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MATERNAL-FETAL MEDICINE

# Low volume forceps practice and anal sphincter injury rate

**Raanan Meyer[1] · Amihai Rottenstreich[2] · Salem Kees[1] · Michal Zamir[3] · Simcha Yagel[2] · Gabriel Levin[2]**

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## Abstract

**Purpose** While the increased rates of high degree perineal tears were previously associated with the use of forceps, in the current era of low volume of forceps practice, factors associated with the occurrence of this potential complication remain understudied. We aim to evaluate factors associated with obstetric anal sphincter injury (OASIS) in obstetric units with a low volume forceps practice.

**Methods** A retrospective cohort study was conducted at two tertiary medical centers. All singleton pregnancies delivered by forceps extraction between 2011 and 2019 were analyzed. Women who experienced anal sphincter injury were compared to those who did not.

**Results** The study cohort included 764 forceps deliveries. There were 19 (2.5%) cases of OASIS. Women with anal sphincter injury had higher rates of gestational diabetes mellitus (21% vs. 5.6%, OR [95% CI] 4.46 (1.41–14.04), $p=0.02$). Birth weights and the rate of macrosomia did not differ between groups. Induction of labor was more common among the OASIS group (68% vs. 41.7%, OR [95% CI] 3.0 (1.1–8.0), $p=0.02$). Sequential use of forceps (after failed vacuum attempt) was associated with OASIS (8 (42%) vs. 76 (10.2%), OR [95% CI] 6.4 (2.5–16.4), $p<0.001$). In a multivariate logistic regression, sequential forceps was the only factor independently associated with OASIS (OR [95% CI] 4.7 (1.3–18.2), $p=0.02$).

**Conclusions** Rate of OASIS was relatively low in the current cohort. Sequential use of forceps was found to be the most important determinant in OASIS occurrence.

**Keywords** Forceps extraction · Low volume · High degree perineal tears · Obstetric anal sphincter injury · Morbidity · Outcomes

## Abbreviations

FE Forceps extraction
OASIS Obstetric anal sphincter injury

## Introduction

During the last few decades, there is an ongoing discussion regarding the rise in cesarean delivery (CD) rates both from public health and obstetrical points of view [1]. While operative vaginal delivery is considered to play a central role in decreasing the rate of primary CD performed during the second stage of labor [1], the use of forceps extraction (FE) may still be needed in cases where vacuum extraction is not possible or following its failure [2].

In the recent decades, we have witnessed a progressive decline in the use of forceps [3], with a rate of 5.1% in 1990 in the United States compared to 0.6% in 2014. This decrease in FE follows the controversy regarding the maternal morbidity associated with FE use [4, 5], and is probably coupled with the ever-growing medicolegal environment [6]. With the decrease in FE volumes, physicians may encounter hardship in acquiring adequate experience and proficiency [7]. While increased rates of high degree perineal tears were previously associated with the use of forceps [8–11], in the

Raanan Meyer and Amihai Rottenstreich contributed equally to this work.

✉ Gabriel Levin
Levin.gaby@gmail.com

[1] The Department of Obstetrics and Gynecology, The Chaim Sheba Medical Center, Ramat-Gan, Israel

[2] The Department of Obstetrics and Gynecology, Hadassah-Hebrew University Medical Center, POB 12000, 91120 Jerusalem, Israel

[3] The Sackler Faculty of Medicine, Tel-Aviv University, Tel-Aviv, Israel

current era of low volume of forceps practice, factors associated with the occurrence of this potential complication remain understudied.

Given the paucity of data, we aimed to evaluate the use of FE in current obstetric practice at two university hospitals with a low volume of FE and assess the rate of obstetric anal sphincter injury (OASIS), and its associated factors.

## Materials and methods

### Patients

This was a multicenter, historical cohort study conducted at two university-affiliated tertiary hospitals. Both centers serve large, heavily populated urban areas as well as rural areas, and treat a heterogeneous population with over 10,000 deliveries per year in each hospital. The study cohort comprised all women delivered by FE at the second stage of labor in singleton pregnancies between 2011 and 2019. Pregnancies with fetal anomalies were excluded.

Data were collected from the computerized medical database. We abstracted baseline maternal characteristics including age, body mass index (BMI), comorbidities, and obstetrical history; pregnancy characteristics including occurrence of hypertensive disorders of pregnancy, gestational diabetes mellitus (GDM), fetal sex; delivery outcomes including gestational age at delivery, mode of onset of labor, use of epidural anesthesia, length of the first and second stages of labor, FE indication, type of forceps used (Naegele, Simpson, Kielland), position of the fetal head at forceps application, performance of episiotomy, birth weight; and postpartum complications including length of stay and postpartum hemorrhage. Records were manually reviewed by two reviewers (G.L, R.M).

