

# FOETAL UMBILICAL BLOOD GAS AND ACID BASE BALANCE AFTER CAESAREAN DELIVERIES UNDER GENERAL AND SPINAL ANAESTHESIA

by

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## SUMMARY

Blood pressure, pulse rate, arterial blood  $O_2$  and  $CO_2$  tensions and pH were measured before anaesthesia and at the time of delivery of foetuses in two groups of women undergoing elective caesarean section, one, under general and the other, under spinal anaesthesia. Foetal weights, Apgar scores at 1 and 5 min after delivery and induction-delivery intervals were noted. Blood samples from umbilical vein and artery were collected immediately after delivery of the infants and were analysed for  $O_2$  and  $CO_2$  tensions and pH. On the basis of Apgar scores and umbilical vessel blood gas analysis no significant difference was seen in the infants delivered by caesarean section under general or spinal anaesthesia. Maternal status (i.e., blood pressure, arterial blood gas tensions and acid-base balance) also showed no difference whether a general or a spinal anaesthetic was used. Only the maternal pulse rate in spinal anaesthesia group was significantly higher at the time of foetal delivery. It has been concluded that the foetal and maternal status remains normal whether one gives general or spinal anaesthesia for caesarean deliveries in normal healthy full term pregnant women.

### Introduction

Choice of an anaesthetic technique even for elective caesarean sections in fully prepared patients is controversial. Spinal anaesthesia enjoys an unenviable reputation

so much so that the use of the technique is banned in certain regions (Macintosh and Lee, 1973). A detailed evaluation of foetal and maternal blood gas and acid-base status in caesarean operations under general anaesthesia and under spinal block has not been widely reported. The present study was undertaken for assessment of foetal biochemical status after caesarean deliveries

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under spinal anaesthesia and to compare it with the status seen after caesarean deliveries under a standard general anaesthetic technique. Maternal blood gas studies were included to see if the foetal status bears any correlation with the mothers biochemical status.

#### *Material and Methods*

This study on the effects of general anaesthesia and spinal subarachnoid block, at caesarean section, on the blood gas tensions and acid-base balance of the mother and the neonate was carried out in two groups of 8 subjects each. All subjects underwent elective caesarean sections performed before the onset of spontaneous labour. The subjects were randomly allocated to the two groups. That only normal healthy pregnant women were included in the study, was assured by detailed history and thorough clinical and laboratory check up.

A femoral artery blood sample was drawn from the mothers before anaesthetic induction and at the time of delivery of the foetus from the uterus.

Foetal umbilical vein and umbilical artery blood samples were drawn after delivery, from a long segment of the umbilical cord isolated between two clamps at the time of delivery.

A trained paediatrician assessed the Apgar scores at 1 minute and 5 minutes after delivery. Infant weight was also recorded. No disparity was seen in the gestational age of infants and the recorded gestation time.  $\text{PaO}_2$ ,  $\text{PaCO}_2$  and pH of the maternal and foetal blood samples were measured using a PHM72 digital acid-base analyser and BMS MK<sub>2</sub> Blood Micro System (Radiometer, Copenhagen). Base excess and blood bicarbonate values were derived by interpolation of  $\text{PaCO}_2$  and pH

readings on a Siggaard-Andersen Nomogram (1963).

*Anaesthetic techniques:* Spinal subarachnoid block was given in the lateral position via a lumbar puncture through L<sub>2</sub>-L<sub>3</sub> lumbar interspinous space, injecting 1.5 ml of heavy bupivacaine. The subjects were immediately turned supine on a horizontal table with a pillow under the neck and head. Blood pressure was frequently monitored and any tendency to excessive hypotension (i.e. the systolic pressure falling below 80 mmHg) was counteracted by rapid intravenous glucose or saline infusion. No vasopressure was required or used.

General anaesthesia was induced with 3-5 mg/kg thiopentone and 1 mg/kg suxamethonium. Respiration was manually controlled after intubation maintaining paralysis with supplements of suxamethonium till foetal delivery and later with pancuronium.

All patients in the two groups were premedicated with atropine 0.6 mg and promethazine 25 mg, given intramuscularly, one hour before induction of anaesthesia.

