Incidence and Risk Factors of Hypotension During Spinal Anesthesia for Cesarean Section at Siriraj Hospital

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Objective: *Spinal anesthesia is commonly used for cesarean section. Its major adverse effect is hypotension. The objective of this study is to determine the incidence and risk factors of hypotension during spinal anesthesia for cesarean section.*

Material and Method: *The authors retrospectively reviewed anesthetic records of 991 patients who received spinal anesthesia for cesarean section at Siriraj Hospital. Exclusion criteria were patients with pregnancy included hypertension, received combination of spinal block with other type of anesthesia.*

Results: *The incidence of hypotension (the lowest systolic blood pressure ≤ 100 mm Hg) was 76.7%. The parameter with increased incidence of hypotension included patient's height < 155 cm (adjusted odd ratio (OR) 1.93, 95%CI 1.19-3.14), baseline systolic blood pressure ≤ 120 mmHg (OR 2.14, 95%CI 1.53-2.99) and analgesic level ≥ T_5 (OR 1.83, 95%CI 1.18-2.84).*

Conclusion: *The risk factors associated with increased incidence of hypotension are the patient's height, baseline systolic blood pressure and level of blockade.*

Keywords: *Hypotension, Spinal anesthesia, Cesarean section*

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Spinal anesthesia is commonly used for cesarean section. It allows the mother to be awake. It also minimizes maternal aspiration pneumonitis and problems with difficult intubation. Finally, it facilitates effective postoperative pain relief. As demonstrated by higher Apgar scores and by neurobehavioral tests, spinal anesthesia avoids the neonatal depression associated with general anesthesia[1,2].

Choices of anesthesia for cesarean delivery in 1988 and 2000 were collected from a general hospital in Thailand[3] (Table 1). General anesthesia was the main technique because the lack of anesthesiologists and nurse anesthetists did not allow the regional block to be performed. In 2004, spinal anesthesia was the main anesthetic technique at Siriraj Hospital because of its reliability and rapid onset.

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The major adverse effect of spinal anesthesia for mothers is hypotension[4,5]. Maternal hypotension leads to uteroplacental hypoperfusion and provokes an acute fall in intervillous blood flow with the potential for fetal acidemia[6,7]. Furthermore, cardiac arrest may occur. To improve our management and patient care, the authors tried to determine the incidence and risk factors of hypotension during spinal anesthesia for cesarean section.

Table 1. Choices of anesthesia in cesarean section (%)

Choices of anesthesia (%)	Thailand		Siriraj
	1988	2000	2004
General anesthesia	71	75.5	17.0
Spinal anesthesia	27	23.9	79.5
Epidural anesthesia	2	0.6	3.1
Combined spinal & epidural anesthesia	-	-	0.4

Material and Method

The authors retrospectively reviewed anesthetic records of 991 patients who received spinal anesthesia and underwent cesarean section at Siriraj Hospital from 1 January to 30 June 2004. Exclusion criteria were patients with pregnancy induced hypertension, preeclampsia, received combination of spinal block with other type of anesthesia (epidural block, inhalation and general anesthesia) and supplementation of high dose opioids(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.

The detailed parameters of patient demographic data (age, body weight, height, ASA status), operative data (duration of operation, emergency status), anesthetic data (type and dosage of local anesthetic agent used, intravenous fluid, vasoactive and sedative agents, sensory level of spinal blockade, usage and doses of spinal opioids) and Apgar scores at 1 and 5 min were collected and recorded. The standard practices included oxygen supplementation, left uterine displacement and monitoring of oxygen saturation, EKG and non-invasive blood pressure.

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

Data analysis

All parameters were coded and recorded in SPSS 10.0. Descriptive statistics were presented as mean, median, Standard Deviation (SD), minimum, maximum or number (%) as appropriate. All parametric and non-parametric data were tested for normal distribution before further appropriate statistical analysis. P value of less than 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). Multivariable analysis via multiple logistic regressions was employed to determine the effect of each independent variable on binary dependent variables after adjusting for the other independent variables. Results were displayed as adjusted OR and 95%CI. The present study was approved by the ethical committee of Faculty of Medicine, Siriraj hospital, Mahidol University.

Results

The records of 991 patients were eligible for the present study. The demographic data is shown in Table 2. Most of the patients were ASA physical status 1 and 2 (53%, 46.6%) and 51.2% were emergency surgery. Hyperbaric bupivacaine was used in 99.2% of the cases. The average volume of this solution was 2.1 $\pm$ 0.2 ml and morphine was added in 98% of the cases. The average analgesic level was at thoracic 4.8 $\pm$ 1.3. The operation time was 67.1 $\pm$ 20.7 minutes.

