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Vacuum-assisted delivery: maternal and neonatal outcomes at a tertiary research hospital

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Abstract

Objective: Vacuum-assisted vaginal deliveries are gradually decreasing due to the fear of complications. This study aimed to compare maternal and neonatal outcomes of vacuum-assisted vaginal deliveries with spontaneous deliveries.

Methods: All nulliparous women who underwent vacuum-assisted deliveries between October 1, 2018, and October 1, 2022, were included in our study, forming the case group. The control group comprised nulliparous women who experienced spontaneous vaginal delivery. We compared the demographic, maternal, and neonatal outcomes of the pregnant women included in both groups.

Results: Caput succedaneum was more prevalent in the vacuum-assisted vaginal delivery group ($p < 0.001$), with lower mean 1st and 5th minute APGAR scores compared to the spontaneous vaginal delivery group ($p < 0.001$, $p = 0.002$, respectively). No significant differences were observed between the two groups concerning cephalohematoma ($p = 0.269$), clavicle fracture ($p = 0.308$), respiratory failure ($p = 0.117$), jaundice ($p = 0.089$), and sepsis ($p = 0.772$). In terms of maternal complications, there were no significant differences between the groups in terms of grade 2/3 perineal tears ($p = 0.082$, $p = 0.159$, respectively), uterine atony ($p = 0.308$), cervical laceration ($p = 0.158$), and hysterectomy ($p = 0.32$)

Conclusion: These findings provide valuable insights for clinicians, suggesting that the use of vacuum assistance might be considered as an alternative before opting for cesarean delivery, especially when necessary indications arise during the second stage of labor.

Keywords: Instrumental delivery, nulliparous, operative birth, vaginal delivery

Introduction

Vaginal delivery rates in the world differ between countries. The vaginal delivery rate in the United States is 67.9%.[1] It is the stage of the final descent of the fetus at the stage of complete cervical dilation extending to fetal expulsion, which is the second of the three stages of labor. Prolongation of the second stage increases maternal and neonatal morbidity.[2] Cesarean section may be required in some cases. Notably, cesarean delivery during the second stage is associated with higher maternal morbidity compared to cesarean delivery in the first stage of labor.[3]

Operative vaginal delivery; is the vaginal delivery of the fetus using instruments such as vacuum or forceps in the second stage of labor and with necessary indications.[4] Indications for operative vaginal delivery such as fetal distress development, prolonged second stage of labor, maternal fatigue, insufficient pushing, and maternal diseases that impede pushing.[5] In the United States, vacuum-assisted vaginal deliveries are 2.6% of all vaginal deliveries.[6] In our country, this procedure is conducted selectively by a limited number of hospitals and experienced physicians. One prominent reason for obstetricians' hesitation toward operative vaginal delivery is the heightened medico-legal concerns. Notably, successful vacuum-assisted vaginal delivery has been shown to contribute to a reduction in cesarean rates.[7]

The primary objective of this study is to compare maternal and neonatal outcomes between nulliparous

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women who undergo vaginal delivery with vacuum assistance and those who do not.