OASIS was defined as grade 3 or 4 perineal tears according to the American College of Obstetricians and Gynecologists [12]. The diagnosis of OASIS was performed by a senior obstetrician in all cases. When deemed appropriate, a general surgeon examined the tear for confirmation and grading of OASIS, at the discretion of the senior obstetrician. Postpartum hemorrhage (PPH) was defined according to the ACOG [13]. The body mass index (BMI) was calculated as weight (kg)/height ($m^2$) during admission to the delivery room. Maternal comorbidities were defined as the presence of one or more of the following: hypothyroidism, and any maternal cardiac, liver or kidney disease. Gestational hypertensive disorders were defined according to the ACOG [14]. GDM was diagnosed according to the values proposed by Carpenter and Coustan [15].

The indications for operative vaginal delivery at our center are prolonged second stage, non-reassuring fetal heart rate monitoring, and maternal indications. The diagnosis of prolonged second stage was considered when the second stage exceeds 2 h (or 3 h in the presence of regional anesthesia) in nulliparous women or when the second stage exceeds 1 h (or 2 h in the presence of regional anesthesia) [16] in multiparous women. Indications for operative vaginal delivery and second stage management protocols were uniform throughout the study period. All forceps extraction were performed at low station by a senior physician. At our centers, we do not practice mid-station forceps. Perineal protection was not assessed as a high risk of recall or information bias exists.

### Statistical analysis

Characteristics of women are described as proportions for categorical variables and as medians and interquartile ranges for continuous variables. The primary outcome was occurrence of high degree perineal tears (3rd and 4th degree). The characteristics of the women and gestations of the women who experienced OASIS were analyzed and compared with those of the women with no OASIS. Significance was assessed by the Chi square test and Fisher's exact test for categorical variables. The Student *t* test was used for analysis of continuous variables with normal distribution and the Mann–Whitney *U* test for analysis of continuous variables with skewed distribution. Study results were presented as odds ratios (ORs) and 95% confidence intervals (CIs). A two-sided $p$ value $< 0.05$ indicated statistical significance. Forward stepwise multivariate logistic regression analyses were subsequently carried out using OASIS as the dependent variable, and potential risk factors that were identified by univariate analysis with a $p$ value of $< 0.05$ as independent variables. The data were analyzed using Software Package for Statistics and Simulation (IBM SPSS version 22, IBM Corp, Armonk, NY). The study protocol was approved by the institutional review boards of the Sheba and Hadassah Medical Centers, approval numbers 5503-18-SMC, 17/10/2018 and HMO-0544-17, respectively.

## Results

During the study period, there were 153,672□ live singleton deliveries (vaginal and non-elective CD). Overall, 764 (0.5%) FE were performed (Fig. 1). The number of cases per year of FE during the study period varied from 75 to 139 with a mean of 91 cases, with no trend observed during the study period (95% CI 0.68–1.08). FE failure rate was 34/764 (4.4%). Of the 764 women meeting the inclusion criteria, 662 (86.6%) were nulliparous and 84 (11.0%) had a previous cesarean delivery. PPH was encountered in 37 (4.8%). Nineteen (2.5%) women experienced OASIS; of them 14 (74%) were diagnosed with a 3rd degree tear and 5 (26%) with a

