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Mediolateral episiotomy and obstetric anal sphincter injuries in nullipara: a propensity score matching study

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Abstract

Background Obstetric anal sphincter injuries are a notable adverse outcome of vaginal deliveries, with incidence rates ranging from 0.25% to 6%. Key risk factors for these injuries include primiparity and operative vaginal deliveries. In recent decades, the use of episiotomy as a preventive measure for obstetric anal sphincter injuries has been subject to extensive scrutiny. The objective of this study was to investigate the role of mediolateral episiotomy in preventing obstetric anal sphincter injuries during vaginal deliveries or vacuum-assisted deliveries within the context of selective use.

Methods Retrospective study of all nulliparous women with a singleton gestation who underwent term vaginal delivery or vacuum-assisted delivery. A propensity score matching with a 1:1 ratio was employed to adjust for confounders. Primary outcome was obstetric anal sphincter injury rate, and the secondary outcome was a composite neonatal outcome (umbilical artery pH < 7.1, neonatal intensive care unit admission, and 5-min Apgar score < 7).

Results The study cohort comprised 22,738 deliveries: 77.0% vaginal deliveries (17,518/22,738) and 23.0% vacuum-assisted deliveries (5,220/22,738) with episiotomy rates of 38.5% (6,751/17,518) and 75.8% (3,959/5,220), respectively. Separate analyses were conducted for the matched vaginal delivery group ($n = 13{,}500$) and the matched vacuum-assisted delivery group ($n = 2{,}518$). No significant differences in obstetric anal sphincter injury rates were observed in the vaginal delivery (OR 1.15, 95% CI 0.78–1.69) or vacuum-assisted delivery (OR 0.58, 95% CI 0.31–1.05) groups. However, in the vacuum-assisted delivery group, episiotomy demonstrated a borderline protective effect against obstetric anal sphincter injuries. Further adjustment for the duration of the second stage of labor duration in vacuum-assisted deliveries revealed a significant protective effect of episiotomy against obstetric anal sphincter injuries, with a number needed to treat of 28 (95% CI 15—224) in cases of prolonged second stages of labor. Episiotomy in vaginal deliveries was associated with a higher rate of composite neonatal outcome (OR 1.23, 95% CI 1.04–1.45), while vacuum-assisted deliveries showed no such association (OR 1.11, 95% CI 0.86–1.44).

Conclusions In context of selective use, mediolateral episiotomy has no significant protective effect on obstetric anal sphincter injuries in women undergoing vaginal delivery. However, there is a possible benefit in vacuum-assisted delivery, especially when considering the duration of the second stage of labor.

Keywords Episiotomy, Obstetric anal sphincter injury, Primiparity, Vaginal delivery, Vacuum assisted delivery

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Background

Obstetric anal sphincter injuries (OASIs) represent a significant adverse outcome of vaginal deliveries (VD), occurring at variable rates of 0.25–6% [1–4]. Primiparity and operative vaginal deliveries (OVD) are among the key risk factors for OASIs [5, 6]. Over recent decades, the practice of episiotomy to preempt obstetric anal sphincter injuries, has undergone significant scrutiny.

A recent analysis of a national French database revealed an increased incidence of OASIs following mediolateral episiotomy in both nulliparous and multiparous women not undergoing OVD [7]. This finding aligns with the conclusions of a 2017 Cochrane review, which suggested that restrictive episiotomy policies could lead to reduced rates of severe perineal trauma in women without OVD [8]. Conversely, the same French study noted a lower incidence of OASIs when episiotomy was performed in conjunction with OVD, either vacuum or forceps deliveries [7]. The efficacy of mediolateral episiotomy for nulliparous patients during OVD is further supported by a recent meta-analysis and additional retrospective observational studies [9–17].

A recent randomized controlled trial (RCT) involving 3,006 women at term, evaluated the outcomes of restrictive versus routine episiotomy practices. While the trial did not offer a sub-analysis of women who underwent OVD, results indicated that OASIs was reduced from 5.4% of the primipara patients in the restrictive episiotomy group to 3.2% in the routine episiotomy group [18]. An earlier RCT involving 200 nulliparous women who underwent OVD found slight differences in OASIs rates—8.1% for routine versus 10.9% for restrictive episiotomy. Although not statistically significant, the small sample size may have limited the trial's ability to demonstrate significance [19]. Another RCT from 2020 similarly reported no significant differences in OASIs rates between restrictive and routine episiotomy practices, further supporting a more selective approach to episiotomy [20]. More recently, the EVA trial found that lateral episiotomy significantly reduced the risk of OASIs in nulliparous women undergoing vacuum-assisted deliveries, highlighting the potential benefit of episiotomy in selected cases [21].

Contemporary guidelines advocate for a restrictive approach with consideration for mediolateral episiotomy [22–25]. Yet, the decision to perform an episiotomy remains an important juncture in labor management, requiring careful consideration of its implications for maternal morbidity, particularly OASIs, which bear profound consequences for postpartum recovery and long-term pelvic floor function.

As the potential protective effect of mediolateral episiotomy against OASIs is controversial, we aimed to explore the role of mediolateral episiotomy in preventing OASIs during VD and vacuum-assisted deliveries (VAD) in nulliparous women. This evaluation was conducted in the context of selective mediolateral episiotomy use and employed propensity score (PS) matching to adjust for potential confounders.

Methods

Our study was a retrospective observational analysis conducted at a tertiary university medical center between August 2007 and September 2019.

Study population

The original cohort included all nulliparous women carrying a singleton pregnancy who underwent term VD or VAD, at or beyond 37 gestational weeks. Cases with missing data, multiple gestations, non-vertex presentation, and those who ultimately had undergone cesarean delivery (CD) [26] were excluded.