Methods

This study was conducted on nulliparous women who gave birth in a tertiary obstetric center between October 1, 2018, and October 1, 2022. There were 19,197 births in our obstetric center during the study period. Of these births, 12,210 (63.6%) were spontaneous vaginal births, 132 (0.69%) were vacuum-assisted vaginal births, and 6,855 (35.71%) were cesarean births. The collected data were anonymized without personal data that could lead to patient identification. The procedures followed were by the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, revised in 2013. Group 1 included 98 nulliparous women with vacuum-assisted vaginal delivery. Group 2 included 205 nulliparous women who had spontaneous vaginal delivery. Inclusion criteria for the study; nulliparous, nulligravid, singleton pregnancy, vertex presentation, estimated fetal weight in the range of 2500-4000gr, above 34th gestational week. Multiple pregnancies, fetal distress, cesarean deliveries, multigravity, multiparity, and non-vertex presentations were not included in the study. Kiwi Omnicup® full delivery vacuum system is used as a vacuum device in our hospital. Vacuum extraction was applied to nulliparous pregnant women by the obstetrician-gynecologists due to a prolonged second stage of labor and maternal exhaustion. Routine episiotomy was systematically performed during delivery for all pregnant women enrolled in the study as part of the standardized protocol. In this study, maternal age, gestational week, newborn birth weight, newborn height, newborn gender, newborn head circumference, fetal biparietal diameter measurement (BPD) in ultrasonography, newborn Apgar scores, maternal prenatal and postnatal hemoglobin, hematocrit values and difference, maternal and neonatal complications, neonatal intensive care units (NICU) needs and delivery indications were examined. The study was planned as a retrospective cohort study. Institutional Ethics Committee approval was received (ID: 27/10/2021-206).

Statistical analysis

Data were statistically analyzed using International Business Machines (IBM, Armonk, NY, USA) Statistical Package for the Social Sciences (SPSS) Statistics for Windows v.20.0 (IBM Corp.). Number, percentage, mean, median, minimum, maximum, and standard deviation values were used in the analysis of the data. The analysis of the normal distribution of continuous variables was evaluated with the Kolmogorov-Smirnov test. Student t-test or Mann-Whitney U test was used for continuous variables in comparisons between groups. A p-value < 0.05 was considered statistically significant.

Results

Three hundred three pregnant women were included in the study, whom of 98 (32.34%) were vacuum-assisted vaginal delivery and 205 (67.65%) were spontaneous vaginal delivery. The two groups were similar in terms of maternal age (p = 0.650), gestational week (p = 0.20), newborn birth weight (p = 0.069), newborn length (p = 0.086), newborn head circumference (p = 0.110), newborn gender (p = 0.197) and fetus BPD (p = 0.052) (Table 1).

Table 1. Demographic parameter of the patients

	Group 1 (n = 98)	Group 2 (n = 205)	p
Age (year)	24.55 ± 4.71	24.3 ± 4.46	p = 0.65
Gestational age (week)	39.7 ± 1.27	39.53 ± 0.99	p = 0.2
Newborn birth weight (g)	3391.73 ± 362.10	3320.73 ± 293.27	p = 0.069
Newborn length (cm)	51.13 ± 2.18	50.7 ± 1.65	p = 0.086
Newborn head circumference (cm)	34.79 ± 1.45	34.52 ± 1.35	p = 0.11
Newborn gender			
Male	57 (58.2%)	103 (50.2%)	p = 0.197
Female	41 (41.8%)	102 (49.8%)	
Fetus BPD (mm)	91.82 ± 2.07	91.29 ± 2.28	p = 0.052

Values are presented mean ± SD and n (%). BPD: Biparietal diameter.

We observed that the indications for hospitalization due to polyhydramnios were significantly higher in the spontaneous vaginal delivery group compared to the vacuum-assisted vaginal delivery group (p = 0.014). However, no statistically significant differences were found between the groups regarding other indications (p > 0.05) (Table 2).

Table 2. Comparison of delivery indications at hospitalization between groups

	Group 1 (n = 98)	Group 2 (n = 205)	p
Pregnant in term action	52 (53.1%)	101 (49.3%)	p = 0.538
Preterem rupture of membranes	27 (27.6%)	63 (30.7%)	p = 0.572
Cholestasis	0 (0%)	3 (1.5%)	p = 0.083
Decreased fetal movements	1 (1%)	6 (2.9%)	p = 0.223
Polyhydramnios	0 (0%)	6 (2.9%)	p = 0.014
Oligohydramnios	13 (13.3%)	22 (10.7%)	p = 0.52
Hypertension	2 (2%)	2 (1%)	p = 0.449
IUGR	1 (1%)	1 (0.5%)	p = 0.594
Preeclampsia	2 (2%)	1 (0.5%)	p = 0.308

Values are presented n (%). IUGR: Intrauterine growth retardation.