Table 2. Demographic data (n = 991)

	Mean $\pm$ SD	Median (min, max)
Age (yr)	29.7 $\pm$ 5.7	30.0 (14, 44)
BW (kg)	67.8 $\pm$ 10.8	66.0 (42, 120)
Height (cm)	156.6 $\pm$ 5.8	157.0 (134, 172)
BMI (kg/m^2)	27.6 $\pm$ 3.9	27.3 (17.1, 45.8)
ASA I : II : III (%)	53.0:46.6:0.4	
Elective : Emergency (%)	48.8:51.2	
Systolic blood pressure (mmHg)	125.9 $\pm$ 15.5	120.0 (90, 170)
Diastolic blood pressure (mmHg)	73.4 $\pm$ 14.2	70.0 (40, 120)
Spinal bupivacaine		
Hyperbaric : Isobaric (%)	99.2:0.8	
Volume (ml)	2.1 $\pm$ 0.2	2.1 (1.5, 3.3)
Spinal morphine		
Yes : No (%)	98.1:1.9	
Dose (mg)	0.25 $\pm$ 0.1	0.25 (0.1, 0.5)
Analgesic level (thoracic)	4.8 $\pm$ 1.3	4 (2, 10)
Operative time (min)	67.1 $\pm$ 20.7	60.0 (30, 28.5)

The authors defined hypotension as the lowest systolic blood pressure ≤ 100 mmHg. The incidence was 76.7% (Table 3) and its onset was 19.17 ± 14.8 min(mean ± SD), 15 min (1, 102) (median (min, max)). A second way to define hypotension is the lowest systolic blood pressure < 100 mmHg or a decrease of more than 20% of baseline (72.2%). The authors found that the incidence of the first criteria was similar to the incidence of the second criteria thus the authors used the first criteria to define maternal hypotension because of its ease of use and that early treatment was the routine practice. The incidence of severe hypotension (defined as the lowest systolic blood pressure < 80 mmHg) was 7.4%. No case of cardiac arrest or death occurred.

Comparing between patients with and without hypotension, when each variable was considered alone, three non-modifiable and one modifiable risk factors were identified. Age ≥ 35 yr, height < 155 cm and baseline systolic blood pressure ≤ 130 mmHg were three non-modifiable risk factors that increased the incidence of hypotension in the varying crude OR from 1.44 to 4.44 with 95%CI (Table 4). Level of sensory ≥ T_5 was the only modifiable risk factor that increased the incidence of hypotension with crude OR = 1.7 and 95%CI (1.15-2.51) (Table 4).

Taking into account all factors simultaneously, the baseline systolic blood pressure OR increased proportionally with every 10 mmHg decrease in blood pressure (Table 5). Patient's height of less than 155 cm increased the incidence of hypotension in OR of 1.44 (95%CI 1.01, 2.06), the same as sensory level T_5 or higher OR was 1.70 (95%CI 1.15, 2.51).

Ephedrine was the most common vasoactive agent used in the treatment of hypotension after spinal block as 67% of the hypotensive group patients and 21% of the non hypotensive group patients received at least one dose of ephedrine and norepinephrine. The number of patients and dosage of vasoactive agents (ephedrine and norepinephrine) were higher in the "hypotensive group" (Table 6). The authors found that 21.3% of "non-hypotensive group" received ephedrine, mostly in the dose less than 20 mg. Three patients received atropine because they had severe bradycardia (heart rate < 50 beat /min).

Although the authors could not collect the amount of preload fluid, the total volume of fluid replacement was significantly higher in the hypotensive group for the treatment of hypotension by fluid loading (Table 6). There were no differences between the two groups in fetal Apgar scores at 1 min and 5 min (Table 7).

Table 3. Incidence of hypotension (n = 991)

Criteria	Incidence	
	Number	%
Systolic BP ≤ 100 mmHg	756	76.7
Systolic BP < 100 mmHg or < 80% of baseline	710	72.2
Systolic BP < 80 mmHg	73	7.4

