The association of maternal BMI and fetal cord blood gases in parturients receiving phenylephrine during cesarean delivery

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Introduction

Obesity in pregnancy is associated with an increased risk of maternal and fetal complications such as hypertension, preeclampsia, diabetes mellitus, venous thromboembolism, and fetal death. Previous studies have shown an inverse relationship between maternal obesity and fetal cord pH in women having cesarean delivery (CD) under spinal anesthesia. However, in these studies, the management of spinal anesthesia-induced hypotension was not standardized, and the majority of cases were managed with ephedrine, which has been associated with fetal acidemia. Phenylephrine, which is now more commonly used, has been shown to be associated with better fetal outcomes compared to ephedrine. The purpose of this study was to examine the relationship between maternal body mass index (BMI) and fetal cord pH in a cohort that received only phenylephrine for spinal anesthesia-induced hypotension. We hypothesized that obesity does not increase the risk of lower umbilical arterial pH in women having cesarean delivery under spinal anesthesia and receiving a prophylactic phenylephrine infusion.

Materials and Methods

This was a retrospective cohort study of all scheduled CD between January 2012 to March 2019 in non-laboring parturients with non-anomalous singleton ≥ 37 weeks gestational age. Women with birth weight < 2,500 g, hypertension, preeclampsia, gestational hypertension, maternal cardiac disease, non-reassuring stress test were excluded. Multivariate linear regression was used to assess whether BMI, race, maximum decrease in systolic blood pressure (SBP) before delivery, time from anesthesia induction-to-delivery, baseline systolic blood pressure, and total dose of phenylephrine received predicted fetal cord arterial pH. The Akaike information criterion (AIC) was used to compare model fits for a large number of predictor sets. Induction of anesthesia to delivery time, maximum decrease in systolic blood pressure, race and maternal BMI were selected by AIC for the final model.

Results

Review of electronic medical records yielded a total of 2,902 cesarean deliveries between March 2012 and January 2019. A total of 761 mother-neonate pairs were included in the data analysis. The mean umbilical arterial pH varied across the BMI categories, and was significantly lower with increasing maternal BMI (p = <0.01). In the univariate model, all the covariates were significant predictors of umbilical arterial pH (p = <0.01). When umbilical arterial pH was treated as a continuous variable, the final multivariate regression model indicated that the four predictors explained 9.8% of the variance in the outcome , R^2 = 0.098. However, maternal BMI was no longer a significant predictor for fetal cord arterial pH (p = 0.36).

Table 1: Patient characteristics stratified by BMI categories

	BMI (kg/m²)					*p* -Value
	<25	25-29.9	30-34.9	35-39.9	≥40	
Number	43	204	233	130	151	
Age (Y)	30.5 ± 4.8	31.4 ± 5.0	31.1 ± 5.2	31.3 ± 6.0	30.1 ± 5.3	0.21
Parous	32 (74%)	163 (80%)	207 (88%)	116 (89%)	141 (93%)	0.0003
Ethnicity						0.3
White	30 (70%)	154 (75%)	158 (68%)	91 (70%)	111 (73%)	
Black	4 (9%)	18 (9%)	32 (14%)	20 (15%)	22 (15%)	
Other	9 (21%)	32 (16%)	43 (18%)	19 (15%)	18 (12%)	
Indications for CD						0.04
Prior cesarean	25 (58%)	138 (67%)	171 (73%)	98 (75%)	115 (76%)	
Breech / Transverse	13 (30%)	40 (20%)	30 (13%)	17 (13%)	15 (10%)	
Other *	5 (12%)	26 (13%)	32 (14%)	15 (12%)	21 (14%)	
Gestational Age (weeks)	39.2 ± 0.5	39.2 ± 0.6	39.3 ± 0.6	39.2 ± 0.6	39.2 ± 0.5	0.78
Birth weight (g)	3247 ± 683	3441 ± 410	3583 ± 460	3773 ± 563	3744 ± 557	<0.001
Induction of Anesthesia to Delivery Time (min)	23.91 ± 5.5	25.6 ± 6.9	26.76 ± 6.9	27.37 ± 8.5	30.23 ± 9.9	
Baseline SBP	114 ± 9	117 ± 11	120 ± 10	123 ± 12	123 ± 13	<0.001
Baseline DBP	73 ± 8	73 ± 9	73 ± 9	74 ± 9	74 ± 11	0.81
Maximum decrease in SBP	15 ± 12	15 ± 14	18 ± 16	20 ± 15	23 ± 18	<0.001
Total phenylephrine dose (micrograms)	1612 ± 815	2117 ± 2299	2243 ± 3084	2300 ± 1494	3107 ± 2278	<0.001