Guidelines and procedures

In our delivery ward, we adhere to a restrictive policy regarding the use of mediolateral episiotomy, considering both nulliparous and multiparous women who are not undergoing VAD. VD is managed by authorized midwives who have the autonomy to make certain obstetrical decisions, including to perform mediolateral episiotomies. For nulliparous women who require VAD, mediolateral episiotomy is commonly performed, carried out by the physician who also performs the VAD. Perineal tears are evaluated and sutured by an obstetrician. VADs are executed by a senior obstetrician or a resident under supervision. If an OASIs is diagnosed or suspected, a senior obstetrician is consulted to confirm or dismiss the diagnosis following a clinical examination (vaginal and rectal examination) of the perineum just after delivery. Our use of forceps is rare. All senior obstetricians are trained in the diagnosis and repair of OASIs.

To classify OASIs, we use the Royal College of Obstetrics and Gynecology staging [23]. Third-degree tears are defined as injuries of the external and/or internal anal sphincter and fourth-degree tears are defined as injuries of the anal sphincter complex and anorectal mucosa.

Prolonged second stage (PSS) of labor was defined as 3 h or more as all the patients in this study were primiparous.

Data collection

Data were retrieved from the hospital's computerized database. Maternal, neonatal, and outcome data were collected. Maternal parameters included age, gravidity, gestational age, parity, history of pregnancy losses and terminations, prior stillbirth, and CDs, use of assisted reproductive technology, pre-pregnancy body mass index (BMI), chronic hypertension, pregestational diabetes, polyhydramnios, oligohydramnios, use of oxytocin, induction of labor, neuraxial analgesia, time in the first, second and third stages of labor, fetal presentation, postpartum hemorrhage (PPH), mode of delivery, and perineal tear's degree. Neonatal parameters included gender, birth weight, 1- and 5-min Apgar scores, umbilical artery pH, and neonatal intensive care unit (NICU) admission.

Outcome measures

The primary outcome was the incidence of OASIs – third- or fourth-degree perineal laceration. The secondary outcomes included PPH and a composite of immediate neonatal outcome, defined as the presence of any of the following: umbilical artery pH < 7.1, NICU admission, and 5-min Apgar score < 7.

Ethics

The study was approved by the local Institutional Review Board (0132–22-RMC) on September 13, 2022. Informed consent was waived due to the retrospective design of the study.

Statistical analysis

Continuous variables were summarized using means and standard deviations (SDs) or medians and interquartile ranges (IQR) [27], depending on their distribution, as assessed by Shapiro–Wilk tests for normality, histograms, and Q-Q plots. Categorical variables were described using frequencies and percentages. The Cochran-Armitage Trend Test was used to assess changes in episiotomy and OASIS rates over the study period.

Two separate analyses were conducted: one for VD and another for VAD, each divided to with episiotomy vs. without. To adjust for confounding factors, propensity score (PS) matching was utilized for each group independently, employing a 1:1 match without replacement. The PSs were estimated using logistic regression, and included variables previously associated with the primary outcome and those showing an association on initial univariate analysis, including BMI, gestational age of 41 weeks or more, use of oxytocin, induction of labor, neuraxial analgesia, and birthweight. Patients were matched using a nearest neighbor matching algorithm with a caliper width of 0.1 standard deviations of the logit of the PS [28].

To evaluate the covariate balance before and after matching, both absolute and relative measures were examined. Prior to matching, covariate balance was assessed by comparing the distribution of baseline characteristics between the two groups using standardized mean differences (SMD) [29]. Post-matching balance diagnostics included visual assessment through Love plots and PS distribution graph (Figures S1 and S2), and quantitative analysis via balance tables. These diagnostics allowed for a thorough examination of covariate distribution, ensuring that matching effectively controlled for potential confounding factors. We iteratively refined the PS model, reassessing balance with each iteration until all model covariates achieved a SMD < 0.1, indicating a high degree of balance [30].

Supplementary Tables S1 and S2 present comparisons between matched datasets and the entire cohort for both the VD and VAD subgroups. These comparisons demonstrated that the matched datasets are representative of the overall data, with most variables showing similar patterns. Where differences are observed, they are not clinically meaningful (except time in second stage of labor in VAD subgroup) and the significant *p*-values are largely attributable to the extensive sample sizes involved.

For the analysis of primary outcome, we chose to use statistical methods for unpaired samples. Comparison between continuous variables was conducted with Student's t-test or Mann–Whitney U test, as appropriate. The chi-squared or Fisher's exact tests were used for the comparison of categorical variables, as appropriate. In addition, logistic regression analyses were applied where appropriate to estimate the odds ratios (ORs).

In the VD and VAD subgroup, an adjusted logistic regression analysis was performed to assess the role of episiotomy in reducing the risk of OASIs while adjusting for the time in second stage of labor. This analysis was prompted by the persistent imbalance in the second stage duration between patients with and without episiotomy, even after PS matching (Tables 1 and 2). Since the length of the second stage of labor is inherently linked to the decision to perform an episiotomy, this factor could not be fully balanced through matching alone. In the VD subgroup, the multivariate analysis also included the year of delivery. This analysis was necessitated by the significant change in episiotomy rates over time within this subgroup ($P < 0.001$), which increased from 25% in 2007 to 43% in 2019. There was no such change in the VAD subgroup.

All statistical analyses were performed using R Statistical Software (version 4.3.2; R Core Team, 2023). A two-tailed *p*-value of less than 0.05 was considered to indicate statistical significance.

