อุบัติการณ์และปัจจัยเสี่ยงที่เกี่ยวข้องกับภาวะความดันโลหิตต่ำในมารดาที่ได้รับการระงับความรู้สึกทางช่องน้ำไขสันหลังระหว่างการผ่าตัดคลอดทางหน้าท้อง

Incidence and Risk Factors Associated with Spinal Anesthesia Induced Predelivery Hypotension for Cesarean Section

รติกร อนุสรธนาวัฒน์ พ.บ., วท.ม.
ว.ว.วิสัญญีวิทยา
วิทยาศาสตรมหาบัณฑิต สาขาวิชาการพัฒนาสุขภาพ

กลุ่มงานวิสัญญีวิทยา
โรงพยาบาลเจ้าพระยายมราช จังหวัดสุพรรณบุรี

Ratikorn Anusorntanawat M.D., M.Sc.
Thai Board of Anesthesiology
Master of Science in Health Development: Clinical Epidemiology
Division of Anesthesiology
Chaoprayayomraj Hospital, Suphan Buri

ABSTRACT

Objective: To investigate the incidence of predelivery hypotension and identify risk factors associated with spinal anesthesia-induced predelivery hypotension for cesarean section.

Materials & methods: A prospective cohort study was conducted from July 1, 2014 to March 15, 2015 on 583 patients undergoing cesarean section under spinal anesthesia. Preloading with intravenous 0.9% NaCl 10 ml/kg before performing spinal anesthesia with 0.5% hyperbaric bupivacaine 2.2 ml plus preservative-free morphine 0.2 mg and turning the patient to supine position with left uterine displacement. Predelivery hypotension (systolic blood pressure < 80% of baseline or < 90 mmHg) was treated by intravenous phenylephrine 100 mcg Data were analyzed using multivariable logistic regression and AuROC.

Results & Discussion: Incidence of predelivery hypotension was 61.7% (95% CI: 57.7, 65.7). The probability of predelivery hypotension increased with supine hypotensive syndrome of pregnancy (SHSP) (adjusted OR 3.82, 95% CI 1.07, 13.59, p=0.04, AuROC 0.69). The other risk factors were anesthetic level at the 5 minute, as compared to T12-T5 level, the incidence increased to 2.85 times (95% CI 1.89, 4.3, p<0.001) and 7.65 times (95% CI 2.66, 22.04, p<0.001) in the T4-T 1 range and C5-C1 range, respectively and the indication of cesarean section, in a comparison with

oligohydramnios, the incidence increased to 2.20 times (95% CI 1.31, 3.70, p=0.003) and 2.35 times (95% CI 1.37, 4.00, p=0.002) in cephalopelvic disproportion (CPD) and previous cesarean section, respectively.

Conclusion: The results indicated that the incidence of spinal anesthesia induced predelivery hypotension for cesarean section increased with SHSP, anesthetic level at the 5th minute upper T5 level, especially C level. CPD and previous cesarean section were related with higher incidence than oligohydramnios.

Keywords: predelivery hypotension, spinal anesthesia, cesarean section, incidence, risk factors

บทคัดย่อ

วัตถุประสงค์ : เพื่อศึกษาอุบัติการณ์ของภาวะความดันโลหิตต่ำและระบุปัจจัยเสี่ยงที่สัมพันธ์กับภาวะความดันโลหิตต่ำเพื่อนำมาใช้ในป้องกันภาวะนี้ ในหญิงตั้งครรภ์ที่ได้รับการระงับความรู้สึกด้วยยาชาทางช่องน้ำไขสันหลังระหว่างการผ่าตัดคลอดทางหน้าท้อง

