TITLE: HEMODYNAMIC CHANGES DURING CESAREAN SECTION UNDER SPINAL ANALGESIA USING IMPEDANCE CARDIOGRAPHY

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Introduction: The cardiovascular effects of ephedrine during cesarean section in human are unknown, and no recent data on the hemodynamic changes during spinal block are available. Therefore, we studied during cesarean section the hemodynamic changes associated with spinal analgesia, ephedrine, delivery, and oxytocin.

Methods: In normal pregnant females, we could not justify using invasive techniques to perform our study. Therefore, we used non-invasive methods which have a close correlation with invasive techniques [1], namely impedance cardiography (IFM Model 400) for measuring cardiac output, left ventricular stroke volume and heart rate, and Dynamap for the arterial blood pressure (BP). The systemic peripheral resistance was calculated using the following equation: SPR (dyne/sec/cm^{-5}) = 1332 x mean BP (torr) divided by cardiac output (ml/sec). The protocol was approved by the Research Committee and the patient's consent was obtained. The study consisted of 28 full-term parturients of Physical Status I undergoing elective repeat cesarean section under spinal analgesia. The baseline measurements were done before the subarachnoid block and after i.v. hydration, 15 ml LRS/kg (1031 ± ml). These measurements were considered the control to which all the following data were compared. Following the intrathecal injection of tetracaine without epinephrine, three sets of readings were taken, separated by about two-minute intervals. When systolic BP reached 80% of the original level (22 patients), ephedrine (23.5 ± 1.4 mg) was injected in the form of an i.v. bolus and four sets of readings were taken. Measurements were also recorded at delivery, within five minutes between delivery and oxytocin, and during 10 minutes of continuous oxytocin i.v. drip (5.6 ± 0.5 U in 10 minutes). The data are expressed as means ± standard error. Paired t-test was used for statistical analysis with $p < 0.05$ being significant.

Results: The results are shown in Table. The systolic, diastolic, and mean BP decreased following spinal block without a decrease in cardiac output. The hypotension was corrected by ephedrine. Delivery decreased the diastolic and mean pressures, but did not change systolic pressure. The only significant change in cardiac output was an increase with delivery. Left ventricular stroke volume increased significantly with ephedrine, with further increase after delivery. The only significant change in heart rate was a decrease following ephedrine. Spinal block to a sensory level of T4.3 + 0.2 did not change the heart rate. Total peripheral resistance decreased with spinal block and following delivery. Ephedrine increased it but was still below control value. Oxytocin administration, as done in this study, did not change the hemodynamics.

Discussion: With spinal analgesia, Ueland and associates allowed BP to decrease by 46%.[2] They found significant decreases in cardiac output (35%) and the stroke volume (44%), while we found no change. With delivery, they found increases in systolic, diastolic and mean BP, while we found no change in systolic BP with significant decreases in diastolic and mean BP. The differences in these results are most likely due to prehydration, lateral uterine displacement, and immediate correction of hypotension in our study.

References.

1. Rasmussen JP, Sorensen B, Kann T: Evaluation of impedance cardiography as non-invasive means of measuring systolic time intervals and cardiac output. Acta Anaesth Scand 19: 210-218, 1975.

2. Ueland K, Gills R, Hansen JM: Maternal cardiovascular dynamics: 1. Cesarean section under subarachnoid block anesthesia. Am J Obst & Gynec. 100: 42-54, 1968.

TABLE

	Variables	Systolic BP (torr)		Diastolic BP (torr)		Mean BP (torr)		Cardiac output (ml/min)		Left V. stroke vol (ml)		Heart rate (beats/min)		Systemic peripheral resist. (dyne/sec/cm^5)	
	Times (minutes)	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Control values		126.0	± 2.4	67.2	± 2.3	86.8	± 2.0	5776	± 365	62.1	± 3.8	93.7	± 2.5	1346	± 92
After Spinal	0.0	108.8	± 3.4*	57.8	± 2.3*	74.8	± 2.4*	5979	± 406	62.7	± 4.5	99.6	± 4.2	1093	± 62*
	4.4	106.2	± 4.5**	55.4	± 2.6**	72.8	± 2.7**	6091	± 5.6	64.1	± 4.3	96.8	± 5.6	1030	± 76**
	5.8	104.4	± 3.8**	52.8	± 4.5**	70.1	± 3.7**	6207	± 493	65.5	± 5.9	95.6	± 6.4	940	± 98**
After Ephedrine	6.9	104.2	± 3.5**	54.9	± 2.8**	71.3	± 2.7**	5548	± 297	60.5	± 6.3	95.0	± 7.5	1084	± 65**
	8.5	115.4	± 4.3	63.1	± 2.8	80.6	± 2.8	5764	± 335	71.0	± 5.1*	84.5	± 5.2	1197	± 74*
	10.2	118.4	± 3.3	64.4	± 2.9	82.4	± 2.9	6045	± 461	74.9	± 5.3*	82.8	± 3.7*	1180	± 81*
	12.4	122.2	± 4.8	64.9	± 2.3	84.0	± 2.8	6447	± 439	78.4	± 5.2*	83.5	± 3.2*	1146	± 86*
After Del.	17.3	117.2	± 4.3	63.8	± 1.8	81.6	± 1.8	6686	± 503	76.7	± 7.4*	92.0	± 5.0	1132	± 75*
After Del.	19.3	119.9	± 2.4	59.2	± 1.8*	79.4	± 1.4*	6918	± 534*	75.7	± 5.2*	93.3	± 4.0	1005	± 74**
After Oxyt	21.6	115.6	± 3.8	57.7	± 2.3*	76.8	± 1.6*	7171	± 567*	75.3	± 5.1*	93.2	± 4.4	936	± 77**
	25.8	118.6	± 3.1	57.2	± 2.0*	77.7	± 1.8*	7064	± 508*	74.7	± 5.4*	93.0	± 3.6	996	± 76**
	29.0	118.7	± 2.6	59.8	± 2.4*	79.5	± 1.9*	7052	± 481*	75.1	± 5.2*	93.7	± 4.5	1009	± 84**

All times are taken from intrathecal injection of tetracaine.
First reading after ephedrine is taken one minute from drug I.V.I.
Oxytocin infusion started 5 minutes after delivery.
* Significant from control values $p < 0.05$; ** $p < 0.01$.