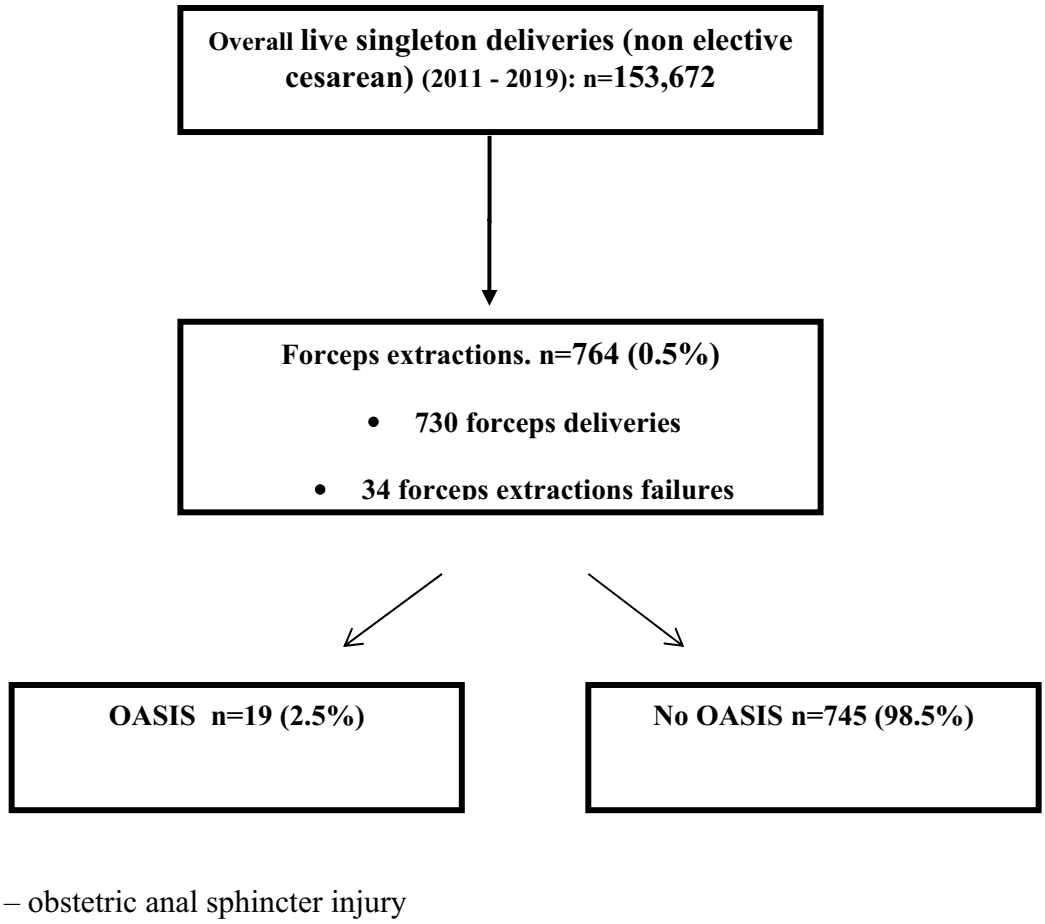


**Fig. 1** Selection of the study group. *OASIS* obstetric anal sphincter injury

4th degree tear. The rate of OASIS did not differ between both participating centers (3.1% vs. 2.3%, $p = 0.63$). Comparison of the OASIS and no OASIS groups is depicted in Table 1. Women in the OASIS group were younger (median 29 years vs. 30 years, $p = 0.04$) with a higher proportion of women aged ≤ 25 years [6 (32%) vs. 108 (14.5%), OR [95% CI] 2.72 (1.01–7.31), $p = 0.03$], and a higher rate of GDM [4 (21%) vs. 42 (5.6%), OR [95% CI] 4.46 (1.41–14.04), $p = 0.02$]. Other maternal characteristics did not differ between groups. Factors found to be associated with OASIS were induction of labor [13 (68%) vs. 311 (41.7%), OR [95% CI] 3.0 (1.1–8.0), $p = 0.02$], non-reassuring fetal status as the indication for expedited delivery [14 (74%) vs. 308 (41.4%), OR [95% CI] 3.9 (1.4–11.1), $p = 0.008$], Simpson's forceps type [9 (47%) vs. 143 (19.2%), OR [95% CI] 3.8 (1.5–9.5), $p = 0.004$], whereas the use of Kielland's forceps was found to be negatively associated with OASIS occurrence [2 (11%) vs. 314 (42.1%), OR [95% CI] 0.2 (0.04–0.7), $p = 0.01$]. Sequential use of forceps (after failed vacuum attempt) was associated with OASIS [8 (42%) vs. 76 (10.2%), OR [95% CI] 6.4 (2.5–16.4), $p < 0.001$]. Length of stay was longer for the OASIS group (median 4 days vs. 3 days, $p = 0.03$) (Table 2).

In a multivariate regression analysis, the only factor found to be independently associated with OASIS was the sequential use of forceps following failed vacuum extraction (adjusted OR [95% CI] 4.7 (1.3–18.2), $p$=0.02).

## Discussion

In this cohort study, we demonstrated that the use of FE for assisted vaginal delivery, in the current low volume FE practice, is associated with a high success rate and a low rate of OASIS, occurring in 2.5% of cases, with sequential use of forceps associated with its occurrence.