วัสดุและและวิธีศึกษา : การศึกษาเชิงวิเคราะห์แบบไปข้างหน้า เก็บข้อมูลตั้งแต่ 1 กรกฎาคม 2557 ถึง 15 มีนาคม 2558 ในหญิงตั้งครรภ์ที่ได้รับการผ่าตัดคลอดทางหน้าท้อง 583 คน ได้รับสารละลายเกลือแกง (0.9% NaCl) 10 มิลลิลิตร/กิโลกรัม ทางเส้นเลือดดำภายใน 15-20 นาที ก่อนให้การระงับความรู้สึกทางช่องน้ำไขสันหลังด้วยยาชาบูพิวาเคน ความเข้มข้นร้อยละ 0.5 ปริมาณ 2.2 มิลลิลิตร ผสมยามอร์ฟีน 0.2 มิลลิกรัม จากนั้นให้ผู้ป่วยนอนหงายหนุนสะโพกขวาให้ท้องเอียงไปทางซ้าย บันทึกอุบัติการณ์ภาวะความดันโลหิตต่ำ (ความดันซิสโตลิก < ร้อยละ 80 ของค่าความดันซิสโตลิกพื้นฐาน หรือ < 90 มิลลิเมตรปรอท) และให้การรักษาด้วยยาฟีนิลเอฟริน ความเข้มข้น 100 ไมโครกรัม/มิลลิลิตร ให้ทางเส้นเลือดดำครั้งละ 1 มิลลิลิตร วิเคราะห์ข้อมูลด้วยการถดถอยโลจิสติกและพื้นที่ใต้กราฟ

ผลและอภิปรายการศึกษา : พบอุบัติการณ์ของภาวะความดันโลหิตต่ำ ร้อยละ 61 (ช่วงเชื่อมั่นร้อยละ 95 คือ 57.7, 65.7) อุบัติการณ์จะสูงขึ้นถ้าผู้ป่วยมีภาวะความดันโลหิตต่ำขณะนอนหงายในหญิงตั้งครรภ์ (สัดส่วนแต้มต่อปรับแล้ว 3.82, ช่วงเชื่อมั่นร้อยละ 95 คือ 1.07, 13.59, p=0.04, พื้นที่ใต้กราฟ 0.69) ปัจจัยอื่นๆ คือ ระดับการชาที่ 5 นาทีหลังจากฉีดยาชาเข้าช่องน้ำไขสันหลัง โดยเมื่อเปรียบเทียบกับ ระดับ T 12-T5 พบว่า ที่ระดับ T4-T1 มีอุบัติการณ์เพิ่มขึ้น 2.85 เท่า (ช่วงเชื่อมั่นร้อยละ 95 คือ 1.89, 4.3, p<0.001) และที่ระดับ C5-C1 มีอุบัติการณ์เพิ่มขึ้น 7.65 เท่า (ช่วงเชื่อมั่นร้อยละ 95 คือ 2.66, 22.04, p<0.001) และข้อบ่งชี้ในการผ่าตัด คือเมื่อเปรียบเทียบกับภาวะน้ำคร่ำน้อย พบว่า ภาวะศีรษะทารกในครรภ์ไม่ได้สัดส่วนกับช่องเชิงกรานเพิ่มความเสี่ยงต่อการเกิดภาวะความดันโลหิตต่ำ 2.20 เท่า (ช่วงเชื่อมั่นร้อยละ 95 คือ 1.31, 3.70, p=0.003) และภาวะผ่าตัดคลอดในการตั้งครรภ์ครั้งก่อนเพิ่มความเสี่ยงต่อการเกิดภาวะความดันโลหิตต่ำ 2.35 เท่า (ช่วงเชื่อมั่นร้อยละ 95 คือ 1.37, 4.00, p=0.002)

สรุป : ปัจจัยเสี่ยงต่อภาวะความดันโลหิตต่ำ คือ ภาวะความดันโลหิตต่ำขณะนอนหงายในหญิงตั้งครรภ์ ระดับการชาที่ 5 นาทีหลังจากฉีดยาชาเข้าช่องน้ำไขสันหลังเสร็จ เหนือระดับ T5 โดยเฉพาะระดับ C และข้อบ่งชี้ในการผ่าตัด คือภาวะศีรษะทารกในครรภ์ไม่ได้สัดส่วนกับช่องเชิงกรานและภาวะผ่าตัดคลอดในการตั้งครรภ์ครั้งก่อน เมื่อเปรียบเทียบกับภาวะน้ำคร่ำน้อย

คำสำคัญ : ภาวะความดันโลหิตต่ำ การให้การระงับความรู้สึกทางช่องน้ำไขสันหลัง การผ่าตัดคลอดทางหน้าท้อง ปัจจัยเสี่ยง อุบัติการณ์

Introduction

Predelivery hypotension after spinal anesthesia for cesarean section is a common serious problem that effects both maternal safety and fetal well-being[1]. The clinical importance of this side effect was clearly correlated with mortality[2]. Although many methods have been used to prevention but no single method completely prevented hypotension during cesarean delivery[3]. The incidence of hypotension in excess of 80% without prophylactic management[4] and varied from 52% to 65% with prophylactic management[5-7].

