Prospective Study of Hypotension after Spinal Anesthesia for Cesarean Section at Siriraj Hospital: Incidence and Risk Factors, Part 2

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Background: *The incidence of hypotension after spinal anesthesia is highest in cesarean section. The authors' first retrospective study identified three risk factors that included two non-modifiable (patient's height and low baseline systolic blood pressure) and one modifiable risk factor (sensory analgesia equal to or higher than T5) associated with hypotension.*

Objective: *To create a prospective record of the event in the patients who received successful spinal anesthesia for cesarean section.*

Material and Method: *A prospective data collection, together with questionnaires that were completed by the responsible anesthetic team at the end of the operation for each consecutive patient. All parameters were coded and recorded in SPSS11.5. To assess the association between two categorical variables in a univariable analysis, chi-square test was used along with odds ratio (OR) and its 95% confidence interval (CI). Mutivariable analysis via multiple logistic regressions was employed to determine the effect of each independent variable.*

Results: *Eight hundred and seven full term pregnant women received successful spinal anesthesia for cesarean section at Siriraj Hospital from July 1 to December 31, 2004. Hypotension was defined as lowest systolic < 100 mmHg and the pressure was lower to equal to or more than 20% of baseline. Incidence of hypotension was 65.1%. Age > 35 yr, BMI > 35 were two non-modifiable risk factors that increased the incidence of hypotension in the crude odds ratio (OR) 1.62 and 2.83 respectively with narrow 95% confidence interval. The level of sensory analgesia equal to or higher than T5 was the only one modifiable risk factor that increased the incidence of hypotension with crude OR 1.55 and narrow 95% CI.*

Conclusion: *Limitation of the dose of local anesthetic agent or addition of some opioids could reduce the incidence and severity of hypotension after spinal anesthesia for cesarean section.*

Keywords: *Hypotension, Spinal anesthesia, Cesarean section*

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Spinal anesthesia is the most common anesthetic technique for cesarean section in Thailand and at Siriraj Hospital[1]. It avoids the neonatal depression associated with general anesthesia[2,3], and higher APGAR scores and neurobehavioral tests. Physiological changes of full term pregnant women and dehydration lead to the highest incidence of hypotension after spinal anesthesia[4-6]. Prolonged maternal hypotension easily leads to fetal academia[7,8]. The authors' first part of the present study reported the incidence of moderate maternal hypotension of 76.7% after spinal anesthesia[9]. That retrospective anesthetic record review confirmed two non-modifiable risk factors. These factors were the patient's height and the baseline systolic blood pressure when it was equal to or lower than 120 mmHg. Sensory level equal to or higher than T5 was the only one modifiable risk factor of hypotension. However, the reviewed handwriting anesthetic record may easily lose some rapid hemodynamics changes. For this reason, the authors did a part two for reevaluation of the incidence and risk factors of

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hypotension after spinal anesthesia. It was a prospective review of records of the events in the patients who received successful spinal anesthesia for cesarean section at Siriraj Hospital between 1 July 2004 and 31 December 2004.

Material and Method

The authors prospectively recorded 807 patients who received spinal anesthesia and underwent cesarean section at Siriraj Hospital. Exclusion criteria were patients with pregnancy induced hypertension, preeclampsia, received combination of spinal block with other types of anesthesia (epidural block, inhalation and general anesthesia), supplementation of high dose opioid (morphine > 0.1 mg/kg or pethidine > 50 mg or fentanyl > 1 □g/kg), or sedative agents (midazolam > 2 mg or ketamine > 1 mg/kg or propofol > 1.5 mg/kg) within 60 minutes after spinal block was performed. Questionnaires of hypotension were completed by the responsible anesthetic team at the end of the operation for each consecutive patient.

The detailed parameters of patient demographic data (age, body weight, height, ASA physical status), operative data(duration of operation, emergency status), and anesthetic data(type and dosage of local anesthetic agent used, intravenous fluid, vasoactive and sedative agents, sensory level of spinal blockage, and usage and doses of spinal opioids) were recorded. Left uterine displacement, supplement of oxygen and monitoring of oxygen saturation, electrocardiography (EKG), and non-invasive blood pressure (NIBP) were routinely institute practice.