The rate of caput succedaneum is higher in vacuum-assisted vaginal deliveries (p < 0.001). There was no statistically significant difference between the groups in cephalohematoma (p = 0.269) and clavicle fracture (p = 0.308). The two groups were similar in terms of respıratory failure (p = 0.117), jaundice (p = 0.089), and neonatal sepsis (p = 0.772) (Table 3).

Table 3. Comparison of groups in terms of neonatal outcomes

	Group 1 (n = 98)	Group 2 (n = 205)	p
Caput succedaneum	34 (34.7%)	29 (14.1%)	p < 0.001
Cephal hematoma	3 (3.1%)	2 (1%)	p = 0.269
Clavicle fracture	2 (2%)	1 (0.5%)	p = 0.308
Respiratory failure	12 (12.2%)	13 (6.3%)	p = 0.117
Jaundice	10 (10.2%)	9 (4.4%)	p = 0.089
Sepsis	4 (4.1%)	7 (3.4%)	p = 0.772

Values are presented n (%)

There was no statistically significant difference in maternal complications between the groups (p > 0.05) (Table 4).

Table 4. Comparison of groups with development of maternal complications

	Group 1 (n = 98)	Group 2 (n = 205)	p
Grade 2 Perineal tear	2 (2%)	12 (5.9%)	p = 0.082
Grade 3 Perineal tear	3 (3.1%)	1 (0.5%)	p = 0.159
Atony	2 (2%)	1 (0.5%)	p = 0.308
Cervical laceration	2 (2%)	0 (0%)	p = 0.158
Hysterectomy	1 (1%)	0 (0%)	p = 0.32

Values are presented n (%)

The mean 1st minute Apgar score was 7.41±0.96 in the vacuum-assisted vaginal delivery group, and 7.88± 0.40 in the spontaneous vaginal delivery group (p < 0.001). The mean 5th-minute Apgar score was 8,83 ± 0,59 in the vacuum-assisted vaginal delivery group, and 8,97 ± 0,16 in the spontaneous vaginal delivery group (p = 0.002). Newborn 1st minute (p < 0.001) and 5th minute (p = 0.002) Apgar scores were found statistically lower in vacuum-assisted vaginal deliveries. No statistically significant difference was observed in pre- and postnatal hemoglobin levels, as well as hemoglobin differences, between the groups (p > 0.05) (Table 5).

Table 5. Newborn Apgar scores and maternal hemogram parameters

	Group 1 (n = 98)	Group 2 (n = 205)	p
APGAR			
1st minute	7.41 ± 0.96	7.88 ± 0.40	p < 0.001
5th minute	8.83 ± 0.59	8.97 ± 0.16	p = 0.002
Prenatal Hb (g/dl)	11.71 ± 1.51	11.84 ± 1.45	p = 0.454
Postnatal Hb (g/dl)	10.06 ± 1.60	10.4 ± 1.54	p = 0.081
Difference of Hb (g/dl)	1.65 ± 1.24	1.47 ± 0.87	p = 0.2
Prenatal Hct (%)	35.45 ± 3.87	35.88 ± 3.62	p = 0.345
Postnatal Hct (%)	30.49 ± 4.58	31.54 ± 4.11	p = 0.047
Difference of Hct (%)	4.97 ± 3.90	4.36 ± 2.53	p = 0.161

Values are presented mean ± SD. APGAR: Activity Pulse Grimace Appearance Respiration. Hb: Hemoglobin. Hct: Hematocrit.

Discussion

In this study, we conducted a comprehensive comparison of maternal and neonatal outcomes between vacuum-assisted vaginal deliveries and spontaneous vaginal deliveries. Our findings revealed no significant differences between the groups concerning maternal age, gestational age at delivery, newborn birth weight, length, gender, head circumference, and fetal biparietal diameter (BPD) (p > 0.05). Peschers et al. in the study comparing vacuum-assisted vaginal deliveries and spontaneous va-

ginal deliveries, there was no difference in maternal age, newborn birth weight, and newborn head circumference between the groups.[8] These parameters exhibit no differences between the groups, underscoring the homogeneous distribution of participants. This similar distribution ensures that independent risk factors potentially influencing the results between the groups have been effectively eliminated.

