 (62%)	[160,185]	73 (62%)	45 (38%)
Maternal BMI	0.063	[18.4, 28.3]	43 (48%)	47 (52%)	[28.3, 42.8]	38 (78%)	11 (22%)
Pregnancy duration	0.222	[231,280]	29 (38%)	48 (62%)	[280,294]	53 (90%)	6 (10%)
Newborn's length	0.076	[46,50.5]	11 (38%)	18 (62%)	[50.5, 57]	67 (74%)	23 (26%)
Newborn's weight	0.066	[2260,3420]	27 (42%)	37 (58%)	[3420,4970]	54 (72%)	21 (28%)
Head circumference	0.061	[31.5, 36]	55 (51%)	53 (49%)	[36,41]	26 (84%)	5 (16%)

Gupta et al. [16] identified a newborn's birth weight greater than 4000 g to be an independent risk factor for anal sphincter injury. Likewise, in our study, the newborn's birth parameters: weight, length and head circumference ($P < 0.05$, $P < 0.01$, $P < 0.001$, respectively) were important risk factors for the occurrence of perineal injury. In primiparous patients with the newborn weighing more than 3420 g the anal sphincter injury occurred in 72%, while when the newborn's weight was lower, the injury occurred in 42%.

The cut-off point for the newborn's head circumference was 36 cm. Primiparous patients delivering babies with a bigger head circumference had an 84% probability of injury, and when the head circumference was below 36 cm, the probability of OASIS was 51%. Likewise, when the newborn's length was greater than 50.5 cm, the mother suffered an OASIS in 74% of cases, whereas when the newborn was shorter, the OASIS was present in 38% of the cases. Other authors have also shown that the women giving birth to a bigger newborn are at higher risk of OASIS [14,15,6].

The impact of increasing pregnancy duration was studied and confirmed by Ozyurt and colleagues, who explained it by the hormonal effects on the changing of the perineal connective tissue that arises in the course of pregnancy [6]. Even though the pregnancy duration was not significantly different in both groups in our study ($P > 0.05$), it corresponded to these findings. When it was greater than 280 days, 90% of the patients suffered OASIS, whereas when it was shorter, only 38% of them had OASIS. The rationale behind this phenomenon is also that as the pregnancy duration increases the babies usually grow in size, which corresponds to the previous findings. Even though these factors are unmodifiable at the time of a spontaneous birth, they could be used to recommend prior induction of the delivery if the ultrasonographically monitored newborn's size is higher than the cut-off values. In a population-based study, Stock proved that induction between the 39th and 40th week lowers the incidence of OASIS in comparison to an expectative delivery [17]. Other authors found that the policy of induction of labour between ≥ 37 weeks and ≤ 38 weeks^{+6days} for women with a constitutionally large fetus for gestational age among women without diabetes did not reduce OASIS [18]. However, in order to confirm this hypothesis, further studies are needed, which would also analyse the effect of the birth after the due date regarding the newborn's weight, length and head circumference.

Among the modifiable risk factors, is an instrumental delivery, such as a vacuum, forceps extraction [19] and midline episiotomy [20], that are considered to be important. However, literature data on mediolateral episiotomy is contradictory. Some researchers managed to demonstrate that a mediolateral episiotomy has a protective role against the occurrence of OASIS [21]. Furthermore, Vathanan's study [22] showed that the risk of OASIS was five times higher in a group of patients in whom an episiotomy was not performed, compared to patients who had an episiotomy. In addition, a research study that included 3038 deliveries proved that the mediolateral episiotomy had a protective role against perineal trauma [23]. On the other hand, a retrospective study that included 168,077 deliveries found episiotomy was a risk factor for OASIS and therefore did not recommend the introduction of mediolateral episiotomy as a prophylactic method against OASIS [24]. We did not find a significant correlation between an episiotomy and OASIS. Our analysis revealed that a vacuum extraction is not significantly more frequent in groups of patients with OASIS. Probably because only exit vacuum (not medium or high) is done in Slovenia. We showed that oxytocin augmentation increased the occurrence of anal sphincter injury as it was previously shown in other studies [25]. The regimen of administration of oxytocin should be studied in detail in the future, to determine more precisely possible influences on OASIS.

Results of multiple logistic regression show that the younger primiparous women with newborns with bigger head circumference are more prone to OASIS.

The strength of our study lies in using the 3D EUS for detecting OASIS. The study sample is large, considering that the EUS examination is considered unpleasant. The weakness of the study is that the parturients without clinically detected OASI were not consecutive, they all came to our office for regular check up after birth, but only the ones who agreed to have EUS done and had signed informed consent were included in the study. Additional limitation of the study is that some parameters in medical records were missing. We also do not have long term follow up, so no data about the late onset of anal incontinence in both groups are available. All the patients who had OASIS received treatment according to the guidelines.

Table 4
Statistics for nominal obstetric parameters; P-value, N – total number of patients for which the parameter was available in their medical records; Columns Yes and No denote the number of patients and percentages in the bricks), that had (Yes) or did not have (No) an episiotomy, vacuum extraction, left in the control group and right in the OASIS group.

		Control group		OASIS group		
Parameter	P value	Yes	No	Yes	No	N
Episiotomy	0.093	32 (55.2)	26(44.8)	58 (69)	26 (31)	142
Vacuum	0.136	1(2.6)	38 (97.4)	9 (11,5)	69 (88.5)	117
Oxytocin augmentation	0.031	32 (59.3)	22 (40.7)	63 (76.8)	19 (23.2)	136

Conclusion

The findings of our study, especially the cut-off values for Caucasian women for the relevant obstetric parameters, can assist in the identification of patients with a higher risk of OASIS at childbirth

We observed that not all OASIS after delivery were detected by clinical examination and that 'occult' OASIS can be overlooked. We

propose to employ EUS after delivery at least for the patients with higher risk of OASIS according to suggested cut-off values to detect OASIS and provide treatment as early as possible in order to prevent anal incontinence.

Author contributions

Kristina Drusany Starič – study design, planning, conduct, data analysis, manuscript writing.

Petra Bukovec – conduct, data analysis, manuscript writing.

Katja Jakopič – planning, conduct, manuscript writing.

Eftim Zdravevski – data analysis, manuscript writing.

Vladimir Trajkovik – data analysis, manuscript writing.

Adolf Lukanović – study design, planning, conduct, manuscript writing.

Conflict of interest

The authors have no conflicts of interest to disclose.

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