Results

The initial dataset included 27,753 singleton term deliveries spanning from August 2007 to September 2019. Post-exclusion criteria application, the cohort was refined to 22,738 patients. This entire included cohort, prior to matching, was divided into 17,518 (77.0%) VDs

Table 1 Patient characteristics—vaginal delivery group

Variable	Before Matching, $N = 17{,}518$[1]						After Matching, $N = 13{,}500$[1]			
	N	Overall	No Episiotomy, $N = 10{,}767$	Episiotomy, $N = 6{,}751$	*P*-value[2]	SMD	No Episiotomy, $N = 6{,}750$	Episiotomy, $N = 6{,}750$	*P*-value[2]	SMD
Age, years	17,486	27.00 (24.00, 30.00)	28.00 (25.00, 31.00)	27.00 (24.00, 30.00)	**< 0.001**	−0.103	28.00 (25.00, 30.00)	27.00 (24.00, 30.00)	**< 0.001**	−0.089
Pre-Pregnancy BMI, Kg/m²	8,549	27.00 (21.93, 29.00)	27.00 (22.31, 29.00)	27.00 (21.48, 29.00)	**< 0.001**	−0.157	27.00 (21.55, 29.00)	27.00 (21.48, 29.00)	0.339	−0.029
DM, Type 1	17,515	45 / 17,515 (0.3%)	29 / 10,767 (0.3%)	16 / 6,748 (0.2%)	0.682	−0.006	17 / 6,750 (0.3%)	16 / 6,747 (0.2%)	0.863	−0.003
DM, Type 2	17,515	12 / 17,515 (< 0.1%)	9 / 10,767 (< 0.1%)	3 / 6,748 (< 0.1%)	0.391	−0.015	6 / 6,750 (< 0.1%)	3 / 6,747 (< 0.1%)	0.508	−0.017
GDM	17,515	919 / 17,515 (5.2%)	589 / 10,767 (5.5%)	330 / 6,748 (4.9%)	0.094	−0.026	365 / 6,750 (5.4%)	330 / 6,747 (4.9%)	0.175	−0.023
Previous abortions	9,308	1,594 / 9,308 (17%)	973 / 5,552 (18%)	621 / 3,756 (17%)	0.213	0.055	634 / 3,649 (17%)	621 / 3,755 (17%)	0.337	−0.023
ART	11,134	589 / 11,134 (5.3%)	378 / 6,928 (5.5%)	211 / 4,206 (5.0%)	0.315	−0.020	216 / 4,261 (5.1%)	211 / 4,206 (5.0%)	0.912	−0.002
Gestational age at delivery, weeks	17,518	39 + 5 (38 + 6, 40 + 2)	39 + 3 (38 + 5, 40 + 1)	39 + 6 (39 + 0, 40 + 3)	**< 0.001**	0.166	39 + 6 (39 + 0, 40 + 3)	39 + 6 (39 + 0, 40 + 3)	0.097	0.027
Labor Induction	17,518	3,830 / 17,518 (22%)	2,240 / 10,767 (21%)	1,590 / 6,751 (24%)	**< 0.001**	0.066	1,565 / 6,750 (23%)	1,589 / 6,750 (24%)	0.625	0.008
Onset of labor:	17,518				**< 0.001**	NA			0.548	NA
Spontaneous		13,688 / 17,518 (78%)	8,527 / 10,767 (79%)	5,161 / 6,751 (76%)			5,185 / 6,750 (77%)	5,161 / 6,750 (76%)		
PG		1,579 / 17,518 (9.0%)	903 / 10,767 (8.4%)	676 / 6,751 (10%)			624 / 6,750 (9.2%)	676 / 6,750 (10%)		
EAB		339 / 17,518 (1.9%)	210 / 10,767 (2.0%)	129 / 6,751 (1.9%)			136 / 6,750 (2.0%)	129 / 6,750 (1.9%)		
PG and EAB		22 / 17,518 (0.1%)	15 / 10,767 (0.1%)	7 / 6,751 (0.1%)			10 / 6,750 (0.1%)	7 / 6,750 (0.1%)		
Oxytocin (for induction)		1,890 / 17,518 (11%)	1,112 / 10,767 (10%)	778 / 6,751 (12%)			795 / 6,750 (12%)	777 / 6,750 (12%)		
Oxytocin (all)	16,369	8,181 / 16,369 (50.0%)	4,862 / 10,060 (48.3%)	3,319 / 6,309 (52.6%)	**< 0.001**	0.086	3,246 / 6,336 (51.2%)	3,318 / 6,308 (52.6%)	0.187	0.027
Neuraxial anesthesia	17,518	13,531 / 17,518 (77%)	8,222 / 10,767 (76%)	5,309 / 6,751 (79%)	**< 0.001**	0.055	5,406 / 6,750 (80%)	5,309 / 6,750 (79%)	**0.039**	−0.036
Second stage length	9,124	76.00 (33.00, 132.00)	68.00 (29.00, 121.00)	89.00 (40.00, 144.00)	**< 0.001**	0.272	74.00 (33.00, 127.00)	89.00 (40.00, 144.00)	**< 0.001**	0.204

[1] Median (IQR) or Frequency (%)

[2] Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's exact test

ART assisted reproductive technology, *BMI* body mass index, *DM* diabetes mellitus, *EAB* extra-amniotic balloon, *GDM* gestational diabetes mellitus, *MOD* mode of delivery, *NA* not applicable, *PG* prostaglandins, *SMD* standardized mean difference and 5,220 (23.0%) VADs (Fig. 1). Episiotomy rates were 38.5% for the VD group and 75.8% for VAD group, with OASIs rates at 0.7% and 1.9%, respectively, leading to an overall OASIs rate of 1.0%. The rates of OASIs remained consistent throughout the study period.

In the VD subgroup, the median age was 27 years (IQR 24–30), median pre-pregnancy BMI was 27 kg/m^2 (IQR 21.93–29), and the median gestational age at delivery was 39 weeks and 5 days (IQR 38 6/7–40 2/7). The matching procedure effectively balanced key maternal characteristics between the groups, as evidenced by the significant reduction in SMDs for age, BMI, and other variables post-matching, denoting negligible differences between women with and without episiotomy. Specific details and metrics of the women's baseline characteristics are delineated in Table 1.

After matching, the VD subgroup comprised of 13,500 patients. The rates of OASIs did not significantly differ between groups (0.7% with episiotomy vs. 0.8% without, OR 1.15, 95% CI 0.78—1.69, $p = 0.489$).