Based on our review of the literature, the prediction of hypotension after spinal anesthesia for cesarean section, however, has been addressed by only a few authors[5, 6]

The primary objective of this study was to determine the incidence of spinal anesthesia-induced predelivery hypotension. Secondary objectives included: identification of risk factors associated with spinal anesthesia-induced hypotension; exploration of the potential diagnostic utility of identified risk factors among patients undergoing cesarean section which is one of most common surgical procedures.

Materials & Methods

This was a part of a prospective cohort study that was registered in the Thai Clinical Trials Registry (TCTR ID: TCTR 20141017001) with the title Safety of Phenylephrine in Antihypotensive Treatment during Spinal Anesthesia for Cesarean Section. Approval for this study was obtained from the Institutional Review Board of Chaoprayayomraj Hospital, Suphan Buri Province, Thailand. All patients gave written informed consent to participate in the study and the data collection was performed from July 1, 2014 to March 15, 2015.

This study enrolled 583 pregnant women undergoing cesarean section who matched the following inclusion criteria: ASA physical status I or II, age $\geq$ 18 years, singleton baby and term pregnancy (gestational age $\geq$ 37 weeks). Exclusion criteria were, as follows: chronic hypertension, gestational hypertension or preeclampsia, cardiovascular disease, cerebrovascular disease, complicated obstetrics (abruptio placentae, placenta previa), known fetal abnormalities, history of monoamine oxidase inhibitor (MAOI) use or other drugs that prolong heart conduction (PR or QT interval), and

contraindications to spinal anesthesia (e.g., coagulopathy, intracranial space occupying lesion, or patient refusal).

Demographic data were obtained at the ward on the evening before the day of surgery. A nurse anesthetist recorded the non-invasive blood pressure (NIBP) and heart rate (HR) of the patient at rest and in a tranquil environment in 3 positions. Averaged systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) from 3 consecutive readings taken in the supine position with left uterine displacement were defined as baseline values. The same measurements were repeated in the left lateral and supine positions to determine supine hypotensive syndrome of pregnancy (SHSP). In emergency cases, average NIBP and HR were recorded only in supine position with left uterine displacement due to a time limitation.

On the day of surgery, a routine spinal anesthesia was performed following the standard guideline. Fluid preload of 0.9% NaCl solution 10 ml/kg IV was given over a 15-20 minute period before performing spinal anesthesia. After standard monitoring instruments were applied, the patient was positioned in the left lateral decubitus position and spinal anesthesia was performed with a 27-gauge Quincke spinal needle at the L2 to L3 or L3 to L4 vertebral interspace. After confirmation of free flow of cerebrospinal fluid, 2.2 ml of 0.5% hyperbaric bupivacaine and 0.2 mg of preservative free morphine were injected intrathecally then the patient was positioned in the supine position with left uterine displacement at 15° by champaign-shaped pillow under right hip.

One-minute automatic interval NIBP, HR, and oxygen saturation (SpO_2) were monitored immediately after finish of spinal medication injection (defined as Time 0), with the continuous monitoring until the baby was delivered. oxygen 6 L/min was given via face mask from induction of spinal anesthesia until baby delivery. Dermatomal level of anesthesia was assessed by loss of cold sensation discrimination at the 1^{st} and 5^{th} minute after finish of spinal injection. Sensory block to T5 level was determined as adequate anesthesia for cesarean section.

Incidence of pre/postdelivery hypotension (SBP < 80% of baseline or < 90 mmHg), reactive hypertension (SBP > 120% of baseline), and serious bradycardia (HR < 60 bpm + hypotension or HR < 45 bpm) were recorded. If hypotension occurred, phenylephrine 100 mcg/ml was administered via intravenous (IV) bolus. Additional phenylephrine doses were given every 1 minute if hypotension persisted. Serious bradycardia was treated by atropine 0.6 mg IV with doses repeated every 2 minutes, as needed. After baby delivery, oxytocin 20 units in 0.9% NaCl 1,000 ml was given via IV infusion. Cases with heart block, arrhythmia, and/or cardiac arrest were recorded and prompt treatment was given. The following times were recorded: finish of spinal injection, skin incision, uterine incision and baby delivery. Incidence of

nausea, vomit, headache and uterine atony were recorded and treated with antiemetic drug (metoclopramide 10 mg IV) for nausea and vomit, and methylergonovine maleate 0.2 mg IV for uterine atony to control of postpartum hemorrhage. Baby characteristics as baby birth weight and Apgar scores at the 1st and 5th minute were recorded.