The first systolic, diastolic blood pressure, and heart rate were used as reference control values. The lowest systolic and diastolic blood pressure, heart rate, and onset of the event were recorded. Treatment of hypotension depended on individual clinical judgment of the responsible staff.

Statistical analysis

All parameters were coded and recorded in SPSS11.5. Descriptive statistics were presented as mean, median, standard deviation (SD), minimum, maximum, or number (%) as appropriation. All parametric and non-parametric data were tested for normal distribution before further appropriate statistical analysis. P-value of 0.05 was used to identify statistical significance. To assess the association between two categorical variables in a univariable analysis, Chi-square test was used along with odds ratio (OR) and its 95% confidence interval (CI). Mutivariable analysis via multiple logistic regression was employed to determine the effect of each independent variables. Results were displayed as adjusted OR and 95% CI.

Results

Eight hundred and seven patients were eligible for the present study. Their demographic data is shown in Table 1. It includes patients' characteristics, age, height, weight, etc. Patients were ASA physical status 1 and 2 (46.1%, 53.9% respectively) and 42% were emergency surgery. Hyperbaric bupivacaine were used in 99.6% of the cases. The average volume of this solution was 2.2 $\pm$ 0.2 ml and 0.2 mg. morphine was

Table 1. Demographic data (n = 807)

	Mean $\pm$ SD	Median (min, max)
Age (yr)	30.1 $\pm$ 6.0	30.0 (15, 46)
Body weight (kg)	67.9 $\pm$ 11.1	66.5 (43, 120)
Height (cm)	157.6 $\pm$ 5.1	157.0 (142, 175)
Body mass index,BMI (kg/m^2)	27.3 $\pm$ 4.4	26.8 (16.5, 48.1)
ASA physical status I : II (%)	46.1:53.9	
Elective: Emergency (%)	58:42	
Systolic pressure (mmHg)	125.3 $\pm$ 17.3	120.0 (90, 120)
Diastolic pressure (mmHg)	73.7 $\pm$ 14.6	70.0 (40, 130)
Spinal morphine		
Yes: No (%)	96.3:3.7	
Spinal bupivacaine		
Hyperbaric: Isobaric (%)	99.6:0.4	
Volume (ml)	2.2 $\pm$ 0.2	2.2 (1, 4)
Analgesic level		
$< T_5 : \geq T_5$	25:75	
Operative time (min)	86.4 $\pm$ 14.3	84.0 (50, 140)

added in 96.3% of the cases. The analgesic level was higher than thoracic 5 in 75% of the cases. The operation time was 86.4 ± 14.3 minutes.

The authors defined hypotension as systolic blood pressure < 100 mmHg and reduction of systolic pressure of more than 20% of baseline. The incidence was 65.1% (Table 2). The authors' used these criteria to define maternal hypotension because its easy to use and early treatment was the routine practice. No case of cardiac arrest or death occurred.

Comparing between patients with and without hypotension, when each variable was considered alone as in univariable analysis, two non-modifiable and one modifiable risk factor were identified. Age > 35 yr, BMI > 35 were two non-modifiable risks factors that increased the incidence of hypotension (odds ratio (OR) 1.62 and 2.83 with 95% CI) (Table 3). Level of sensory analgesia equal to or higher than T5 was the only modifiable risk factor that increased the incidence of hypotension (OR 1.55 and 95% CI).

Taking into account of all factors in multiple logistic regression analysis (Table 3), patient's age equal to or more than 35 years increased the incidence of hypotension in adjusted odds ratio 1.63 (95% CI