The birth indications in women in the vacuum-assisted vaginal delivery group were pregnant at term labor 52 (53.1%), preterm rupture of membranes 27 (27.6%), decreased fetal movements 1 (1%), oligohydramnios 13 (13.3%), hypertension 2 (2%) and preeclampsia 2 (2%) the indications for hospitalization of operative vaginal deliveries in the study of Ture et al. were pregnant with term labor, term pain, overdue pregnancy 152 (51.87%), preterm rupture of membranes 68 (23.20%), decreased fetal movements 4 (1.36%), oligohydramnios 17 (% 5.8), hypertension 10 (3.41%) and preeclampsia 7 (2.38%).[9] The results are similar to our study. In both groups, the first two hospitalization indications for delivery are identical. This similarity arises from the relatively lower prevalence of other indications.

In this study, the rate of caput succedaneum was 34 (34.7%) in the vacuum-assisted vaginal delivery group and 29 (14.1%) in the spontaneous vaginal delivery group. The rate of caput succedaneum was significantly higher in newborns delivered with vacuum assistance ($p < 0.001$). Similar findings were reported by Abbas et al., where caput succedaneum occurred in 74 (47.1%) newborns in the vacuum-assisted vaginal group compared to 15 (2.5%) in the spontaneous vaginal delivery group.[10] Additionally, Lawani et al. found a higher rate of caput succedaneum in the vacuum-assisted vaginal delivery group, with 54 (11.71%) cases, compared to 5 (1.08%) in the spontaneous vaginal delivery group.[11]

Cephalohematoma developed in 3 (3.1%) newborns in the vacuum-assisted vaginal delivery group and in 2 (1%) newborns in the spontaneous vaginal delivery group. There was no statistically significant difference between the two groups in terms of cephalohematoma development ($p = 0.269$). Comparing these findings to previous studies, Abbas et al. reported a higher rate of cephalohematoma in the vacuum-assisted vaginal delivery group (14.6%) compared to the spontaneous vaginal delivery group (0.5%).[10] Ferraz et al. found a higher rate of cephalohematoma in the vacuum-assisted vaginal delivery group (1.9%) compared to the spontaneous vaginal delivery group (0.4%).[12] Egami et al. also reported a higher rate of cephalohematoma in the vacuum-assisted vaginal delivery group (19%) compared to the spontaneous vaginal delivery group (1%).[13] In our study, the caput succedaneum result is consistent with the literature. Contrary to the general literature, our study did not find a significant difference in cephalohematoma rates between the two groups, despite higher rates in the vacuum-assisted vaginal delivery group. In our clinic, we limit the number of vacuum applications to a maximum of three trials. If the vacuum intervention is unsuccessful after the third attempt, we discontinue the procedure. This approach may contribute to the lack of a significant difference in terms of cephalohematoma development observed in our study. Minor neonatal complications such as caput succedaneum and cephalohematoma are extracranial issues resulting from the suction force exerted on the fetal scalp due to negative pressure generated by the vacuum device. The dimensions of these complications are assessed through transcranial ultrasonography after birth. Typically, they spontaneously resolve within two weeks postpartum, without impacting neonatal morbidity and without necessitating medical intervention.[14] To minimize the occurrence of caput succedaneum and cephalohematoma, proper placement of the vacuum bell toward the flexion point of the fetal head, preventing unnecessary detachment from the fetal scalp, and adjusting the vacuum device arm following the rotation and descent of the fetal head during birth are recommended practices.[15]