Statistical analysis

Sample size calculation was performed according to the objective to determine Safety of Phenylephrine in Antihypotensive Treatment during Spinal Anesthesia for Cesarean Section, in which the required sample size was higher than the sample size required for the objective of this study. The dichotomous variable “predelivery hypotension” (yes/no) was used as a target criterion. Firstly, variables were checked with univariate analysis for associations with predelivery hypotension. The continuous data were presented as mean and median, using either unpaired t-test or Mann-Whitney U test, as appropriate. The categorical data were presented as number (n) and percentage (%), using the chi-square test or Fisher exact test, as appropriate. Secondly, possible associated factors with predelivery hypotension were analyzed by univariate and multivariable logistic regression. Multivariable logistic regression was analyzed by using the enter method; the variables which were p-value less than 0.2 from univariate analysis, clinical importance and no multi-collinearity were included into the full model. The reduced model was done by excluded the variables which were not statistically significant association ($p \geq 0.05$). The better model with a smaller Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) was choosen and assessed the fit of model. The results were reported as crude and adjusted odds ratio (OR) with 95% confidence interval (CI), p-value and the area under the curve (AuROC). A p-value less than 0.05 was considered as statistically significant. All were analyzed by Stata version 12 (StataCorp, College Station, TX, USA).

Results

Five hundred and eighty three patients were recruited at Chaoprayayomraj Hospital during the study period. Incidence of spinal anesthesia-induced predelivery hypotension for cesarean section was 61.7% (n=360, 95% CI: 57.7, 65.7). Demographic and baseline characteristic data are shown in Table 1. There were statistically significant differences in baseline SBP, baseline HR, ASA physical status, indication for cesarean section and supine hypotensive syndrome of pregnancy (SHSP) between predelivery hypotension and no predelivery hypotension group.

Table 1 Demographic and baseline characteristic data

Variables	Total n=583		Predelivery hypotension n=360		No predelivery hypotension n=223		P value
	mean	(S.D.)	mean	(S.D.)	mean	(S.D.)	
Age (yr)	28.2	(5.8)	28.3	(6.0)	28.1	(5.7)	0.70[a]
Weight (kg)	70.9	(12.7)	71.7	(13.3)	69.9	(11.8)	0.10[a]
Height (cm)	158.7	(5.9)	158.4	(5.7)	159.1	(5.1)	0.16[a]
Gestational age (wk)	38.2	(0.7)	38.2	(0.6)	38.2	(0.8)	0.72[a]
Baseline							
SBP	119.2	(12.2)	120.6	(12.5)	117.8	(11.9)	0.02[a]
DBP	74.8	(10.7)	74.7	(9.6)	74.8	(12.2)	0.97[a]
Heart rate	85.9	(11.8)	87.1	(12.2)	84.2	(11.2)	0.004[a]
	n	(%)	n	(%)	n	(%)	
Gravida	581	(99.7)	358	(99.4)	223	(100)	0.28[b]
1	255	(43.7)	147	41.1	108	48.4	
2	253	(43.4)	165	46.1	88	39.5	
3	59	10.1)	37	10.3	22	9.9	
4	13	2.2)	9	2.5	4	1.8	
5	1	0.2)	0	0.0	1	0.4	
Parity	581	(99.7)	358	(99.4)	223	(100)	0.48[b]
0	297	(50.9)	174	(48.6)	123	(55.20	
1	246	(42.2)	159	(44.4)	87	(39.0)	
2	33	(5.7)	22	(6.1)	11	(4.9)	
3	5	(0.9)	3	(0.8)	2	(0.9)	
ASA	582	(99.8)	359	(99.7)	223	(100)	0.04[b]
I	554	(95.0)	347	(96.7)	207	(92.8)	
II	28	(4.8)	12	(3.3)	16	(7.2)	
Indication	581	(99.7)	358	(99.4)	223	(100)	0.002[b]
oligohydramnios	116	(19.9)	55	(15.4)	61	(27.4)	
cephalopelvic disproportion	238	(40.8)	152	(42.5)	86	(38.6)	
previous cesarean section	199	(34.1)	134	(37.4)	65	(29.1)	
PROM	7	(1.2)	2	(0.6)	5	(2.2)	
breech	18	(3.1)	12	(3.4)	6	(2.7)	
decrease fetal movement	3	(0.5)	3	(0.8)	-	-	
Underlying disease	582	(99.8)	359	(99.7)	223	(100)	0.10[b]
none	552	(94.7)	347	(96.7)	205	(91.9)	
diabetes mellitus	23	(3.9)	10	(2.8)	13	(5.8)	
asthma	5	(0.9)	2	(0.6)	3	(1.3)	
premature ventricular contraction	1	(0.2)	-	-	1	(0.4)	
tricuspid regurgitation	1	(0.2)	-	-	1	(0.4)	
SHSP	491	(84.2)	305	(84.7)	186	(83.4)	0.012[b]
no	468	(80.3)	285	(93.4)	183	(98.4)	
yes	23	(3.9)	20	(6.6)	3	(1.6)	

