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Impact of Delivery Mode on Morbidity in Preterm Infants with Very Low Birth Weights (<1500 Grams)

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Abstract

The mode of delivery and gestational age for very-low-birth-weight (VLBW) preterm infants are not yet well established and are constant topics of debate. **Objective:** To analyze the impact of delivery mode on morbidity in preterm infants weighing less than 1500 g. **Results:** Among 21,957 births, 81 were analyzed; 53 were delivered vaginally, and 28 were delivered by cesarean section. The median maternal age, gestational age and body mass index among those delivered vaginally and by cesarean section were 20 years and 22.5 years, 27.6 weeks and 30.1 weeks, and 26.0 kg/m^2 and 27.8 kg/m^2, respectively. With respect to neonatal blood gas parameters, for those born vaginally and by cesarean section, the median pH was 7.32 and 7.24, the pCO_2 was 41.5 mmHg and 51.1 mmHg, and the pO_2 was 22.3 mmHg and 16 mmHg. The median fetal weight among those born by cesarean section and vaginally were 1180 g and 955 g, respectively. The median Apgar scores at the first and fifth minutes among those born by cesarean section and vaginally were 5.00 and 8.00 and 4.50 and 7.00, respectively. **Conclusion:** There was no significant difference between the results of vaginal and cesarean delivery for VLBW infants. Thus, further studies on this subject are needed.

Keywords

Prematurity, Very Low Birth Weight Newborns, Mode of Delivery, Epidemiology, Morbidity

1. Introduction

Preterm birth refers to the birth of a fetus at a gestational age between 22 and 37

weeks. [1] According to the Brazilian Unified Health System, 1.4% of births result in very-low-birth-weight (LBW) infants, defined as infants weighing less than 1500 g. Despite the low incidence of these births, this group of newborns (NBs) has a neonatal mortality rate of 12.5%, and among them, 37% die within the first year of life. The mortality rate is higher among very preterm NBs, reaching 93% among NBs at 23 gestational weeks; however, the survival rates progressively increase with increasing gestational age. [2]

Despite the great advances achieved by epidemiological investigations in the fields of perinatology and neonatal intensive care, one of the greatest challenges in this field is the choice of mode of delivery for VLBW infants. [2] According to the available literature, these fetuses tend to be born by cesarean section. However, the gestational age at which the benefits of birth by cesarean section outweigh the benefits obtained with vaginal delivery is not well established. [3] Thus, understanding the factors that determine the best survival rates is imperative in order to improve the care provided to this category of preterm births and to reduce adverse outcomes. [4]

The mode of delivery for VLBW infants has been widely debated, with the aim of identifying the best outcomes for those born by cesarean section compared with those born vaginally. Two studies must be emphasized. The first of these, performed at *King Abdulaziz Medical City-Jeddah,* Saudi Arabia, reported that the survival rates of VLBW infants with a gestational age of ≤ 26 weeks were better with cesarean section delivery (87.3%) than with vaginal delivery (71.8%). This study revealed an increase in the rates of cesarean deliveries for NBs up to 33 weeks, from 45% to 72%, between 1989 and 2018. [5] The second study, a Chinese retrospective cohort study, analyzed 242 preterm infants between 2015 and 2021 and revealed that there was no significant difference in the mortality of these children with respect to the mode of delivery. In the study, there appeared to be lower morbidity among infants born by cesarean section; however, when the outcomes of NBs were related to gestational age, the best results were related to a higher gestational age and not to the mode of delivery. Thus, it has been impossible to affirm the superiority of one mode of delivery over the other, so further studies on this subject are needed. [6]

Considering the relevance of the aforementioned data, this study was conducted to evaluate the perinatal impact of the indicated mode of delivery for NBs weighing less than 1500 g at the Department of Gynecology and Obstetrics of the General Hospital of Caxias do Sul.

2. Materials and Methods

A cross-sectional, retrospective study of data collected from a database of 21,957 births was conducted, and the perinatal impact of the type of delivery on VLBW infants weighing less than 1500 g delivered from 1998 to 2017 at the Department of Gynecology and Obstetrics of the General Hospital was evaluated. The following criteria were included in Caxias do Sul: primiparous pregnant woman without any known complications during pregnancy until birth, singleton pregnancy with

a live fetus, and cephalic presentation. We excluded causes of cesarean section other than those identified during labor. The following variables were evaluated: 1) maternal characteristics, including maternal age; body mass index (BMI) > 30 kg/m^2 (obesity grades 2 and 3), calculated from the weight of the pregnant woman at the beginning of pregnancy (according to the WHO criteria, obtained as the weight–square ratio height); 2) neonatal characteristics, including gestational age at delivery (calculated based on the first day of the last menstrual period and corroborated by early ultrasound or the Capurro index); fetal weight (in grams); pH, pCo_2, pO_2, HCO_3, and base excess (BE) in umbilical artery blood collected immediately after delivery; mode of delivery (vaginal with or without forceps and cesarean section); and the Apgar score at the 1st and 5th minutes of life.