Student 't' tests as applicable for between- and within-group comparisons were used for statistically comparing means and for evaluating the significance of mean changes. Mean blood pressures were calculated by adding one-third of pulse pressure to the diastolic pressure (Jennings, 1964) and tabulated for further statistical analysis. Apgar scores were compared by the method of Ridit analysis (Pandey, Ratra and Badola, 1967). Mean pH values were computed by first converting the pH values into hydrogen ion concentrations (cH) and then reconverting the mean and S.E. value of cH to pH (Hill, 1967). Correlations between maternal and foetal  $\text{PaO}_2$  and  $\text{PaCO}_2$  values were assessed by calculating correlation coefficients (Bailey, 1959).

*Observations*

The mean values of age, body weight, height, haemoglobin concentration, gestation time and induction-delivery interval were comparable in the two groups (Table I).

Mean values of the maternal mean blood pressures and pulse rates before induction of anaesthesia (control) and at the time of foetal delivery are shown in Table II. The spinal anaesthesia group showed a significantly higher mean maternal pulse rate at foetal delivery. The mean blood pressures at delivery were significantly lower than control values in both groups.

Table III shows the mean values of arterial blood oxygen and carbon dioxide tensions along with acid-base balance data (pH, standard bicarbonate and base excess) before anaesthesia and at the time of delivery of the foetus from the uterus, in the two groups of mothers undergoing caesarean section under general and spinal anaesthesia, respectively. The control values are within the normal range seen in the laboratory for comparable adults. No significant changes occurred during anaesthesia till the foetal delivery. The corresponding mean values in the two groups were also statistically comparable.

TABLE I

*Mean ( $\pm$  SE) Values of the Indicated Parameters in the Two Groups of Women Undergoing Caesarean Section Under General and Spinal Anaesthesia*

Group & Anaesthesia	Age (yrs)	Body weight	Height (cm)	Haemoglobin (g%)	Gestation time (weeks)	Induction-delivery interval (min)
I (General)	24.6 $\pm$ 2.1	49.2 $\pm$ 1.1	149.9 $\pm$ 1.1	11.3 $\pm$ 0.3	38.1 $\pm$ 0.3	17.6 $\pm$ 1.0
II (Spinal)	26.9 $\pm$ 1.4	49.0 $\pm$ 1.6	147.8 $\pm$ 1.1	10.9 $\pm$ 0.2	38.3 $\pm$ 0.5	16.1 $\pm$ 2.5

No Significant difference between corresponding group means ( $p > 0.05$ ).

TABLE II

*Mean ( $\pm$  SE) of Mean Blood Pressure and Pulse Rate of Mothers Before Anaesthesia (Control) and at Foetal Delivery*

Group & Anaesthesia	Mean blood pressure (mmHg)		Pulse rate (b.p.m.)	
	Control	At foetal delivery	Control	At foetal delivery
I (General)	96.0 $\pm$ 2.3	88.8@ $\pm$ 3.0	84.0 $\pm$ 3.1	87.5 $\pm$ 2.8
II (Spinal)	93.2 $\pm$ 3.2	79.2@ $\pm$ 3.8	85.0 $\pm$ 2.4	99.3* $\pm$ 3.0

\* Mean pulse rate at foetal delivery in group II significantly higher than the control value in the group and corresponding value in group I ( $p < 0.05$ ).

@ Significantly less than the control values in the group ( $p < 0.05$ ).

TABLE III  
Mean ( $\pm$  SE) Maternal Arterial Blood  $O_2$  and  $CO_2$  Tension and Acid-base Data Before Anaesthesia (Control) and at the Time of Foetal Delivery

Group & Anaesthesia	PaO <sub>2</sub> (mmHg)		PaCO <sub>2</sub> (mmHg)		pH		Bicarbonate (mmol/l)		Base excess (mmol/l)	
	Control	At foetal delivery	Control	At foetal delivery	Control	At foetal delivery	Control	At foetal delivery	Control	At foetal delivery
I (General)	103.5 $\pm$ 9.3	85.5 $\pm$ 4.1	36.5 $\pm$ 3.0	33.9 $\pm$ 3.1	7.307 $\pm$ 8.265	7.347 $\pm$ 8.470	19.0 $\pm$ 2.2	18.7 $\pm$ 1.9	-6.2 $\pm$ 2.6	-5.9 $\pm$ 2.0
II (Spinal)	99.8 $\pm$ 3.9	114.7 $\pm$ 12.9	28.6 $\pm$ 2.6	33.6 $\pm$ 2.1	7.441 $\pm$ 8.777	7.403 $\pm$ 8.697	19.4 $\pm$ 1.8	21.0 $\pm$ 1.6	-3.6 $\pm$ 1.6	-2.9 $\pm$ 1.5

There were no significant differences between any two corresponding mean in the two groups or between control mean values and means at foetal delivery ( $p > 0.05$ ).