Episiotomy was associated with a reduction in spontaneous grade 1 and grade 2 tears (50.8% vs. 10%, OR 0.11, 95% CI 0.10—0.12, $p < 0.001$), and an increased incidence of PPH (2.8% vs. 4.0%, OR 1.47, 95% CI 1.22—1.78, $p < 0.001$). Regarding neonatal outcome, NICU admissions and Apgar scores less than 7 at 5 min did not significantly vary between the two groups. However, episiotomy was linked to a higher occurrence of the composite neonatal outcome (4.8% without vs. 5.9%

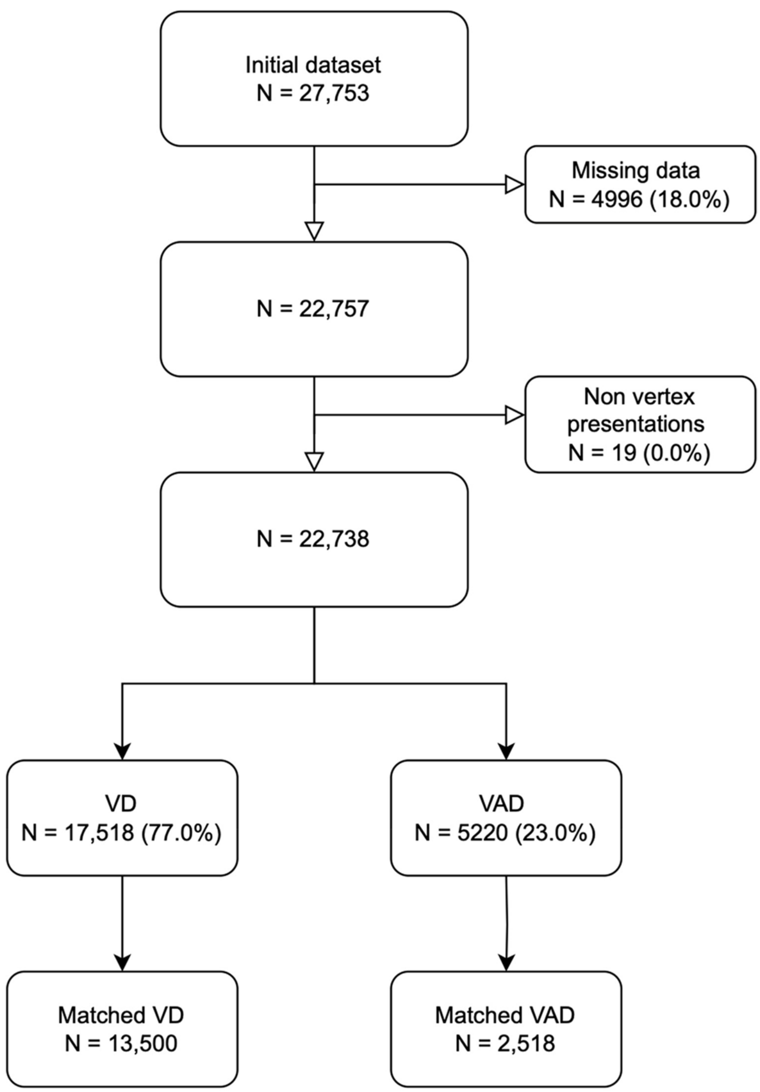

Fig. 1 Flow Chart. VD vaginal delivery; VAD vacuum assisted delivery

with episiotomy, OR 1.23, 95% CI 1.04—1.45, $p = 0.018$, Table 2).

In the VD subgroup, an adjusted logistic regression analysis was performed to assess the role of episiotomy in reducing the risk of OASIs while adjusting for the year of delivery and time in second stage of labor. The adjusted OR of 0.66 (95% CI: 0.39–1.08) remained non-protective against OASIs (Fig. 2).

In the VAD subgroup, the median age was 29 years (IQR 26–31), median pre-pregnancy BMI was 27 kg/m^2 (IQR 21.78–29), and median gestational age at delivery was pinpointed at 40 weeks and 0 days (IQR 39 0/7–40 4/7). Post-matching, these characteristics along with others demonstrated substantial equivalence between the groups, with negligible differences as evidenced by the SMDs. Comprehensive details and specific measures of the patient characteristics are detailed in Table 2.

The VAD subgroup, after matching, comprised 2518 women. In this subgroup, we observed a substantial, although non-significant, trend towards episiotomy being protective against OASIs, with occurrence of 2.3% in the no episiotomy group compared to 1.4% in the episiotomy group (OR 0.58, 95% CI 0.31–1.05, $p = 0.074$). The rate of episiotomy remained consistent throughout the study period ($P = 0.566$). The incidence of spontaneous grade 1 and 2 tears was significantly lower following episiotomy (11.0% vs. 20.0%, OR 0.47, 95% CI 0.37–0.59, $p < 0.001$). However, the episiotomy group experienced a higher rate of PPH (7.5% vs. 5.2%, OR 1.46, 95% CI 1.06–2.02, $p = 0.022$). No significant differences were noted in NICU admissions, umbilical artery pH less than 7.1, Apgar scores below 7 at 5 min, or the composite neonatal outcomes (Table 3).

In this subgroup of VAD, an adjusted logistic regression analysis was conducted to evaluate the role of episiotomy in reducing the risk for OASIs, while controlling for the length of the second stage of labor. The results showed that after adjusting for the length of the second stage of labor, episiotomy was associated with an OR of 0.39 for OASIs (95% CI: 0.16—0.86), yielding a number needed to teat (NNT) of 28 (95% CI 15—224). Figure 3 depicts this risk across time length of the second stage of labor, differentiated by episiotomy status.

Discussion

This study offers a comprehensive analysis of the role of mediolateral episiotomy in preventing OASIs during VD and VAD among nulliparous women. Our findings show that in the context of selective use, there is no significant protective effect of mediolateral episiotomy during VD. However, in VAD, mediolateral episiotomy exhibited a borderline significant protective effect against OASIs, which became statistically significant upon adjusting for the duration of the second stage of labor.