a=unpaired t-test; b=Chi square test

Intraoperative and postoperative data pertaining to anesthesia and surgery are shown in Table 2. There were statistically significant differences in anesthetic level at the 1st and 5th minute, intraoperative nausea, postdelivery hypotension, reactive hypertension, serious

bradycardia, duration from finish of spinal injection to uterine incision and to baby delivery. Baby birth weight and Apgar score at the 1st and 5th minute were in normal value and no statistically significant differences were found between 2 groups.

Table 2 Intraoperative and postoperative data pertaining to anesthesia and surgery

Variables	Total n=583		Predelivery hypotension n=360		No Predelivery hypotension n=223		P value
Intraoperative data	n	(%)	n	(%)	n	(%)	
Anesthetic level at 1st minute							0.002[b]
L5-L1	97	(16.6)	51	(14.2)	46	(21.0)	
T12-T5	432	(74.1)	268	(74.4)	164	(74.9)	
T4-T1	50	(8.6)	41	(11.4)	9	(4.1)	
Anesthetic level at 5th minute							<0.001[b]
T12-T5	193	(33.1)	85	(23.6)	108	(50.5)	
T4-T1	345	(59.2)	244	(67.8)	101	(47.2)	
C5-C1	36	(6.2)	31	(8.6)	5	(2.3)	
Nausea	125	(21.4)	87	(24.2)	38	(17.0)	0.04[b]
Vomit	47	(8.1)	34	(9.4)	13	(5.8)	0.12[b]
Headache	15	(2.6)	12	(3.3)	3	(1.3)	0.14[b]
Postdelivery Hypotension	158	(27.1)	128	(36.6)	30	(13.5)	<0.001[b]
Reactive hypertension	14	(2.4)	14	(3.9)	-	-	0.003[b]
Serious bradycardia	29	(5.0)	24	(6.7)	5	(2.2)	0.02[b]
Uterine atony	190	(32.6)	120	(34.3)	70	(31.4)	0.47[b]
	mean	(S.D.)	mean	(S.D.)	mean	(S.D.)	
Finish of spinal injection to skin incision (min)	4.2	(1.3)	4.3	(1.4)	4.0	(1.2)	0.08[a]
Finish of spinal injection to uterine incision (min)	6.9	(2.0)	7.1	(2.1)	6.5	(1.8)	<0.001[a]
Finish of spinal injection to baby delivery (min)	8.2	(2.1)	8.5	(2.2)	7.8	(1.8)	<0.001[a]
Postoperative data	n	(%)	n	(%)	n	(%)	
Nausea	38	(6.5)	28	(7.8)	10	(4.5)	0.12[b]
Vomit	35	(6.0)	24	(6.7)	11	(4.9)	0.39[b]
Neonatal characteristics	n	(%)	n	(%)	n	(%)	
Apgar score at 1st minute							0.26[b]
8	6	(1.0)	2	(0.6)	4	(1.8)	
9	576	(98.8)	357	(99.2)	219	(98.2)	
10	1	(0.2)	1	(0.3)	-	-	
Apgar score at 5th minute							0.30[b]
9	7	(1.2)	3	(0.8)	4	(1.8)	
10	576	(98.8)	357	(99.2)	219	(98.2)	
	mean	(S.D.)	mean	(S.D.)	mean	(S.D.)	
Baby birth weight (g)	3142.7	399.1	3138.3	391.4	3149.8	412.1	0.46[a]