In this study, an initial descriptive analysis of the data was conducted to obtain a comprehensive understanding of the characteristics of the dataset. This included measures of central tendency, dispersion, and distribution for the variables in question. In particular, the median was used as a key metric for both ordinal categorical and quantitative variables. For quantitative variables such as birth weight, the median and the interquartile range (IQR) offered an accurate representation of the central location of the data. This approach was crucial to establish a solid reference point for subsequent analyses, including ordinal regression, and to provide a clear and objective overview of the characteristics of the study population.

The current study focused on VLBW infants weighing less than 1500 g who were born to mothers without identifiable risk factors. The main objective of this study was to evaluate the impact of the type of delivery, vaginal delivery with or without forceps vs. cesarean section, on the Apgar score in the first and fifth minutes of the life of the neonate. Data analysis was performed using R software with the "MASS" package. The suitability of the model was evaluated with metrics such as the residual deviation and the Akaike information criterion (AIC).

3. Results

Among 21,957 births, 81 were analyzed using various physiological and neonatal metrics and, according to the aforementioned inclusion factors. Of these, 53 vaginal deliveries (65.4%) and 28 cesarean deliveries (34.6%) were selected. **Table 1** shows the descriptive analysis of the study population. In the sample, maternal age had a median of 21 years (IQR: 13 - 42), with a normality test (W) of 0.907, $p < 0.001$; the median gestational age was 29.4 weeks (20.0 - 37.2), $p = 0.803$; and the mean body mass index (BMI) was 26.45 kg/m^2 (IQR: 19.07 - 48.75), $p < 0.001$. With respect to blood gas parameters, in a subgroup of 39 neonates, the median pH was 7.27, the pCO_2 was 46.9 mmHg, and the pO_2 was 17.8 mmHg. The median HCO_3 concentration was 20.6 mmol/L, and the median BE was −5.8. Both pO_2 and BE were significant ($p < 0.001$).

The median fetal weight was 1040 g (IQR: 534 - 1490) ($p < 0.004$), and the difference was related to a higher gestational age. Importantly, the Apgar scores obtained were as follows: the median Apgar score in the first minute was 4.5 (n =

70), and that in the fifth minute was 7.0 (n = 69). The Apgar scores of preterm infants are typically lower than those of term infants. The recovery identified at the 5th minute reflects adequate care in the delivery room.

Table 1. Descriptive statistics of the population of the General Hospital of Caxias do Sul.

						Shapiro-Wilk	
	n	Median	IQR	Minimum	Maximum	W	p
Maternal age	81	21	7.0	13	42	0.907	<0.001
Gestational age	81	29.4	5.1	20.0	37.20	0.990	0.803
BMI	81	26.45	5.95	19.07	48.75	0.907	<0.001
pH	39	7.27	0.152	6.8	7.634	0.920	0.009
pCO_2	39	46.9	16.1	25.4	88.00	0.964	0.247
pO_2	39	17.8	11.85	4.2	61.40	0.883	<0.001
HCO_3	39	20.6	5.7	11.3	27.20	0.969	0.337
BE	39	−5.8	4.6	−21.7	−0.80	0.852	<0.001
Fetal weight	81	1.040	505	534	1.490	0.952	<0.004
Apgar 1 minute	70	4.5	6.0	0	9	0.893	<0.001
Apgar score 5 minutes	69	7.0	4.0	0	10	0.812	<0.001

Source: prepared by the authors (2024). Legend: maternal age in years; gestational age in months; BMI: body mass index in kg/m^2; fetal weight in grams; min: minute; HCO_3: bicarbonate; BE: base excess.

The descriptive analysis of the study population, considering both types of delivery, is presented in Table 2. In cases of vaginal delivery, the median maternal age was 20 years, the median gestational age was 27.6 weeks, and the BMI was 26.0 kg/m^2. In cases of cesarean delivery, these medians were 22.5 years, 30.1 weeks and 27.8 kg/m^2, respectively. The pregnant women who delivered their children by cesarean section were older and had a higher gestational age and slightly higher BMI than the women who delivered vaginally.

Regarding the neonatal gasometric parameters, there was a clear difference between the two types of delivery, but the difference was not significant. In the vaginal delivery group, the median pH was 7.32, the pCO_2 was 41.5 mmHg, and the pO_2 was 22.3 mmHg. Conversely, in the cesarean section group, the median pH was 7.24, the pCO_2 was 51.1 mmHg, and the pO_2 was 16 mmHg.

With respect to fetal weight, the LBW infants who were delivered by cesarean section had a median weight of 1180 g and those who were delivered vaginally had a median weight of 955 g. The Apgar scores at the first and fifth minutes were also slightly higher for neonates born by cesarean section, with medians of 5.00 and 8.00, respectively, than for those born vaginally, at 4.50 and 7.00, respectively. With respect to the Apgar score at the first and fifth minutes, the coefficients were −0.3512 and −0.4702, with p values associated with t values of −0.7577 and −0.9786, respectively, indicating that this relationship was not significant at the 0.05 level.

Table 2. Descriptive statistics for the type of delivery.