In a landscape of diverse findings on the prevention of OASIs [7–15, 18, 19], our study emerges with a robust dataset and refined analysis techniques, such as PS matching, which enhance the reliability of our conclusions [31]. By focusing on nulliparous women and the specific circumstances of VAD and prolonged second stage of labor (PSS), it contributes an important layer to the existing body of published evidence. Our findings align with previous studies and suggest enhanced benefits during extended second stages of labor in VAD, thus offering valuable evidence to inform clinical decisions in obstetric care [10, 11, 13, 16, 21].

The potential protective effect of episiotomy with respect to OASIs can be evaluated from two distinct perspectives: comparing the outcomes of restrictive versus routine episiotomy policies or assessing the direct association between episiotomy and the occurrence of OASIs. While varied results have been reported, with episiotomy being found protective, neutral, or even harmful in preventing OASIs, these findings often vary based on the population studied—nulliparous versus multiparous, or those undergoing VD versus OVD [7–15, 18, 19]. Current policy assessments and clinical guidelines predominantly endorse a restrictive use of episiotomy, advising its employment in select circumstances [22–24, 32].

Although our study did not directly compare these two approaches, episiotomy at our institution is not performed routinely but is instead subject to the clinical judgment and experience of the attending midwife or obstetrician. However, a considerable majority of nulliparous women undergoing VAD still receive an episiotomy. This approach reflects an individualized decision-making process, where episiotomy is performed when assessed to be necessary. It is reasonable to assume that while some of these episiotomies were performed for indications unrelated to OASIs, a portion was specifically aimed at reducing the risk of OASIs.

The relatively high rate of episiotomy in our facility, combined with the low rate of OASIs compared to global averages [1–4], suggests that we may tend to overestimate the risk of OASIs. On one hand, this overestimation likely contributes to a lower rate of OASIs; on the other hand, it may result in a higher rate of episiotomy and its associated complications. This balance may reflect the benefit of selective episiotomy use in reducing OASIs.

Previous studies have reported conflicting findings on the influence of second stage length on the risk of OASIs. It is postulated that the observed effects may be due to confounding factors associated with both second stage length and OASIs, such as large head circumference, increased fetal weight, malposition, higher BMI and OVD

Table 2 Patient characteristics – vacuum assisted delivery group

Variable	Before Matching, $N = 5{,}220$[1]						After Matching, $N = 2{,}518$[1]			
	N	Overall	No Episiotomy, $N = 1{,}261$	Episiotomy, $N = 3{,}959$	*P*-value[2]	SMD	No Episiotomy, $N = 1{,}259$	Episiotomy, $N = 1{,}259$	*P*-value[2]	SMD
Age, years	5,203	29.00 (26.00, 31.00)	29.00 (26.00, 32.00)	29.00 (26.00, 31.00)	0.104	−0.050	29.00 (26.00, 32.00)	28.00 (25.00, 31.00)	**0.005**	−0.114
Pre-pregnancy BMI, kg/m^2	2,377	27.00 (21.78, 29.00)	27.00 (23.05, 29.00)	27.00 (21.48, 29.00)	**< 0.001**	−0.219	27.00 (23.04, 29.00)	27.00 (22.72, 29.00)	0.942	0.004
DM, Type 1	5,214	32 / 5,214 (0.6%)	7 / 1,261 (0.6%)	25 / 3,953 (0.6%)	0.760	0.010	7 / 1,259 (0.6%)	6 / 1,259 (0.5%)	0.781	−0.011
DM, Type 2	5,214	4 / 5,214 (< 0.1%)	1 / 1,261 (< 0.1%)	3 / 3,953 (< 0.1%)	> 0.999	−0.001	1 / 1,259 (< 0.1%)	2 / 1,259 (0.2%)	> 0.999	0.023
GDM	5,214	334 / 5,214 (6.4%)	80 / 1,261 (6.3%)	254 / 3,953 (6.4%)	0.918	0.003	80 / 1,259 (6.4%)	61 / 1,259 (4.8%)	0.100	−0.066
Previous abortions	2,793	520 / 2,793 (18.6%)	100 / 538 (18.6%)	420 / 2,255 (18.6%)	0.433	−0.028	99 / 536 (18.5%)	101 / 541 (18.7%)	0.137	−0.057
ART	3,218	199 / 3,218 (6.2%)	58 / 801 (7.2%)	141 / 2,417 (5.8%)	0.152	−0.057	58 / 801 (7.2%)	55 / 906 (6.1%)	0.332	−0.047
Gestational age	5,220	40 + 0 (39 + 0, 40 + 4)	40 + 0 (39 + 0, 40 + 4)	40 + 0 (39 + 0, 40 + 4)	**0.033**	0.067	40 + 0 (39 + 0, 40 + 4)	40 + 0 (39 + 0, 40 + 5)	**0.007**	0.106
Induction	5,220	1,516 / 5,220 (29%)	307 / 1,261 (24%)	1,209 / 3,959 (31%)	**< 0.001**	0.139	306 / 1,259 (24%)	331 / 1,259 (26%)	0.252	0.046
Onset of Labor:	5,220				NA	NA			0.636	NA
Spontaneous		3,704 / 5,220 (71%)	954 / 1,261 (76%)	2,750 / 3,959 (69%)			953 / 1,259 (76%)	928 / 1,259 (74%)		
PG		602 / 5,220 (12%)	135 / 1,261 (11%)	467 / 3,959 (12%)			134 / 1,259 (11%)	136 / 1,259 (11%)		
EAB		129 / 5,220 (2.5%)	22 / 1,261 (1.7%)	107 / 3,959 (2.7%)			22 / 1,259 (1.7%)	26 / 1,259 (2.1%)		
PG and EAB		11 / 5,220 (0.2%)	0 / 1,261 (0%)	11 / 3,959 (0.3%)			0 / 1,259 (0%)	1 / 1,259 (< 0.1%)		
Oxytocin (induction)		774 / 5,220 (15%)	150 / 1,261 (12%)	624 / 3,959 (16%)			150 / 1,259 (12%)	168 / 1,259 (13%)		
Oxytocin (all)	5,029	2,602 / 5,029 (51.7%)	517 / 1,240 (41.7%)	2,085 / 3,789 (55.0%)	**< 0.001**	0.269	515 / 1,238 (41.6%)	520 / 1,238 (42%)	0.979	0.008
Neuraxial anesthesia	5,220	4,562 / 5,220 (87%)	1,116 / 1,261 (89%)	3,446 / 3,959 (87%)	0.174	−0.045	1,114 / 1,259 (88%)	1,144 / 1,259 (91%)	0.049	0.078
Second stage length	2,747	165.00 (88.00, 196.00)	159.00 (87.00, 194.00)	167.00 (88.00, 196.00)	0.182	0.060	159.00 (88.00, 194.00)	176.00 (108.00, 202.00)	**< 0.001**	0.212