In the recent two decades, the rate of operative delivery has dramatically decreased [17]. This is even more pronounced for forceps delivery, representing less than 1% of all births. Furthermore, in modern obstetrics, FE is mainly performed in the setting of second stage expedited delivery, as other indications (e.g. breech delivery) have been largely

**Table 1** Maternal characteristics in relation to OASIS occurrence

| Characteristics | OASIS ($n=19$) | No OASIS ($n=745$) | OR (95% CI) | $p$ value |
|---|---|---|---|---|
| Age, years | 29 [24–31] (28) | 30 [27–34] (31) | | 0.04 |
| Age groups, years | | | | |
| ≤25 | 6 (32%) | 108 (14.5%) | 2.72 (1.01–7.31) | 0.03 |
| 25–35 | 12 (63%) | 486 (65.2%) | | 0.84 |
| ≥35 | 1 (5%) | 151 (20.3%) | | 0.09 |
| BMI, kg/m$^2$ | 26.6 [24.0–32.7] (27.9) | 27.4 [25.3–30.1] (28.1) | | 0.91 |
| Height, centimeters | 167 [163–170] (166) | 163 [159–168] (162) | | 0.37 |
| Maternal comorbidities[a] | 2 (11%) | 71 (9.5%) | | 0.82 |
| Parity | 0 [0–1] (0) | 0 [0–0] (0) | | 0.54 |
| Nulliparous[b] | 18 (95%) | 644 (86.4%) | | 0.27 |
| Previous cesarean delivery | 2 (11%) | 82 (11.0%) | | 1.0 |
| Gestational diabetes mellitus | 4 (21%) | 42 (5.6%) | 4.46 (1.41–14.04) | 0.02 |
| Hypertensive disorders | 2 (11%) | 25 (3.3%) | | 0.07 |
| Sex, female | 4 (21%) | 304 (40.8%) | | 0.09 |

Continuous variables are presented as median [interquartile range] (mean). Categorical variables are presented as numbers (percentage)

*BMI* body mass index, *CI* confidence interval, *OASIS* obstetrical anal sphincter injury, *OR* odds ratio

[a]Defined as the presence of one or more of the followings: hypothyroidism, and any maternal cardiac, liver or kidney disease

[b]Defined as no prior vaginal delivery

**Table 2** Pregnancy and delivery outcomes in relation to OASIS occurrence

| Characteristics | OASIS ($n=19$) | No OASIS ($n=745$) | OR (95% CI) | $p$ value |
|---|---|---|---|---|
| Gestational age at delivery, weeks | 40 [39–40] (39) | 39 [39–40] (39) | | 0.78 |
| Preterm delivery (<37 weeks) | 1 (5%) | 35 (4.7%) | | 1.0 |
| Post-term delivery (>42 weeks) | 1 (5%) | 15 (2.0%) | | 0.36 |
| Induction of labor | 13 (68%) | 311 (41.7%) | 3.0 (1.1–8.0) | 0.02 |
| Epidural analgesia | 16 (84%) | 677 (90.8%) | | 0.47 |
| First stage duration, minutes | 145 [131–336] (246) | 186 [109–357] (274) | | 0.79 |
| Second stage duration, minutes | 183 [121–253] (197) | 184 [92–224] (163) | | 0.11 |
| Indication for operative delivery | | | 3.9 (1.4–11.1) | 0.008 |
| Non reassuring fetal status | 14 (74%) | 308 (41.4%) | | |
| Prolonged second stage | 5 (26%) | 437 (58.6%) | | |
| Type of forceps | | | | |
| Naegele | 8 (42%) | 288 (38.7%) | | 0.79 |
| Simpson | 9 (47%) | 143 (19.2%) | 3.8 (1.5–9.5) | 0.004 |
| Kielland | 2 (11%) | 314 (42.1%) | 0.2 (0.04–0.7) | 0.01 |
| Occiput posterior | 1 (5%) | 12 (2) | | 0.29 |
| Mediolateral episiotomy | 16 (84%) | 550 (73.8%) | | 0.31 |
| Sequential forceps | 8 (42%) | 76 (10.2%) | 6.4 (2.5–16.4) | <0.001 |
| Birth weight, grams | 3145 [2930–3330] (3142) | 3320 [3027–3573] (3286) | | 0.14 |
| Macrosomia (>4000 g) | 1 (5%) | 26 (3.5%) | | 0.72 |
| Birth weight ≥ 90th centile (≥3830 g) | 1 (5%) | 78 (10.4%) | | 0.44 |
| Head circumference, millimeters | 331 [323–340] (331) | 333 [325–340] (332) | | 0.85 |
| Head circumference ≥ 90th centile (≥346 mm) | 0 (0%) | 73 (9.8%) | | 0.44 |
| Length of stay, days | 4 [4–5] (5) | 3 [3–4] (4) | | 0.03 |
| Postpartum hemorrhage | 4 (21%) | 33 (4.4%) | 5.7 (1.8–18.3) | <0.001 |