a=unpaired t-test; b=Chi square test

Univariate analysis showed the significant association between predelivery hypotension and the following factors: baseline SBP, baseline HR, ASA, SHSP, anesthetic level at 1st and 5th minute, duration from finish of spinal injection to uterine incision and to baby delivery (p-value <0.05) (Table 3). Multivariable logistic regression was analyzed by using enter method, the results showed that the patient with supine hypotensive syndrome of pregnancy (SHSP) was significantly associated with predelivery hypotension after adjusting for and anesthetic level at the 5th minute and indication of cesarean section (adjusted OR 3.82, 95% CI 1.07, 13.59, p=0.04, AuROC 0.69). Anesthetic level at the 5th minute was associated with predelivery hypotension, in a comparison between the incidence of predelivery hypotension in T12-T5 and the other two anesthetic level ranges, the incidence increased to 2.85 times (95% CI 1.89, 4.3, p<0.001) and 7.65 times (95% CI 2.66, 22.04, p<0.001) in the T4-T1 range and C5-C1 range, respectively. The indication of cesarean section was associated with predelivery hypotension, in a comparison with oligohydramnios, the incidence increased to 2.20 times (95% CI 1.31, 3.70, p=0.003) and 2.35 times (95% CI 1.37, 4.00, p=0.002) in cephalo-pelvic disproportion (CPD) and previous cesarean section, respectively.

Table 3 Multivariable logistic regression between associated factors and predelivery hypotension

Variables	Crude OR	95%CI	P value	Adjusted OR	95%CI	P value
Baseline SBP	1.02	1.002,1.03	0.02			
Baseline HR	1.02	1.01, 1.04	0.004			
ASA			0.04			
I	1.00	reference				
II	0.45	0.21, 0.96	0.04			
Indication			0.003			
oligohydramnios	1.00	reference				
CPD	1.96	1.25, 3.08	0.003	2.20	1.31, 3.70	0.003
previous c/s	2.29	1.43, 3.66	0.001	2.35	1.37, 4.00	0.002
PROM	0.44	0.08, 2.38	0.343	0.38	0.06, 2.57	0.322
breech	2.22	0.78, 6.31	0.135	3.01	0.86, 10.52	0.085
SHSP						
no	1.00	reference		1.00	reference	
yes	4.28	1.25, 14.61	0.02	3.82	1.07, 13.59	0.04
Anesthetic level at 1 min						
L5-L1	1.00	reference				
T12-T5	1.47	0.95, 2.30	0.09			
T4-T1	4.11	1.80, 9.37	0.001			
Anesthetic level at 5 min						
T12-T5	1.00	reference		1.00	reference	
T4-T1	3.07	2.13, 4.43	<0.001	2.85	1.89, 4.3	<0.001
C5-C1	7.88	2.94, 21.12	0.06	7.65	2.66, 22.04	<0.001
Finish of spinal injection to uterine incision (min)	1.20	1.09, 1.32	<0.001			
Finish of spinal injection to baby delivery (min)	1.20	1.09, 1.31	<0.001			

Discussion

The incidence of predelivery hypotension was 61% (n=360). Not only the sympathectomy resulting from neuraxial blockade but also the pregnancy induced physiological changes, led to as much as 55%-90% of hypotension after spinal anesthesia during cesarean section[8]. Furthermore the subarachnoid block resulted in venous pooling of blood in the lower legs, led to decreased venous return and reduced cardiac output[9]. The previous studies[10, 11] indicated that the vena caval compression by gravid uterus obstructed the venous return and caused hypotension, too. The prophylactic methods of the present study used fluid preload to prevent relative hypovolemia after vasodilatation and venous pooling from sympathectomy and left uterine displacement to reduce venous return obstruction from gravid uterus compressed vena cava. Many studies used the prophylactic therapeutic interventions based on this understanding, however they did not completely prevent neuraxial anesthesia induced hypotension in cesarean sections[12].