[1] Median (IQR) or Frequency (%)

[2] Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's exact test

ART assisted reproductive technology, *BMI* body mass index, *DM* diabetes mellitus, *EAB* extra-amniotic balloon, *GDM* gestational diabetes mellitus, *MOD* mode of delivery, *NA* not applicable, *PG* prostaglandins, *SMD* standardized mean difference

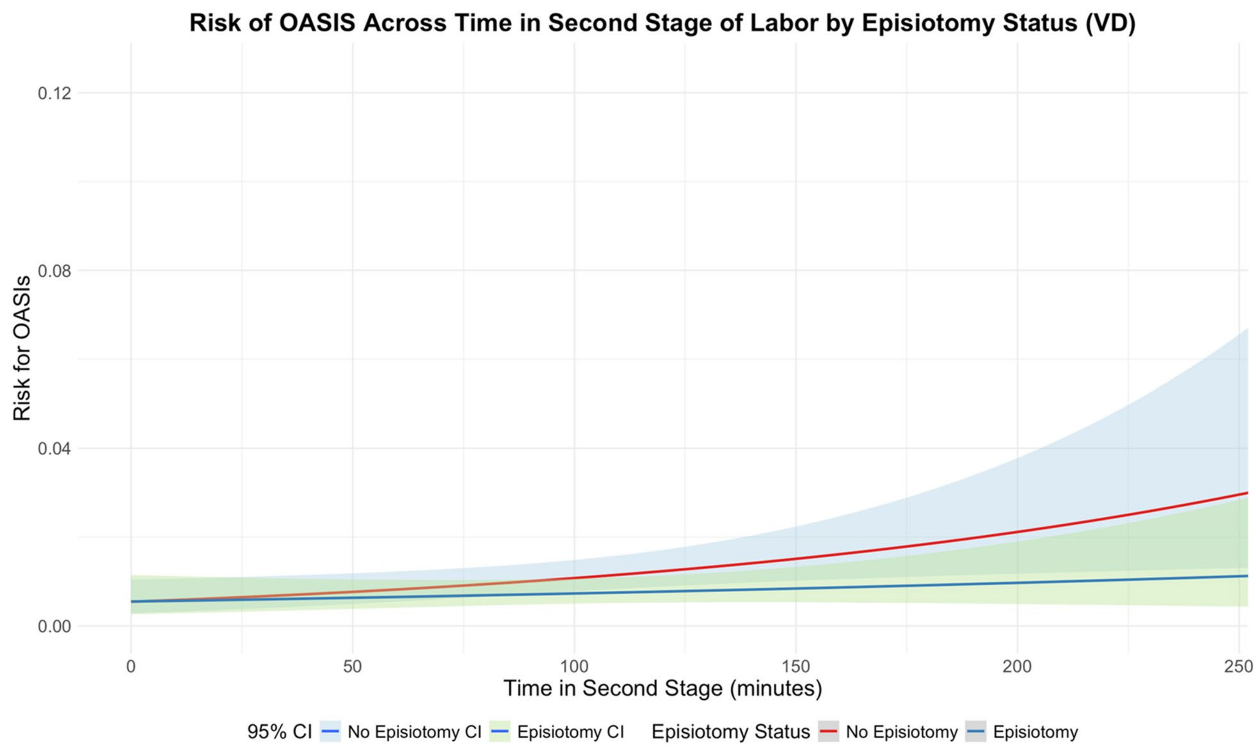

Fig. 2 Risk of OASIS across time in second stage of labor by episiotomy status (VD). CI confidence interval; OASIs Obstetric Anal Sphincter Injuries; VD vaginal delivery

Table 3 Results of mediolateral episiotomy and obstetric anal sphincter injuries in nulliparae