Table 2. Univariated analysis risk factors of hypotension

Variable	Grouping	Hypotension		Crude OR	95%CI for OR
		NO number (%)	Yes number (%)		
Age ≥ 35 yr	No	225 (37.2)	380 (62.8)	1	
	Yes	57 (28.2)	145 (71.8)	1.62	1.06, 2.49
BMI ≥ 35 kg/m^2	No	273 (36.0)	486 (64.0)	1	
	Yes	9 (18.75)	39 (81.3)	2.83	1.31, 6.11
Emergency	No	164 (35.0)	305 (65.0)	1	
	Yes	118 (35.0)	220 (65.0)	1.00	0.75, 1.34
Baseline systolic blood pressure ≤ 120 mmHg	No	124 (33.3)	248 (66.7)	1	
	Yes	158 (36.3)	277 (63.7)	0.88	0.65, 1.17
Analgesic level ≥ T5	No	86 (42.6)	116 (57.4)	1	
	Yes	196 (32.9)	400 (67.1)	1.55	1.12, 2.15
Heart rate < 60 beat/min	No	268 (34.4)	511 (65.6)	1	
	Yes	14 (50.0)	14 (50.0)	0.52	0.25, 1.12
ASA	I	128 (34.4)	244 (65.6)	1	
	II	154 (35.4)	281 (64.6)	0.957	0.72, 1.3
Add morphine	No	8 (26.7)	22 (73.3)	1	
	Yes	274 (35.3)	503 (64.7)	0.67	0.29, 1.52

Table 3. Multiple logistic regression and variables associated with hypotension

Variable	p-valve	Adjusted OR	95% CI for OR
Age ≥ 35 yr	0.028	1.63	1.05, 2.52
BMI ≥ 35 kg/m^2	0.009	2.79	1.29, 6.06
Analgesic level ≥ T5	0.008	1.56	1.12, 2.18

Table 4. Vasoactive agents administration (mean ± SD)

	Hypotension group	Non-hypotension group	p-value
Ephedrine(mg)	16.3 ± 11.45	5.1 ± 8.2	0.000
Levophed (μg)	4.0 ± 5.9	0.7 ± 2.1	0.000
Adrenarine (mg)	0.001 ± 0.022	0.000	0.142

1.05,2.52), the same as BMI equal to or higher than 35 had an adjusted odds ratio of 2.79 (95% CI 1.29,6.06) and sensory level equal to or higher than T5 had adjusted odds ratio of 1.56 (95% CI 1.12,2.18).

Discussion

In this part, the criteria of hypotension were changed. Cases were coded of "hypotension" when they had both criteria. These were the reduction of systolic blood pressure to lower than or equal to 100 mmHg and the lowest systolic blood pressure was more than 20% below the baseline. The second criterion was added up because there were 5-10% of the presented cases that their baseline systolic blood pressure was already lower than 100 mmHg before the spinal block. This was the reason why the incidence of hypotension in this part two was lower than in part one (65.1% compared to 76.7%).

The incidence of 65.1% was lower than in the study of Neti et al[8] where they reported 73.3% maternal hypotension (Systolic blood pressure lower than 100 mmHg or decreased to more than 20% of baseline). The difference was not much and the authors estimated the incidences varied between 65-80% by inclusion criteria and the study groups.

Introducing one questionnaire to be completed for each consecutive patient reminded the responsible anesthetic team to rethink the true lowest blood pressure and heart rate during completion of all data. In real situations, there were a lot of things that had to be done at the same time such as "Calm and support the mother", positioning, close observation of all vital signs, clinical sign of adequate respiration, conscious stage and stabilized blood pressure, and heart rate. Usually, all attention was focused on the patient's management and drug administration. After the birth and the bleeding were under control, anesthetic records were completed with some retrospective data. Administration of vasoactive substances were not always guided by definite systolic blood pressure but sometimes guided by the trend of hypotension. Because of rapid hemodynamic change, either manual data recording or automatic data processing[9] were easily incomplete. Sometimes vasoactive substances were administrated for prevention of further reduction of blood pressure and blood pressure was never lowered to study criteria. The presented data demonstrated that 89.5% of the cases received at least one dose of vasoactive substance.

Sensory level equal to or higher than T5 was reconfirmed as a risk factor of hypotension in our first part and others[10-12]. More complete data collection in the authors' second part, could identify two other non-modifiable risk factors of "age > 35 years" and "BMI > 35". These findings confirmed the more logical physiological spreading of local anesthetic agent in spinal column during spinal anesthesia[10,11,13]. Because the dose of heavy bupivacaine in the institute is quite unique, the spreading was related to BMI (not to patients'height as in the first part). Both big uteri size and high BMI increased abdominal pressure with compression of the subarachnoid cavity and caused more cephalad spreading of heavy bupivacaine[14].