	Delivery method	Age	GI	BMI	pH	pCO_2	pO_2	HCO_3	BE	Weight	Apgar 1'	Apgar 5'
No.	Vaginal	53	53	53	18	18	18	18	18	53	44	44
	Cesarean section	28	28	28	21	21	21	21	21	28	26	25
Median	Vaginal	20	27.6	26.0	7.32	41.5	22.3	19.8	−6.20	955	4.50	7.00
	Cesarean section	22.5	30.1	27.8	7.24	51.1	16.0	21.5	−5.50	1.180	5.00	8
IQR	Vaginal	6.00	5.70	6.01	0.10	9.75	10.9	4.20	4.20	477	6.00	4.00
	Cesarean section	7.50	3.40	7.87	0.16	12.0	6.60	6.30	6.30	426	5.75	3.00
Minimum	Vaginal	13	20.0	19.1	7.07	25.4	4.20	14.5	−14.0	534	0	0
	Cesarean section	13	23.6	20.1	6.80	40.4	8.00	11.3	−21.7	585	0	0
Maximum	Vaginal	40	37.1	48.8	7.63	73.8	61.4	24.1	−2.60	1.490	9	10
	Cesarean section	42	37.2	47.1	7.32	88.0	34.3	27.2	−0.80	1.480	9	9

Source: Prepared by the authors (2024). Legend: IQR: interquartile range; GA: gestational age; BMI: body mass index; HCO_3: bicarbonate; BE: base excess; Weight: fetal weight; 1' and 5' Apgar score: 1st and 5th minute Apgar score.

4. Discussion

A review of the literature reveals that there are inconclusive results regarding the superiority of some delivery methods in relation to others since the current studies are quite discordant. Some studies have demonstrated advantages related to vaginal delivery, especially regarding lower rates of respiratory distress syndrome at birth. Other studies indicate the possible association between cesarean delivery and a higher incidence of persistent symptomatic ductus arteriosus, but further investigations are needed to clearly establish the superiority of vaginal delivery over cesarean section. [7]-[11]

There are also studies citing the possible advantages of cesarean section over vaginal delivery, especially regarding the lower incidence of intraventricular hemorrhage demonstrated in some of them [12]-[18]. The number of cesarean section births of preterm infants aged less than 26 weeks of gestation has increased significantly in the last decade in the United States. The justification for this increase is not convincingly supported in the literature. In this review, we summarize recent analyses suggesting that infants with a gestational age under 26 weeks who are delivered by cesarean section may have a survival advantage. The advisability of intervening in these pregnancies with cesarean sections to deliver these unborn children, however, remains uncertain. [19]

In an analysis of pregnant women who delivered by cesarean section, the median BMIs were 27.8 kg/m^2 for women who delivered by cesarean section and 26 kg/m^2 for women who delivered vaginally. A study in Caxias do Sul suggested a relationship between maternal obesity and increased cesarean section rates, among other factors, and in our study, we observed slightly higher BMI values among mothers who delivered their children by cesarean section. [9] Madi *et al.* reported associations between obesity, older age and cesarean delivery; however, no associations were detected with the Apgar score or gestational age, among

other variables. [20] A Saudi study compared the mode of delivery and rates of failure in progress in labor related to maternal height and BMI. The results found a higher failure rate of progression among pregnant women measuring 151 - 155 cm when compared to those measuring < 151 cm and those measuring > 155 cm. The newborns of pregnant women < 151 cm were significantly smaller. Laboring women with a BMI of >26 had a 12.1% rate of cesarean section due to failure to progress in labor and those of BMI < 26 was 5.2%. Therefore, the data found are in line with the higher rate of cesarean section in patients with higher BMI in this study. [21]

The median age of the patients was 22.5 years for those who had a cesarean delivery and 20 years for those who had a vaginal delivery, showing that maternal age was slightly higher for mothers whose NBs were delivered by cesarean section. Kasirer *et al*. reported that little is known about the association between maternal age and BLBW; however, they still concluded that neonatal outcomes differ with respect to maternal age in this class of neonates, with adverse perinatal outcomes being predominant among younger mothers. [22]

The median gestational age of mothers who gave birth vaginally was 27.6 weeks, which was lower than that of patients who underwent cesarean section (30.1 weeks); this directly influences the median weight of newborns born via the previously mentioned routes (vaginal, 955 grams; cesarean section, 1180 grams). The median Apgar scores at the first and fifth minutes were 4.5 and 7 for those born vaginally and 5 and 8 for those born by cesarean section, which is also directly related to the fact that the second group included, in general, fewer preterm NBs.

Regarding the arterial blood gas parameters of the normal umbilical cord for preterm infants, despite the difference between the results, they do not seem to be of any clinical significance.

5. Conclusion

The study demonstrated that mothers who delivered VLBW newborns by cesarean section had higher BMI and age than those who had a vaginal delivery. When we compare the APGAR score, the birth weight and the umbilical cord blood gas parameters, we realize that the differences in outcomes are only related to the slight difference in gestational age between the two studied groups. The results of this study indicate that there is no significant difference between vaginal and cesarean delivery for VLBW infants. This points to the need for additional studies to provide a more robust evaluation of these relationships.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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