Variable	VD $N = 13,500$				VAD $N = 2,518$			
	No Episiotomy $N = 6,750$[1]	With Episiotomy $N = 6,750$[1]	P-value[2]	OR (95% CI)	No Episiotomy $N = 1,259$[1]	With Episiotomy $N = 1,259$[1]	P-value[2]	OR (95% CI)
Grade 1 and 2 tears	3,428 / 6,750 [50.8%]	688 / 6,747 [10%]	< 0.001	0.110 (0.100—0.121)	252 / 1,259 [20%]	133 / 1,259 [11%]	< 0.001	0.472 (0.375–0.590)
OASIs	48 / 6,750 [0.7%]	55 / 6,750 [0.8%]	0.489	1.147 (0.779–1.688)	29 / 1,259 [2.3%]	17 / 1,259 [1.4%]	0.074	0.580 (0.311–1.050)
PPH	188 / 6,750 [2.8%]	273 / 6,747 [4.0%]	< 0.001	1.472 (1.220–1.780)	66 / 1,259 [5.2%]	94 / 1,259 [7.5%]	0.022	1.458 (1.056–2.025)
NICU admission	238 / 6,676 [3.6%]	269 / 6,676 [4.0%]	0.160	1.136 (0.951–1.357)	120 / 1,219 [9.8%]	134 / 1,241 [11%]	0.437	1.109 (0.855–1.439)
Umbilical artery pH < 7.1	13 / 5,443 [0.2%]	29 / 5,209 [0.6%]	0.009	2.338 (1.240–4.656)	8 / 1,056 [0.8%]	5 / 1,029 [0.5%]	0.431	0.640 (0.193–1.924)
Apgar at 5 min < 7	19 / 6,750 [0.3%]	20 / 6,750 [0.3%]	0.873	1.053 (0.559–1.988)	12 / 1,258 [1.0%]	7 / 1,259 [0.6%]	0.249	0.581 (0.215–1.448)
Composite neonatal outcome[3]	261 / 5,412 [4.8%]	305 / 5,212 [5.9%]	0.018	1.227 (1.036-1.453)	129 / 1,042 [12%]	140 / 1,029 [14%]	0.407	1.115 (0.863–1.441)
Grade 1 and 2 tears	3,428 / 6,750 [50.8%]	688 / 6,747 [10%]	< 0.001	0.110 (0.100—0.121)	252 / 1,259 [20%]	133 / 1,259 [11%]	< 0.001	0.472 (0.375–0.590)

[1] Frequency [%]

[2] Pearson's Chi-squared test; Fisher's exact test

[3] Composite neonatal outcome was defined as umbilical artery pH < 7.1, neonatal intensive care unit admission, or 5-min Apgar score < 7

CI confidence interval, *NICU* neonatal intensive care unit, *PPH* post-partum hemorrhage, *OASIs* obstetric anal sphincter injuries, *OR* odds ratio, *VAD* vacuum-assisted delivery, *VD* vaginal delivery

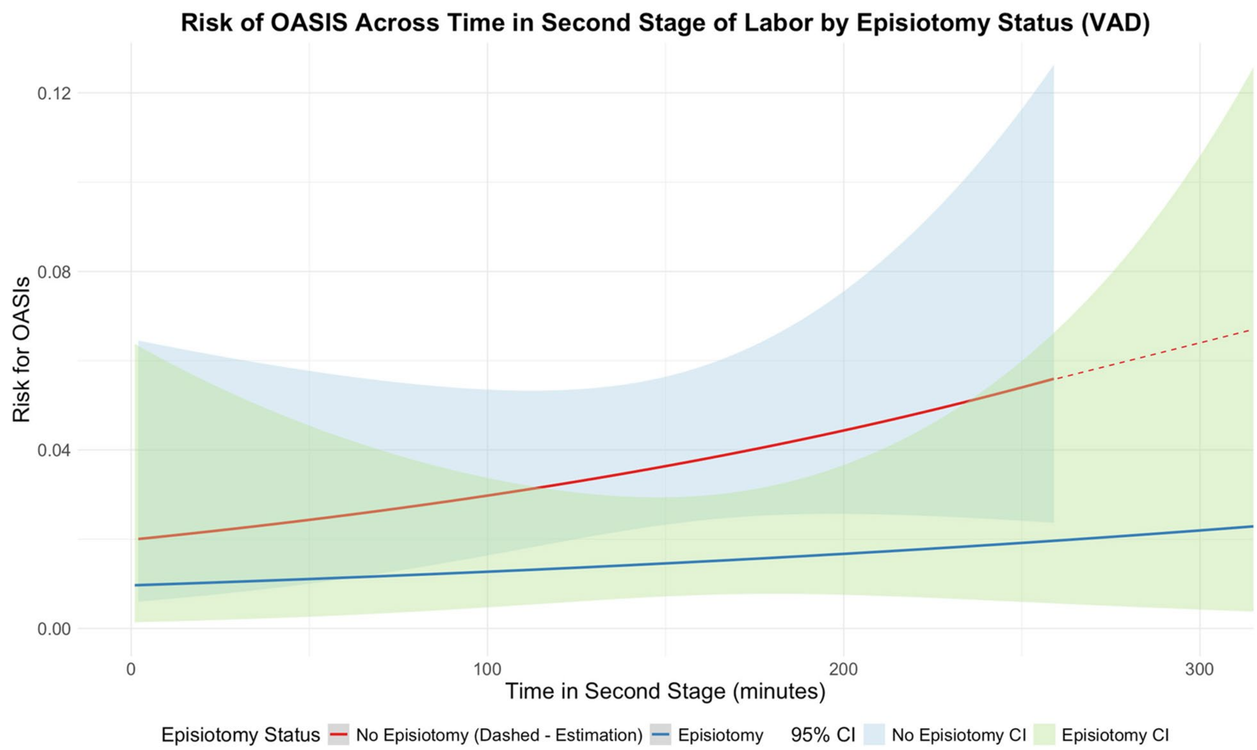

Fig. 3 Risk of OASIS across time in second stage of labor by episiotomy status (VAD). CI confidence interval; OASIs Obstetric Anal Sphincter Injuries; VAD vacuum assisted delivery

[33–38]. Our findings are consistent with this hypothesis; we observed that the risk for OASIs remained relatively stable across the duration of the second stage of labor in the VAD subgroup who underwent episiotomy. In contrast, the risk increases slightly with the progression of the second stage in the VAD subgroup without episiotomy, as illustrated in Fig. 3. This results in a widening gap in the risk for OASIs between patients with and without episiotomy as labor progresses. This pattern suggests that the protective effect of episiotomy may become more pronounced with an extended second stage of labor. In this study, we presented a NNT of 28 in the subgroup of women undergoing VAD with PSS of labor. However, it is important to note that the 95% CI was wide (15–224), reflecting the relatively smaller sample size in this subgroup ($n=462$).

