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Comparative analysis of blood gas and biochemical parameters in neonatal pups delivered by Eutocia and caesarean section

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Abstract

The present study evaluated respiratory and metabolic adaptation in neonatal puppies delivered by eutocia and caesarean section using blood gas and biochemical analysis. A total of 512 neonates were categorized into eutocia (n = 237) and caesarean section (n = 273) groups. Venous blood samples were collected immediately after birth (0 min) and at 60 min postpartum and analyzed using a blood gas analyzer. Parameters assessed included pH, pCO₂, pO₂, sO₂, bicarbonate, electrolytes, glucose, lactate, hematocrit, hemoglobin, and base excess. Significant differences ($p < 0.05$) were observed between delivery modes and sampling times for multiple variables. Eutocia-born pups demonstrated faster physiological stabilization than caesarean-delivered pups. Blood gas analysis proved to be a reliable tool for assessing neonatal vitality and acid-base status immediately after birth.

Keywords: Blood gas analysis, neonatal pups, Eutocia, caesarean section, acid-base balance, lactate

Introduction

The neonatal period represents a critical transitional phase from intrauterine to extrauterine life characterized by rapid physiological and metabolic adaptation. In dogs, early development comprises neonatal (birth-2 weeks), infant (2-6 weeks), and pediatric stages (6-12 weeks). Neonatal mortality remains a major concern in veterinary medicine, with reported morbidity and mortality rates ranging from 5-35%. Hypoxia is one of the primary causes of neonatal depression and can be evaluated through blood gas analysis, which provides valuable information regarding respiratory and metabolic status.

Clinical assessment of newborn animals is often challenging due to limited examination feasibility and lack of diagnostic indicators, which may result in empirical treatment approaches. Mortality in puppies born through normal delivery is reported to be approximately 5.5%, whereas caesarean-delivered neonates show mortality rates between 6% and 11%. Blood gas analysis is routinely used in neonatology to assess acid-base disturbances and guide clinical intervention. Applying similar diagnostic approaches in veterinary neonatology may improve early detection of respiratory distress and metabolic imbalance.

The objective of the present study was to compare blood gas, electrolyte, and metabolic parameters in puppies delivered through eutocia and caesarean section at defined postnatal intervals to determine the influence of delivery mode on early neonatal physiological adaptation.

Materials and Methods

The study was conducted at veterinary hospitals in Hyderabad, India, between January 2020 and July 2022. Neonates were grouped based on mode of delivery into eutocia and caesarean section groups. Blood samples were collected immediately after birth and at 60 minutes postpartum from the jugular vein using sterile syringes and analyzed using a blood gas analyzer. Parameters measured included pH, pCO₂, pO₂, oxygen saturation, bicarbonate, electrolytes, glucose, lactate, hematocrit, hemoglobin, and base excess. Statistical comparisons were performed between groups and sampling intervals, and differences were considered significant at $p < 0.05$.

Results

Significant differences were observed in several blood gas and biochemical parameters between delivery modes and time intervals. Blood pH increased significantly from birth to 60 minutes in both groups, with greater improvement in eutocia pups. Partial pressure of carbon dioxide decreased significantly over time, indicating progressive respiratory adaptation, while caesarean-delivered pups exhibited higher initial values. No significant temporal change was observed in pO₂ values. Bicarbonate concentrations increased significantly, indicating correction of metabolic acidosis. Electrolyte variations were observed between groups, and caesarean pups showed comparatively lower calcium concentrations. Blood glucose increased in eutocia pups but decreased in caesarean pups. Lactate levels declined significantly in both groups. Hematocrit, hemoglobin, and base excess values also differed significantly between delivery modes.