Data are reported as mean ± standard deviation or number (percentage)

BMI, body mass index

* Includes maternal indication, macrosomia, unstable lie and unknown

Table 2: Neonatal outcome data stratified by BMI category

	BMI (kg/m²)					*p* -Value
	<25	25-29.9	30-34.9	35-39.9	≥40	
Number	43	204	233	130	151	
pH	7.29 ± 0.05	7.29 ± 0.05	7.28 ± 0.06	7.28 ± 0.05	7.27 ± 0.07	<0.01
pH ≤ 7.21	0	1 (0.5%)	5 (2.0%)	1 (0.8%)	4 (2.6%)	<.01
Base deficit (mmol/L)	1.58 ± 2.17	1.39 ± 2.17	1.53 ± 2.53	1.49 ± 2.39	1.67 ± 2.91	0.89
Apgar 1 min	8 (8,9)	8 (7,9)	8 (7,9)	8 (7,9)	8 (7,9)	0.14
Apgar 5 min	9 (9,9)	9 (9,9)	9 (9,9)	9 (9,9)	9 (9,9)	0.07
NICU admission	1(2%)	5 (2.4%)	13 (5.6%)	6 (4.6%)	11 (7.3%)	0.30

Data are reported as mean ± standard deviation, median (interquartile range) and number (percentage)

BMI, body mass index

NICU, Neonatal intensive care unit

Table 3. Univariate and Multivariate Regression results for umbilical cord arterial pH

	Univariate			Mutivariate: Continuous			Mutivariate: Categorical (pH <=7.21 vs pH> 7.21)			
	B	SE	p	B	SE	p	B	odds ratio	SE	p
Intercept	-	-	-	7.324	0.01	<.01	-3.3	0.04	0.65	<.01
BMI (ref = < 25)										
25-29.9	0.00	0.01	0.74	-0.002	0.01	0.81	-0.65	0.52	0.62	0.29
30-34.9	0.01	0.01	0.41	-0.003	0.01	0.78	-0.21	0.81	0.58	0.71
35-39.9	0.01	0.01	0.37	-0.002	0.01	0.82	-0.6	0.55	0.64	0.35
≥ 40	0.02	0.01	0.01	-0.013	0.01	0.19	0.23	1.26	0.59	0.7
IADT	0.00	0.00	0.00	-0.001	0	0.01	0.02	1.02	0.01	0.29
Race (ref=1)										
2	0.02	0.01	0.01	-0.014	0.01	0.03	0.36	1.43	0.36	0.32
3-7	0.01	0.01	0.18	-0.008	0.01	0.15	0.39	1.48	0.34	0.24
Max decrease in SBP	0.00	0.00	<.01	-0.001	0	<.01	0.03	1.03	0.01	<.01

BMI = Body Mass Index (kg/m²)
IADT = Induction of Anesthesia to Delivery Time

Conclusion

Our study demonstrates that increasing maternal BMI is associated with lower fetal umbilical arterial cord pH. The relationship between BMI and umbilical arterial pH however ceased to exist after adjusting for changes in blood pressure. The decrease in umbilical arterial pH is likely due to the larger decrease in intraoperative blood pressure we observed with increasing BMI, possibly due to increased weight of the abdominal wall in these parturients impairing venous return and placental perfusion. These findings suggest that tighter hemodynamic goals may be necessary when managing hypotension during CD in obese women. In addition, reducing the time between induction of spinal anesthesia-to-delivery of the fetus may improve neonatal outcomes.

References

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