Table 4. Univariated analysis risk factors of hypotension

Variable	Grouping	Hypotension		Crude OR	95%CI for OR
		NO Number (%)	Yes Number (%)		
Age	<35 yr	195 (25.1)	583 (74.9)	1	
	≥35 yr	35 (16.8)	173 (83.2)	1.65	1.11, 2.46
Height	≥155 cm	143 (25.0)	428 (75.0)	1	
	<155 cm	53 (18.8)	229 (81.2)	1.44	1.01, 2.06
Elective emergency	Elective	111 (23.2)	367 (76.8)	1	
	Emergency	118 (23.6)	383 (76.4)	0.98	0.73, 1.32
Baseline systolic blood pressure	>130 mmHg	103 (35.9)	184 (64.1)	1	
	120-130 mmHg	98 (22.6)	335 (77.4)	1.88	1.35, 2.62
	<120 mmHg	29 (11.0)	234 (89.0)	4.44	2.82, 7.00
Volume of heavy bupivacaine	≤2 ml	96 (21.3)	355 (78.7)	1	
	>2 ml	123 (24.2)	386 (75.8)	0.85	0.63, 1.15
Analgesic level	<T5	58 (29.1)	141 (70.9)	1	
	≥T5	80 (19.5)	330 (80.5)	1.70	1.15, 2.51

Table 5. Multiple logistic regression and variables associated with hypotension

Variable	Grouping	p valve	Adjusted OR	95%CI for OR
Age	<35 yr		1	
	≥35 yr	0.098	1.60	0.92, 2.80
Height	≥155 cm		1	
	<155 cm	0.008	1.93	1.19, 3.14
Baseline systolic blood pressure	>130 mmHg		1	
	120-130 mmHg	0.005	1.96	1.23, 3.11
	<120 mmHg	<0.0001	2.14	1.53, 2.99
Analgesic level	<T5		1	
	≥T5	0.007	1.83	1.18, 2.84

Table 6. Vasoactive agents and intravenous fluid (IV) administration

	Total	Hypotension group	Non-hypotension group	p value
Ephedrine				
Yes (%)	56.4	67.1	21.3	
Range (mg)	2-42	2-42	6-30	
Mean ± SD (mg)	12.6±6.8	12.7±7.0	11.8±5.6	<0.001
≤ 10 mg (%)	39.0	39.3	36.1	
11-19 mg (%)	48.0	47.3	55.1	
≥ 20 mg (%)	13.0	13.4	8.1	
Norepinephrine				
Yes (%)	21.0	26.1	4.3	
Range (g)	2-52	2-52	2-16	
Mean ± SD (g)	8.6±6.5	8.7±6.6	7.4±4.2	<0.001
≤ 4 (g) (%)	43.5	43.6	40.0	
5-12 (g) (%)	42.6	42.1	50.0	
>12 (g) (%)	13.9	14.3	10.0	
IV administration				
Range (ml)	400-7501	400-7501	500-2600	
Mean ± SD (ml)	1261±543	1282±581	1194±388	
< 1000 ml (%)	25.1	23.8	29.1	0.032
1000-1500 ml (%)	53.3	52.6	55.5	
> 1500 ml (%)	21.6	23.6	15.3	

Table 7. Median Apgar scores at 1 and 5 min in the two study groups

Apgar scores (minute)	Hypotension group (n = 756)	Non-hypotension group (n = 235)	p value
1	9 (2, 10)	9 (4, 10)	0.412
5	10 (7, 10)	10 (6, 10)	0.355

Discussion

The incidence of hypotension defined as the lowest systolic blood pressure (SBP) ≤ 100 mmHg in the present study is 76.7%. This is close to the study of Neti et al[8] (73.3%) even though they performed their study by defining maternal hypotension as the SBP < 100 mmHg or a decreased of more than 20% of baseline SBP. The authors used the presented criteria because of its ease in clinical practice. There is also a limitation of retrospective study to identify true baseline blood pressure control.

The authors believed that the real incidence of hypotension might be more than 76.7%. The weakness of retrospective study and manual data record is the incomplete recording data. The management of hypotension in the present study depended upon the individual judgment of responsible personnel. The presented data demonstrated that ephedrine and norepinephrine were given to patients in the non-hypotension group (21.3% and 4.3% respectively). This implied that some cases were treated before the study's criteria were met or the hypotension was recognized and treated but the lowest blood pressures were not manually recorded.

The onset of hypotension in the present study was 19.2 minutes close to the 15 minutes of the study of Neti et al[8] and at the peak effect of the local anesthetic. Because of early treatment, the incidence of severe hypotension (defined as SBP < 80 mmHg) was 7.4% and is close to the other studies[9-11]. No case of sudden cardiac arrest occurred.