Blood Parameters	Labor	Evaluation	
		At birth	After 60min
pH	Eutocia	7.02±0.01 ^{bB}	7.20±0.01 ^{aA}
	Caesarean	7.07±0.01 ^{aB}	7.13±0.01 ^{bA}
pCO ₂ (mmHg)	Eutocia	50.14±1.09 ^b	47.63±1.15 ^a
	Caesarean	50.54±0.94 ^{aA}	46.07±0.92 ^{bB}
pO ₂ (mmHg)	Eutocia	18.00±0.99 ^b	16.10±0.89 ^b
	Caesarean	20.08±0.80 ^a	18.79±0.88 ^a
sO ₂ (%)	Eutocia	27.02±1.05 ^{bA}	23.33±0.63 ^{bB}
	Caesarean	28.05±1.01 ^{aA}	23.96±0.62 ^{aB}
HCO ₃ (mmol/L)	Eutocia	20.01±0.37 ^{bB}	22.26±0.34 ^{bA}
	Caesarean	22.87±0.51 ^{aB}	23.25±0.71 ^{aA}
Na (mmol/L)	Eutocia	143.28±1.11 ^a	142.65±1.11 ^b
	Caesarean	143.00±1.30 ^b	143.20±0.98 ^a
K (mmol/L)	Eutocia	4.11±0.11 ^b	4.23±0.10 ^b
	Caesarean	4.14±0.10 ^{aB}	4.49±0.10 ^{aA}
Ca (mmol/L)	Eutocia	1.61±0.02 ^{aA}	1.56±0.01 ^{aB}
	Caesarean	1.50±0.01 ^{bA}	1.43±0.03 ^{bB}
Cl (mmol/L)	Eutocia	111.14±1.71 ^a	109.51±1.69 ^b
	Caesarean	110.18±1.66 ^b	112.11±1.76 ^a
Glucose (mg/dL)	Eutocia	104.33±1.72 ^{aB}	122.88±1.21 ^{aA}
	Caesarean	100.82±1.99 ^{bA}	74.42±1.89 ^{bB}
Lactate (mmol/L)	Eutocia	7.03±0.09 ^{bA}	5.39±0.16 ^{aB}
	Caesarean	7.05±0.20 ^{aA}	5.05±0.14 ^{bB}
Haematocrit (%)	Eutocia	47.56±0.70 ^b	47.19±0.71 ^b
	Caesarean	54.39±0.58 ^{aB}	57.02±0.39 ^{aA}
Hemoglobin (g/dL)	Eutocia	14.75±0.14 ^{aA}	14.32±0.13 ^{bB}
	Caesarean	9.11±0.18 ^{bB}	18.46±0.12 ^{aA}
BE (Base excess in blood) (mmol/L)	Eutocia	-6.59±0.21 ^{bA}	-4.28±0.18 ^{aB}
	Caesarean	-7.80±0.18 ^{aA}	-2.99±0.12 ^{bB}
BE (Base excess in ECF) (mmol/L)	Eutocia	-10.58±0.18 ^{bB}	-11.24±0.12 ^{aA}
	Caesarean	-11.02±0.12 ^a	-11.02±0.12 ^b

^{a,b} Different superscript lowercase letters indicate significant differences ($p < 0.05$) between groups in the same evaluation period

^{A,B} Different superscript uppercase letters indicate significant differences ($p < 0.05$) between evaluation period with in same group

Conclusion

Blood gas and biochemical parameters differed significantly between delivery modes and postnatal intervals. Puppies delivered through eutocia exhibited faster physiological recovery than those delivered via caesarean section. Blood gas analysis is a valuable diagnostic tool for evaluating neonatal viability immediately after birth.

Discussion

Blood gas and metabolic evaluation is an important diagnostic tool for assessing neonatal vitality. Both groups exhibited low pH and high pCO₂ at birth, indicating respiratory acidosis. Elevated pCO₂ stimulates neonatal respiratory reflexes and facilitates adaptation. Lactate concentrations reflected tissue oxygenation status and neonatal viability. Higher pCO₂ values observed in caesarean-delivered pups may be attributed to anesthetic-induced respiratory depression and delayed pulmonary fluid clearance. Lower calcium concentrations in surgically delivered neonates may impair uterine contractility and contribute to fetal stress. Glucose variations were likely related to differences in timing of nursing. Overall, delivery mode significantly influenced neonatal physiological adaptation, with eutocia-delivered pups demonstrating faster normalization of physiological parameters.

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