The mean body weights of the infants delivered in the two groups are also statistically comparable (Table IV). Table IV also shows the mean Apgar scores at 1 min. and 5 min. after delivery. The mean scores were compared by the method of Ridit analysis and no significant difference was found in the mean scores at 1 and 5 minutes after delivery in the two groups (Fig. 1). The mean Apgar scores at 5 minutes in both groups were of course significantly higher than the mean scores at 1 minute (Fig. 2).

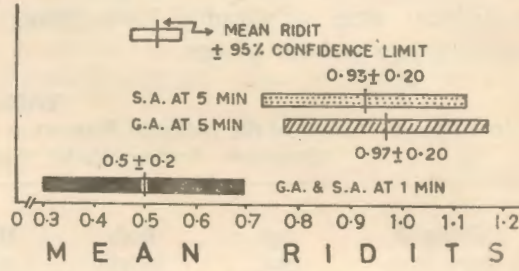


Fig. 1

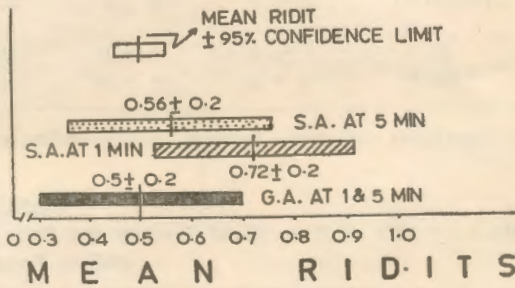


Fig. 2

Mean oxygen and carbon dioxide tensions and mean values of pH, bicarbonate and base excess in the foetal umbilical vein and umbilical artery blood samples are shown in Table V. Oxygen tensions in the umbilical vein blood were higher and carbon dioxide tension lower than in the umbilical artery blood. But there were no statistically significant differences in these gas tensions

TABLE IV  
*Infant weights and Apgar Scores (Mean  $\pm$  SE)*

Group & Anaesthesia	Weight (kg)	Apgar score	
		At 1 min	At 5 min
I (General)	3.0* $\pm$ 0.1	7.3 $\pm$ 0.4	9.5 $\pm$ 0.2
II (Spinai)	2.8* $\pm$ 0.1	8.1 $\pm$ 0.3	9.6 $\pm$ 0.2

\* No significant difference in the mean infant weights in the two groups ( $p > 0.05$ ).

For statistical significance of difference in mean Apgar scores in the two groups see figures 1 and 2.

in the blood samples from the two vessels. The mean pH, bicarbonate and base excess values in blood samples from the two vessels were also statistically comparable. There were also no significant differences in the corresponding mean values of blood gas tensions and acid-base parameters in the two groups.

Oxygen tensions in the umbilical venous blood did not show any significant correlation with the maternal blood oxygen or carbon dioxide tensions. But in the spinal anaesthesia group a significant positive correlation ( $r = + 0.724$ ,  $p < 0.05$ ) was seen between the maternal arterial carbon dioxide tension and umbilical venous blood carbon dioxide tension.

### Discussion

Before discussing the clinical implications of the findings in the present study it would be interesting to see how the mean values of blood gas and acid base parameters observed by us compare with those reported in the obstetric literature (Table VI). The mean values of oxygen tension, carbon dioxide tension, pH, bicarbonate and base excess in the arterial blood samples of

mothers reported by us compare well with those quoted by Low (1977). However, there is a marked disparity between the mean oxygen tension values in the foetal umbilical vein and umbilical artery blood samples reported by us and those reported by Low (1977). Other foetal blood parameters are comparable.

Administration of an anaesthetic to the mother before delivery may affect the foetus in at least two ways. The effect may be direct following placental transfer of anaesthetic drugs and adjuvants leading to foetal effects or it may be indirect through changes in the maternal homeostasis and quantitative and qualitative changes in the uteroplacental blood flow.