In our study, we found the newborn 1st minute ($p < 0.001$) and 5th minute ($p = 0.002$) Apgar score averages to be lower in the vacuum-assisted vaginal delivery group. In a study by Levin et al. 1st minute Apgar score of infants was < 7 in 29 (5%) of vacuum-assisted deliveries and 10 (22%) of cesarean deliveries in the second stage of labor.[16] This difference is statistically significant ($p<0.05$). In the study conducted by Shumeli et al. 5th minute Apgar score of infants was < 7 0.5% in vacuum-assisted vaginal deliveries and 2.2% in cesarean deliveries in the second stage of labor.[17] This difference is statistically significant ($p<0.05$). The rate of newborns with a 1st and 5th minute Apgar score < 7 is higher in women with cesarean section in the second stage of labor compared to vacuum-assisted deliveries. In our study, although Apgar scores were lower in the vacuum-assisted vaginal delivery group than in the spontaneous vaginal delivery group, when we reviewed the literature, it was seen that the Apgar scores after cesarean delivery were lower than in vacuum-assisted deliveries. We suggest vacuum application before cesarean section in necessary indications in the second stage of labor.

In our study, there was no statistically significant difference between the two groups for grade 2/3 perineal tear, cervical laceration, atony, and hysterectomy ($p>0.05$). Lawani et al. found that perineal tears occurred

in 9 (1.95%) cases in the operative vaginal delivery group and in 7 (1.51) cases in the spontaneous vaginal delivery group.[11] The perineal tear was not statistically significant between both groups (p>0.05). In the study by Kreft et al. cervical laceration was found in 7 (0.8%) cases in the vacuum-assisted vaginal delivery group and in 9 (0.2%) cases in the spontaneous vaginal delivery group.[18] They found no significant difference between the two groups in terms of cervical laceration development (p>0.05). In our study maternal complications in vacuum-assisted vaginal deliveries and spontaneous vaginal deliveries were similar. Our findings align with the existing literature. The results we have presented regarding the development of maternal complications should encourage clinicians to consider the use of vacuum assistance.

The mean of maternal hemoglobin difference between prenatal and postnatal period in vacuum-assisted vaginal deliveries was 1.65 ± 1.24g/dl, and the mean of maternal hemoglobin difference between prenatal and postnatal period in spontaneous vaginal deliveries was 1.47 ± 0.87g/dl. The mean of maternal hematocrit difference between the prenatal and postnatal period in vacuum-assisted vaginal deliveries was 4.97 ± 3.90%, and the mean of maternal hematocrit difference between the prenatal and postnatal period in spontaneous vaginal deliveries was 4.36 ± 2.53%. There was no significant difference in hemoglobin and hematocrit change between groups (p > 0.05). Lawani et al. showed that postpartum bleeding occurred in 14 (3.03%) women in the operative vaginal delivery group and in 12 (2.6%) women in the spontaneous vaginal delivery group.[11] There was no statistically significant difference between the two groups regarding postpartum bleeding (p>0.05). The absence of a difference in terms of maternal complication development supports the result that there is no significant difference in hemoglobin and hematocrit changes between the two groups.

The strengths of our study are that it was conducted in nulliparous women and that the numbers in the case and control groups were high. The limitations of our study are its retrospective design and lack of long-term follow-up data.

Conclusion

We found that the development of cephalohematoma, clavicle fracture, respiratory failure, jaundice and sepsis did not increase significantly in vacuum-assisted deliveries. In addition, we found that vacuum-assisted deliveries did not significantly increase the development of grade 2/3 perineal tear, atony, cervical laceration, postpartum hemorrhage and hysterectomy compared to spontaneous vaginal deliveries. These results could encourage obstetricians to prefer vacuum-assisted vaginal delivery before cesarean section when necessary indications occur in the second stage of labor. Increasing rates of vacuum-assisted vaginal deliveries will decrease primary cesarean section rates. Operative vaginal deliveries should be included in the training of residents assistant doctors and the number of obstetricians trained and experienced in this field should be increased.

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