Based on the pre-eclamptic women studies, Sharwood-Smith G et al[12] suggested that “venous capacitance” rather than venous pressure might be the determinant of spinal anesthesia-induced hypotension in obstetrics. The increased presence of “vasodilator prostaglandins and nitric oxide” and “endothelium-dependent alteration of vascular smooth muscle function” during pregnancy had a vasodilatory effect which was counteracted by the intrinsic sympathetic vascular tone. This intrinsic vascular tone was adversely effected after spinal anesthesia, leading to over fall in blood pressure. Studies have shown that cardiac output remain nearly unchanged even after sympathetic blockade[13]. Although the varied understanding of neuraxial anesthesia induced hypotension in pregnancy, vasopressors remain the major role in increasing the arterial blood pressure and lowering the possible adverse maternal and fetal effects[14].

The following factors were identified with multivariable analysis as having a significant association with a higher incidence of predelivery hypotension: supine hypotensive syndrome of pregnancy (SHSP), anesthetic level at the 5th minute and indication of cesarean section; CPD and previous cesarean section comparing to oligohydramnios. SHSP had OR 3.82, because of no definite definition to diagnosis SHSP so the author applied the criteria of orthostatic hypotension that was an excessive fall in blood pressure when the patient changed from left lateral decubitus to supine position and resulting a drop of > 20 mmHg systolic, >10 mmHg diastolic, or both. SHSP (aortocaval compression syndrome) was a common problem mainly in late pregnancy, however it had been reported to occur as early as 16 weeks of gestation age. The various range of symptoms were from unspecific complaints to severe maternal hypotension, cardiovascular collapse, loss of consciousness and consecutive fetal depression[15]. There was a case report showed that SHSP

could be considered the probable cause of maternal and fetal death that was supported by the position of the body and autopsy findings in a 41-year-old 39-week-pregnant woman, resulted from inferior vena cava compression by gravid uterus[16]. Predominantly, this syndrome was provoked by placing the patient supine. For the anesthesiologists, cesarean section was most relevant, because of the coincidence of several risk factors[15].

The anesthetic level at the 5th minute after finish of spinal injection between T4–T1 which was associated with increased risk of predelivery hypotension (OR 2.85) that was similar to previous studies[6, 17]. And the block height to C level showed strong association with predelivery hypotension (OR 7.65). The blockage of the sympathetic nervous system led to the sensory block height. There was a compensatory vasoconstriction in the upper extremities to counteract with lower blood pressure when the sensory block was lower than T4. The cardioaccelerator fibers (T1–T4) were blocked if the anesthetic level higher than or equal T4. Furthermore, C level sensory blockade was correlated with relatively higher decreased in systolic blood pressure[17].

Indication of cesarean section was the associated factor with predelivery hypotension. Oligohydramnios referred to amniotic fluid volume that was less than expected for gestational age. It was typically diagnosed by ultrasound examination and might be described qualitatively (eg, normal, reduced) or quantitatively (eg, amniotic fluid index [AFI] $\leq$5)[18]. Cephalopelvic disproportion (CPD) and previous cesarean section were significant associated with higher risk of predelivery hypotension when comparing with oligohydramnios (OR 2.2 and 2.35, respectively). CPD occurred when there was mismatch between the size of the fetal head and size of the maternal pelvis, resulting in “failure to progress” in labor for mechanical reasons[19]. The probable explanation maybe the oligohydramnios related with amniotic fluid volume that was less than CPD or previous cesarean section, resulting to lower risk of predelivery hypotension from gravid uterus less compressed inferior vena cava.

In the present study, there were statistically significant higher incidence of postdelivery hypotension 128 out of 360 (36.6%) in predelivery hypotension group. However postdelivery hypotension occurred without predelivery hypotension that was 30 out of 223 (13.5%) so closed monitoring and prompt treatment were still required after baby delivery. The incidence of serious bradycardia together with predelivery hypotension was 24 out of 360 (6.7%) was statistically significant higher than sole serious bradycardia that was 5 out of 223 (2.2%), this might be from the side effect of phenylephrine-induced bradycardia in treatment of spinal anesthesia-induced hypotension in this study. The result showed the incidence of reactive hypertension was 14 out of 360 (3.9%) in predelivery hypotension group but this incidence was not found in patient without

predelivery hypotension, it might be from the effect of atropine-induced reactive hypertension in treatment of phenylephrine-induced bradycardia.

