

# Prevention of Hypotension Following Spinal Anesthesia for Cesarean Section using Noninvasive Transthoracic Electrical Impedance Cardiography

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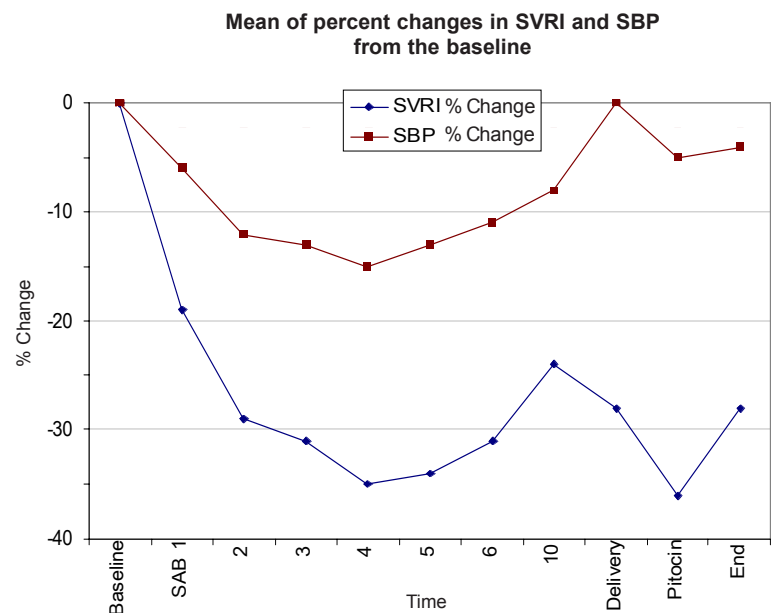
## Introduction

The decrease in systemic vascular resistance (SVR) due to preganglionic sympathetic blockade with spinal anesthesia may result in peripheral pooling of blood, which will lead to a decrease in cardiac output and hypotension. SVR obtained noninvasively by thoracic impedance cardiography (ICG) is useful in predicting the risk of hypotension with regional anesthesia (1). The purpose of this randomized study was to determine whether early treatment of drop in systemic vascular resistance index (SVRI), as obtained by ICG following spinal anesthesia prevents development of hypotension in healthy women undergoing cesarean section (CS).

## Methods

Following IRB approval, in this study informed consent was obtained from 90 healthy women at term undergoing planned CS under spinal anesthesia. After crystalloid preloading with 1L of lactated Ringer's, spinal anesthesia was induced with 1.6 mL of intrathecal 0.75% hyperbaric bupivacaine and 20mcg fentanyl. In all patients, hemodynamic parameters such as cardiac output, stroke volume, and particularly SVRI were continuously obtained before and after spinal anesthesia using a ICG (BioZ<sup>®</sup>, Cardiodynamics, San Diego, CA). The hemodynamic data from the first consecutive 30 patients were analyzed to determine the changes in SVRI and systolic blood pressure following initiation of spinal anesthesia (Figure 1).

Figure 1. Hemodynamic Data



This analysis indicated that a significant drop in SVRI precedes the hypotension which occurs after spinal anesthesia. Following this pilot analysis, 60 patients were randomized into two groups: In the SVRI group, a drop in SVRI  $\geq 20\%$  following spinal anesthesia was immediately treated with IV ephedrine in 5-mg boluses at 1-2 minute interval.

Hypotension was defined as a decrease in systolic blood pressure (SBP) of  $\geq 20\%$ . In the control group, drop in SBP  $\geq 20\%$  following spinal anesthesia was treated with ephedrine 5- mg increments. Intravenous phenylephrine in 25 mcg increments were also used as needed. A P value of  $\leq 0.05$  was considered significant.

## Results

Demographic characteristics and baseline ICG data were similar in two groups (Table 1 and 2).

**Table 1:** Maternal demographic characteristics.

Characteristic	Control n = 30	SVRI n = 30	P-value
Age (yr)	28 ± 5	26 ± 5	0.95
Height (in)	62 ± 3	61 ± 2	0.39
Weight (lb)	168 ± 17	166 ± 25	0.06
Gestational age (wk)	38.6 ± 0.9	38.8 ± 0.8	0.20
HCT (%)	34.6 ± 3.3	35.0 ± 3.3	0.98
Platelets (1,000 / cm <sup>3</sup> )	228 ± 51	234 ± 66	0.32

Data are presented as mean ± SD.