The parameters that have statistically significant differences associated with development of hypotension in the present study include maternal height < 155 cm, control systolic blood pressure below 130 mmHg and sensory level higher than T_5 (Table 5). The present results provide a statistically clear confirmation of previously identified risk factors for the development of hypotension after spinal block; the level of sensory analgesia above T_5. The explainable physiology is the higher level of sensory blockade, the more autonomic blockade causing more vasodilatation and more hypotension. Level of T_1-T_4 is the location of cardio accelerate nerve fibers. Blockade above T_4 level may lead to negative inotropic and chronotropic heart function and causes more hypotension[12]. In addition to previously identified risk factors, the authors found that the maternal height < 155 cm, and the incidence of hypotension were increased significantly. However, in a previous study, Mark et al[13]concluded that height did not affect the spread of hyperbaric spinal anesthesia. Theoretically, the amount of local anesthetic agents in the sense of milligram and total volume should affect the severity of hypotension. Harten et al[14] showed that adjusting the dose of hyperbaric bupivacaine to the patient's height and weight decreased the incidence and severity of maternal hypotension. But at this institute, most of the dose of 0.5% heavy bupivacaine is 11 mg or 2.2 ml. This may be the reason why its use in the maternal height < 155 cm, may cause hypotension. However, Neti et al[8] used the dose according to the patient's height for example, height < 150 cm, 2ml, height 151-155 cm, 2.1 ml.

In the present study, the incidence of hypotension in patients with baseline SBP $\leq$ 130 mmHg was significantly increased. The mechanism of this risk factor has not been explained. Despite the fear, anxiety, excitement and emotional effect of patients to the operative environment, the authors speculate that patients with low baseline SBP may have low baseline systemic vascular resistance thus after spinal anesthesia, vasodilatation was increased. Further study about this risk factor is needed to confirm this hypothesis.

The high incidence of hypotension in the present study may be from lack of time to prehydrate the patients before the spinal block. The efficacy of prophylactic ephedrine for averting hypotension after spinal block is controversial. From a meta-analysis of prophylactic ephedrine for prevention of hypotension in spinal block for cesarean delivery showed that at 14 mg of ephedrine the number needed to treat was only 7.6, while the same number was needed to harm. At larger doses, the likelihood of causing hypertension was greater than the advantage of prevention of hypotension and a minor decrease in umbilical arterial pH was noted[15].

Hypotension after spinal block was the surrogate outcome. Apgar scores were similar in the two groups at 1 min and 5 min. The authors cannot prove that this was associated with improved fetal outcome. The frequency of hypotension reflects the size of the problem. Strategic plan to reduce this incidence and proper initial management of mild hypotension after spinal block are the key to success.

Conclusion

The authors found that the risk factors associated with increased incidence of hypotension could be divided into two groups. The first group has the non modifiable risk factors that include the patient's height and the baseline systolic blood pressure. The second group has the modifiable risk factor that includes the level of blockage.

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การศึกษาอุบัติการณ์และปัจจัยเสี่ยงของภาวะความดันเลือดต่ำในการระงับความรู้สึกผู้ป่วยผ่าตัดคลอดด้วยวิธีการฉีดยาชาเข้าช่องน้ำไขสันหลัง

เสาวภาคย์ จำปาทอง, ฐิติมา ชินะโชติ, ชูศรี พิศลยบุตร, ทองภรณ์ ฮิมหมั่นงาน

วัตถุประสงค์*: เพื่อนำไปใช้เป็นแนวทางในการทำนายและวางแผนป้องกันภาวะความดันเลือดต่ำในการระงับความรู้สึกผู้ป่วยผ่าตัดคลอดด้วยการฉีดยาชาเข้าช่องน้ำไขสันหลัง*

วัสดุและวิธีการ*: ศึกษาแบบบันทึกการดมยาสลบของผู้ป่วย 991 ราย ที่ได้รับการผ่าตัดคลอดภายใต้การระงับความรู้สึกด้วยการฉีดยาชาเข้าช่องน้ำไขสันหลังในโรงพยาบาลศิริราช*

ผลการศึกษา*: อุบัติการณ์ของภาวะความดันเลือดต่ำ (เมื่อค่าความดันซีสโทลิก ≤ 100 มิลลิเมตรปรอท) เท่ากับร้อยละ 76.7 ปัจจัยเสี่ยงที่สำคัญคือ ความสูงน้อยกว่า 155 เซนติเมตร, ความดันเลือดซีสโทลิกพื้นฐาน ≤ 120 มิลลิเมตรปรอท และระดับการชา ≥ T5*

สรุป*: ปัจจัยเสี่ยงที่สัมพันธ์กับภาวะความดันเลือดต่ำคือความสูง, ความดันเลือดซีสโทลิกพื้นฐานและระดับการชา*