As anticipated, and in line with previous studies, episiotomy has been shown to be in association with lower rates of minor spontaneous tears in both VD and VAD [39]. However, interpreting this and any other potential benefits of episiotomy requires prudence, as this is not the desired goal of an episiotomy. Episiotomy cannot be regarded as protective against minor tears, as it is itself an iatrogenic injury to the perineal skin and muscles, which is more severe [40–43]. Moreover, it is essential to consider episiotomy's potential benefits within the broader spectrum of associated risks, including the increased rates of PPH observed in our study and supported by existing literature for VD and VAD subgroups [44, 45], and with other potential drawbacks of episiotomy, such as dyspareunia, compromised pelvic floor function, sexual dysfunction, and perineal pain [8, 45, 46].

In circumstances where episiotomy is utilized to hasten delivery amidst fetal distress, its potential in mitigating OASIs may not be the primary consideration; instead, the justification for its use could lie in optimizing perinatal outcomes [47, 48]. In our study, a higher incidence of composite neonatal outcomes and lower pH levels were observed in conjunction with episiotomy use within the VD subgroup. Such associations likely reflect the use of episiotomy in urgent delivery situations, necessitated by fetal distress, rather than suggesting any direct adverse effect of episiotomy on fetal outcomes, for which there is no established clinical or biomechanical basis.

Clinical implications

Our findings suggest that while episiotomy may not significantly alter the rates of OASIs in VD, it potentially offers a protective benefit in VAD, especially when considering the length of the second stages of labor. The practice of mediolateral episiotomy, specifically when tailored to individual labor dynamics and not applied routinely, may allow clinicians to strategically mitigate the risk of severe perineal trauma.

Research implications

There remain unanswered questions regarding the long-term outcomes of selective episiotomy in this clinical context. Future research should explore the implications of episiotomy on maternal postpartum recovery, sexual function, long term pelvic floor health, as well as its potential impact on psychological well-being. Moreover, further studies should aim to delineate the specific clinical circumstances under which episiotomy provides the most benefit, and whether these benefits extend to different patient populations. Finally, the exploration of patient-centered outcomes and satisfaction would also be a valuable addition to the current body of research.

Strengths and limitations

The strength of our study lies in its large sample size, and the rigorous PS matching and logistic regression adjustment, which mitigate confounding factors and highlight the independent association of episiotomy with various outcomes. The comparison between matched and unmatched datasets did reveal statistically significant differences; however, these did not translate into clinical relevance. For example, while BMI exhibited a statistical difference due to the large sample size, the medians remained identical across datasets, underscoring the robustness of our matching process (Tables S1 and S2).

Our study is not without limitations. First, this study was a retrospective observational study. The inherent constraints of retrospective data collection and the possibility of unmeasured confounding should be considered when interpreting the results. Second, the incidence of OASIs could be underreported since ultrasound scans, necessary for identifying occult cases, were not systematically utilized. Third, we lack detailed information on the specific indications for performing episiotomy, such as the need to shorten the second stage of labor due to maternal or fetal concerns, or anatomical considerations like a short perineal length. It is reasonable to assume that the indication for performing an episiotomy influences its role in preventing OASIs. Forth, the practice of performing episiotomy is not standardized. Different physicians and midwifes may vary in their episiotomy technique (although all in this study were mediolateral) and in their interpretation of the indications for performing episiotomy. These variations may introduce heterogeneity in the outcomes and limit the generalizability of our findings. Fifth, we lack data on the long-term outcomes of episiotomy and OASIs, which limits our ability to assess whether performing episiotomy is beneficial or detrimental in the context of long-term effects. Sixth, we do not have information regarding the presentation (occiput anterior vs. occiput posterior). As occiput posterior presentation is a known risk factor for OASIs, including it in the matching process could have been advantageous.

Finally, as listed in Table 2, following matching there was still imbalance in the length of the second stage of labor. This change is expected because a main indication of VAD is PSS of labor and, in this setting, it is more likely for an episiotomy to be performed. For this reason, we performed an additional multivariate analysis with adjusting for the length of the second stage. This analysis is debatable in the context of PS matching; however, we believe it to be necessary in order to fully comprehend our observations. The fact that we got the similar results after adjusting for the time in second stage strengthens our conclusion.

Conclusion

In settings where mediolateral episiotomy is selectively employed, our findings suggest it may confer a protective effect against OASIs in nulliparous patients undergoing VAD. This protective effect could potentially become more pronounced as the length of the second stage of labor increases.

Abbreviations

ART	Assisted reproductive technology
BMI	Body mass index
CD	Cesarean delivery
CI	Confidence interval
DM	Diabetes mellitus
EAB	Extra-amniotic balloon
GDM	Gestational diabetes mellitus
IQR	Inter quartile range
MOD	Mode of delivery
NA	Not applicable
NICU	Neonatal intensive care unit
NNT	Number needed to treat
OASI	Obstetric anal sphincter injury
OR	Odds ratio
OVD	Operative vaginal delivery
PG	Prostaglandins
PPH	Post-partum hemorrhage
PS	Propensity score
PSS	Prolonged second stage
SD	Standard deviation
SMD	Standardized mean differences
VAD	Vaginal assisted delivery
VD	Vaginal delivery

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Supplementary Material 4.

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Not applicable.

Authors' contributions
All authors contributed to the study conception and design. The first draft of the manuscript was written by OB, and all authors commented on previous versions of the manuscript. Material preparation and data collection were performed by OB, OH, DC, BN, AP, AW and EH. Data analysis was done by OB and AW. All authors read and approved the final manuscript. Except for the substantial contribution to the conception of this work mentioned above, all authors read, revised and approved the draft and this final manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the local Institutional Review Board (0132–22-RMC) on September 13, 2022. All procedures performed in studies involving human participants were approved and in accordance with the ethical standards of the institutional research review board at Rabin Medical Center and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required. This article does not contain any studies with animals performed by any of the authors. The Rabin Medical Center institutional review board approved the study with waiver of informed consent due to the retrospective, observational design of the study.

Competing interests
The authors declare no competing interests.

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