**Table 2:** Baseline ICG data.

Parameter	Control n = 30	SVRI n = 30	P-value
Systolic BP	120 ± 10	118 ± 10	0.49
Diastolic BP	66 ± 8	68 ± 10	0.51
Heart Rate (rate)	81 ± 14	86 ± 13	0.19
Stroke Volume (mL)	64 ± 10	59 ± 13	0.058
Velocity Index (1/1000 sec <sup>-1</sup> )	54 ± 15	53 ± 14	0.71
Thoracic Fluid Content (kohm <sup>-1</sup> )	40 ± 5	39 ± 6	0.26
SVRI (dynes sec / cm <sup>5</sup> )	2131 ± 446	2196 ± 537	0.61

Data are presented as mean ± SD.

The incidence of hypotension was significantly lower in the SVRI group compared to the control group (37% vs 77%, P =0.002) (Table 3).

**Table 3:** Intraoperative events.

Event	Control n = 30	SVRI n = 30	P-value
SAB to Delivery (min)	32 ± 7	31 ± 6	0.61
Hypotension after analgesia	23 (77)	11 (37)	0.002
Nausea & Vomiting	7 (23)	2 (7)	0.07
Ephedrine (mg)	14 ± 11 (0 – 35)	21 ± 12 (0 – 40)	0.019
Neosynephrine (mcg)	8 ± 37 (0 – 200)	27 ± 61 (0 – 225)	0.15
Total intravenous fluids (mL)	2180 ± 626	2144 ± 596	0.82
Estimated blood loss (mL)	1117 ± 346	1067 ± 278	0.54

Data are presented as mean ± SD, or N (%) or (range).

More patients had nausea/vomiting in the control group. There was no significant difference in the neonatal outcome between the two groups (Table 4).

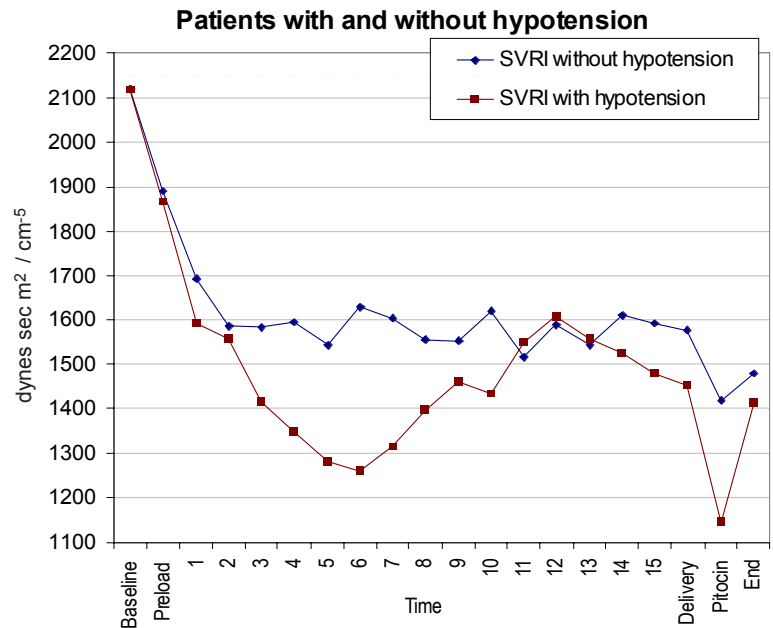
**Table 4:** Infant and maternal outcomes.

Infant outcome	Control n = 30	SVRI n = 30	P-value
Birth Weight (g)	3533 ± 405	3433 ± 485	0.2
Umbilical Artery Blood:			
pH: Mean	7.23 ± 0.07	7.22 ± 0.09	0.14
≤ 7.20	4 (13)	6 (20)	0.78
< 7.00	1 (3)	1 (3)	
pCO <sup>2</sup> (mmHg):	59.1 ± 8.2	60.4 ± 13.0	0.11
Base Excess (mEq/L)	- 6.3 ± 3.2	- 7.2 ± 3.9	0.25
Umbilical Venous Blood:			
pH: Mean	7.30 ± 0.05	7.29 ± 0.07	0.12
pCO <sup>2</sup> (mmHg):	46.9 ± 4.0	48.2 ± 6.7	0.009
Base Excess (mEq/L)	- 4.8 ± 2.9	- 5.1 ± 3.0	0.23

Data are presented as mean ± SD, or N (%).

Figure 2 shows the changes in the SVRI in randomized patients who developed hypotension vs who did not develop hypotension.

**Figure 2.** Changes in SVRI



## Discussion

A significant decrease in SVRI precedes the hypotension after spinal anesthesia as determined by ICG. Early treatment of drop in SVRI immediately following spinal anesthesia is effective in minimizing the risk of hypotension in women undergoing cesarean section.

We were able to use vasopressor more efficiently in preventing hypotension after spinal anesthesia. Reduced incidence of nausea and vomiting was observed.

### References:

1. *Am J Obstet Gynecol.* 1996;174:1019-25.
2. *Anesthesiology.* 1993;79:262-269.