The correlation of circulatory instability with higher cephalic levels of neuraxial blockade has already been proven in previous studies[9]. Circulatory regulation is affected by a blockade of the sympathetic nervous system, with resulting reductions in both venous return and systemic vascular resistance. Furthermore, when the level of analgesia exceeds T4, cardio-acceleratory fibers are blocked, leading to a decrease in heart rate and cardiac output.

Although the authors were able in this exploratory investigation to demonstrate that data collected with an anesthesia information management system are suitable for developing a multivariate model for identifying risk factors for relevant hypotension, this must be validated in further studies. Some limitations of the present study must be acknowledged. A retrospective analysis of routine medical data collected on-line cannot be as objective as a prospective study with complete and uniform data. This is especially true for data recorded as "not documented" and thus regarded as "not pathological" for the purposes of the present study, a fact that has to be retained for interpretation of data and study results.

Finally, it may be said that patients developing relevant hypotension during spinal anesthesia will probably also tend to develop hypotension during general anesthesia. Therefore, the anesthesiologist should not necessarily refrain from using spinal anesthesia in patients with independent risk factors for hypotension. However, the knowledge of these risk factors should be useful in increasing vigilance in those patients most at risk for hypotension, in allowing for more timely therapeutic intervention, or even in suggesting the use of alternative methods of spinal anesthesia, such as titrated continuous or small-dose spinal anesthesia or reduction dose of spinal local anesthetic agent and supplement with low dose of fentanyl or other available opioids.

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ปัจจัยเสี่ยงที่มีผลการเกิดภาวะความดันเลือดต่ำภายหลังได้รับการฉีดยาชาเข้าช่องไขสันหลังเพื่อการผ่าตัดคลอดในโรงพยาบาลศิริราช

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อัตราการเกิดภาวะความดันเลือดต่ำจากการฉีดยาชาเฉพาะที่เข้าช่องไขสันหลังพบได้บ่อยที่สุดในการผ่าตัดคลอดจากการศึกษาในครั้งแรกซึ่งเป็นการศึกษาข้อมูลย้อนหลังสามารถระบุปัจจัยเสี่ยงได้ 3 ปัจจัย ได้แก่ ความสูงของผู้ป่วย ระดับความดันเลือดก่อนการฉีดยาชา และระดับการชาที่เท่ากับหรือสูงกว่าระดับ T5 การศึกษาครั้งนี้ดำเนินการวางแผนการเก็บรวบรวมข้อมูลอย่างเป็นระบบ และบันทึกรายละเอียดลงแบบสอบถามทันทีที่เสร็จการผ่าตัดคลอด ในผู้ป่วยทุกรายที่ได้รับการผ่าตัดคลอดในโรงพยาบาลศิริราชตั้งแต่วันที่ 1 กรกฎาคม ถึง 31 ธันวาคม พ.ศ. 2547 บันทึกและประเมินผลโดยโปรแกรม SPSS 11.5 เพื่อเปรียบเทียบปัจจัยเสี่ยงต่าง ๆ ที่เพิ่มอัตราการเกิดภาวะความดันเลือดต่ำ หาความสัมพันธ์ระหว่างปัจจัยเสี่ยงที่มีนัยสำคัญทางสถิติด้วยวิธี multiple logistic regression จากผู้ป่วยทั้งหมด 807 รายที่ระดับการชาเพียงพอสำหรับการผ่าตัดคลอด พบภาวะความดันเลือดต่ำภายหลังการฉีดยาชาเฉพาะที่เข้า ช่องไขสันหลังร้อยละ 65.1 และพบปัจจัยเสี่ยงในผู้ป่วยที่มีอายุมากกว่า 35 ปี ค่า BMI ≥ 35 และระดับการชาที่เท่ากับ หรือสูงกว่าระดับ T5 ดังนั้นการควบคุมปริมาณยาชาที่ใช้ เพื่อไม่ให้การชาสูงกว่า T6 ซึ่งเป็นปัจจัยเสี่ยงปัจจัยเดียวที่ควบคุมได้ จะสามารถลดอัตราการเกิดภาวะความดันเลือดต่ำจากการฉีดยาชาเฉพาะที่เข้าช่องไขสันหลังในการผ่าตัดคลอด