Conclusion

The incidence of spinal anesthesia-induced predelivery hypotension for cesarean section increased with SHSP, anesthetic level at the 5th minute upper T5 level, especially C level. CPD and previous cesarean section were related with higher incidence than oligohydramnios. Closed careful monitoring in the risky patients who have these conditions and prompt treatment of hypotension are very important method to prevent the consequent adverse maternal and fetal effects.

References

1. Habib AS. A review of the impact of phenylephrine administration on maternal hemodynamics and maternal and neonatal outcomes in women undergoing cesarean delivery under spinal anesthesia. Anesth Analg 2012;114(2):377-90.
2. Sanborn KV, Castro J, Kuroda M, et al. Detection of intraoperative incidents by electronic scanning of computerized anesthesia records. Comparison with voluntary reporting. Anesthesiology 1996; 85(5):977-87.
3. Cyna AM, Andrew M, Emmett RS, P, et al. Techniques for preventing hypotension during spinal anaesthesia for caesarean section. Cochrane Database Syst Rev 2006(4):Cd002251.
4. Saravanan S, Kocarev M, Wilson RC, et al. Equivalent dose of ephedrine and phenylephrine in the prevention of post-spinal hypotension in Caesarean section. Br J Anaesth 2006;96(1):95-9.
5. Ohpasanon P, Chinachoti T, Sriswasdi P, et al. Prospective study of hypotension after spinal anesthesia for cesarean section at Siriraj Hospital: incidence and risk factors, Part 2. J Med Assoc Thai 2008;91(5):675-80.
6. Somboonviboon W, Kyokong O, Charuluxananan S, et al. Incidence and risk factors of hypotension and bradycardia after spinal anesthesia for cesarean section. J Med Assoc Thai 2008;91(2):181-7.
7. Russell IF. Spinal anaesthesia for caesarean section. The use of 0.5% bupivacaine. Br J Anaesth 1983;55(4):309-14.
8. Mercier FJ, Bonnet MP, De la Dorie A, et al. [Spinal anaesthesia for caesarean section: fluid loading, vasopressors and hypotension]. Ann Fr Anesth Reanim 2007; 26(7-8):688-93.
9. Marx GF. Supine hypotension syndrome during cesarean section. JAMA 1969;207 (10):1903-5.

10. Holmes F. Spinal analgesia and caesarean section; maternal mortality. J Obstet Gynaecol Br Emp 1957;64(2):229-32.
11. Lees MM, Scott DB, Kerr MG, et al. The circulatory effects of recumbent postural change in late pregnancy. Clin Sci 1967; 32(3):453-65.
12. Sharwood-Smith G, Drummond GB. Hypotension in obstetric spinal anaesthesia: a lesson from pre-eclampsia. Br J Anaesth 2009;102(3):291-4.
13. Tamilselvan P, Fernando R, Bray J, et al. The effects of crystalloid and colloid preload on cardiac output in the parturient undergoing planned cesarean delivery under spinal anesthesia: a randomized trial. Anesth Analg 2009;109(6):1916-21.
14. Nag DS, Samaddar DP, Chatterjee A, et al. Vasopressors in obstetric anesthesia: A current perspective. World J Clin Cases 2015;3(1):58-64.
15. Kiefer RT, Ploppa A, Dieterich HJ. [Aortocaval compression syndrome]. Anaesthesist 2003;52(11):1073-83.
16. De-Giorgio F, Grassi VM, Vetrugno G, et al. Supine hypotensive syndrome as the probable cause of both maternal and fetal death. J Forensic Sci 2012;57(6):1646-9.
17. Carpenter RL, Caplan RA, Brown DL, et al. Incidence and risk factors for side effects of spinal anesthesia. Anesthesiology 1992; 76(6):906-16.
18. Elsandabesee D, Majumdar S, Sinha S. Obstetricians' attitudes towards 'isolated' oligohydramnios at term. J Obstet Gynaecol 2007;27(6):574-6.
19. Maharaj D. Assessing cephalopelvic disproportion: back to the basics. Obstet Gynecol Surv 2010;65(6):387-95.