Between-group comparisons of mean values of pulse rate and mean blood pressure before anaesthesia and at the time of foetal delivery under the two techniques of anaesthesia in this study did not reveal any significant difference except for the significantly higher pulse rate at delivery under spinal anaesthesia. The control and delivery time mean values of blood gas tensions and acid-base data in the maternal arterial blood and foetal umbilical vessel blood in

**TABLE V**  
*Mean ( $\pm$  SE) Blood Gas Tensions and Acid Base Data in Foetal Umbilical Vein and Artery  
 (Blood Samples Collected Immediately after Delivery)*

Group & Anaesthesia	PaO <sub>2</sub> (mmHg)		PaCO <sub>2</sub> (mmHg)		pH		Bicarbonate (mmol/l)		Base Excess (mmol/l)	
	UV	UA	UV	UA	UV	UA	UV	UA	UV	UA
I (General)	37.0 $\pm$ 3.8	33.8 $\pm$ 6.6	51.6 $\pm$ 3.7	52.6 $\pm$ 3.8	7.264 $\pm$ 8.432	7.252 $\pm$ 8.329	23.8 $\pm$ 2.5	23.7 $\pm$ 2.3	- 3.4 $\pm$ 2.6	- 3.6 $\pm$ 2.5
II (Spinal)	44.0 $\pm$ 4.8	36.4 $\pm$ 5.2	40.2 $\pm$ 1.7	42.7 $\pm$ 4.6	7.337 $\pm$ 8.711	7.293 $\pm$ 8.356	21.3 $\pm$ 0.9	20.5 $\pm$ 1.9	- 3.9 $\pm$ 1.0	- 5.4 $\pm$ 1.8

UV, umbilical vein; UA, umbilical artery.

The corresponding mean values of various indicated parameters in the two groups did not differ significantly ( $p > 0.05$ ).

**TABLE VI**  
*Mean Values of Blood Gas and Acid Base Values Observed in the Present Study Compared to Those Reported by Low (1977).*

Blood gas & acid base parameters	Maternal arterial blood			Foetal			
	Present study		Reported by Low (1977)	Umbilical vein		Umbilical artery	
	General	Spinal		Present study*	Reported by Low (1977)	Present study	Reported by Low (1977)
PaO <sub>2</sub>	103.5 (85.5)	22.8 (114.7)	90 mmHg	40.5	28	35.1	15
PaCO <sub>2</sub>	36.5 (33.9)	28.6 (33.6)	28 mmHg	45.9	40	49.5	50
pH	7.31 (7.35)	7.44 (7.40)	7.43 mmHg	7.30	7.34	2.27	7.26
Bicarbonate	19.0 (18.7)	19.4 (21.0)	21.5	22.5	18.0	22.1	16.5
Base excess	-6.2 (-5.9)i	-3.6 (-2.9)	-2.5	-3.7	-3.0	-4.5	-5.0

\* Pooled means of both general and spinal anaesthesia groups of the present study. Mean values in maternal arterial blood of the present study shown in parentheses are of samples in the spinal anaesthesia group.

the two anaesthetic groups were also statistically comparable.

References

It may therefore be concluded that uneventful general and spinal subarachnoid anaesthetic in full-term healthy pregnant women are indistinguishable in their foetal effect as revealed by Apgar scores and foetal umbilical blood gas tensions and acid-base balance.

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Summary

Forty-two pregnant women were divided into two groups: 21 received general anaesthesia and 21 received spinal anaesthesia. Foetal umbilical blood gas tensions and acid-base balance were measured at 1, 5, and 10 minutes after delivery. Apgar scores were also recorded. There were no significant differences between the two groups in any of the measured parameters.

TABLE I

Umbilical blood gas tensions and acid-base balance at 1, 5 and 10 minutes after delivery

Parameter	General Anaesthesia (n=21)	Spinal Anaesthesia (n=21)
pH	7.38	7.38
PO <sub>2</sub> (mmHg)	35	35
PCO <sub>2</sub> (mmHg)	45	45
HCO <sub>3</sub> <sup>-</sup> (mmol/L)	22	22
Base Excess (mmol/L)	-2	-2

The results are shown in Table I. There were no significant differences between the two groups in any of the measured parameters.

Discussion

The results of this study show that both general and spinal anaesthesia provide a safe and effective method of anaesthesia for the mother and foetus. There were no significant differences between the two groups in any of the measured parameters.

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