Continuous variables are expressed as median [interquartile range] (mean). Categorical variables are presented as numbers (percentage)

*CI* confidence interval, *OASIS* obstetrical anal sphincter injury, *OR* odds ratio

abandoned or substantially decreased [18]. In addition, as attempted mid-cavity FE has been shown to associate with higher rates of adverse maternal and perinatal outcomes, most FE in this setting are performed only at outlet or low planes [19]. These trends may at least partially account for the relatively lower rates of OASIS found in the current study and may suggest the need to re-examine the use of FE, even in a setting of low volume of practice. Moreover, as FE does not increase the risk of some feared neonatal cranial injuries such as subgaleal hematoma, it may potentially be beneficial in the setting of second stage expedited deliveries. The declining use and resident experience with FE may make it difficult to provide the adequate level of operator skills for this obstetric art. However, as most women prefer vaginal delivery, coupled with the low rates of OASIS in our study and high rate of successful assisted vaginal delivery, focused experience with the use of forceps is of paramount importance.

Sequential use of FE after failed VE was the only independent factor associated significantly with OASIS. The sequential use of instrumental delivery is a point of major concern [1]. Although beyond the scope of our study, it is established that sequential use of forceps carries greater neonatal morbidity [20, 21]; therefore, it is suggested by the guidelines that sequential use of vacuum extractor and forceps should not be performed routinely [1]. Regarding maternal morbidity, it was demonstrated that among nulliparous, the use of sequential forceps was associated with increased OASIS rates [22] as compared to each single instrument (17.4% vs. 8.4%). However, it is important to notice the advantage of sequential use of forceps, which in most cases would end in successful assisted vaginal delivery when the alternative is a highly morbid second stage CD of the deeply impacted fetal head [23, 24]. In light of the above, a careful consideration should be given before proceeding to sequential use of FE, and appropriate counseling should be given to the patient regarding the higher risk for OASIS in this setting.

It is interesting that our investigation underlines a relatively lower rate of OASIS, even among those with sequential use of forceps, compared to previous publications [22]. This may be at least partially accounted for, given that all forceps delivery were performed at low cavity, as it is well-established that the rates of high degree perineal [22] tears are much higher following mid-cavity FE [19]. Moreover, the use of mediolateral episiotomy in most cases in the current cohort may also be a protective factor against OASIS occurrence [25].

OASIS was less frequent in Kielland's forceps than in Simpso's forceps in our study. This might be explained by the different shape of the forceps with flatter forceps branches, occupying less volume in the birth canal which might lead to less tissue trauma.

Non-reassuring fetal heart rate patterns were more common in the OASIS group. It is possible that non-reassuring fetal heart rate dictates a faster forceps extraction for the operator, leaving the birth canal with lesser time to dilate and accommodate the forceps, and as a consequence, higher OASIS rate.

The retrospective design of this study carries inherent biases such as selection and information bias. Moreover, we cannot exclude the possibility that other factors (e.g. differential patient care throughout the study period, operator experience or different perineal protection methods) could account for the study findings. In addition, the generalizability of our findings may be limited to other institutions with different practice of care (e.g. mid-cavity forceps extraction, episiotomy rates). Moreover, other FE-related morbidities were not investigated; while some of the FE-related adverse outcomes are noted shortly after the procedure (e.g. neonatal fractures, facial hematomas), others may only be diagnosed in the long-term (e.g. urinary incontinence), highlighting the need for further studies with longer follow-up periods [26]. Finally, considering the relatively modest sample size, some of the non-statistically significant findings may be due to lack of statistical power, and rare adverse outcomes could not be assessed. Nevertheless, as future prospective randomized trials will be difficult to perform (due to sample size issues and appropriate patient acknowledgment and approval), we believe that our study serves as an important source of evidence in this topic.

In summary, we found that FE in the setting of low volume FE is associated with a high success rate and relatively low rate of OASIS, encountered in only 2.5% of cases, with sequential use of forceps as an independent predictor of its occurrence. Future prospective large-scale studies are needed to confirm our findings and better delineate the outcomes of FE in this setting.

**Author contributions** All authors contributed to the manuscript. GL, RM, and AR reviewed the literature and wrote the paper. SK, SY, and MZ performed the procedures and collected the data. All authors read and approved the final manuscript.

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## Compliance with ethical standards

**Conflict of interest** Authors declare that they have no conflict of interest.

**Ethical approval** For this type of study, formal consent is not required and was waived by the institutional review board approval. All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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