



Association between preoperative shock index and hypotension after spinal anaesthesia for non-elective caesarean section: a prospective cohort study.

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Introduction

Due to time constraints, most patients undergoing non-elective Caesarean Section (CS) are unable to receive adequate volume replacement, which puts them at higher risk of experiencing the hypotensive effects of spinal anaesthesia.

This is especially concerning for patient who already have underlying fluid depletion. Baseline heart rate (HR) and systolic blood pressure (SBP) to predict the occurrence of post-spinal hypotension in CS has yielded inconsistent results.

It has been observed that that early hypovolemia does not usually result in significant changes in HR or SBP.

As an alternative, the shock index (SI), calculated as the ratio of heart rate to systolic blood pressure, may be a better indicator of acute hypovolemia. ¹

Studies have shown that SI might be a better measure of the degree of haemodynamic stability than HR or SBP alone. ^{1,2}

In obstetric population, the threshold of SI of ≥ 0.9 has been associated with increased risk of maternal adverse outcomes. ³⁻⁵

Based on this cut off value, we hypothesized that an SI value of ≥ 0.9 may be associated with an increased risk of hypotension following spinal anaesthesia for non-elective CS.

Methods

This prospective, single-center, cohort study was conducted at B.P. Koirala Institute of Health Sciences (BPKIHS), from January 2021 to February 2022.

Ethical approval was obtained from the Institutional Review Committee of BPKIHS (reference number: IRC/1872/020).

Written informed consent was obtained from participants either in the labour room or obstetric emergency ward prior to the study procedure.

INCLUSION CRITERIA

Term pregnant women of ASA PS status II who underwent emergency CS (categories either 2 or 3) with spinal anaesthesia.

EXCLUSION CRITERIA

Parturient with pregnancy induced hypertension, gestational hypertension, known foetal abnormalities, contraindication to spinal anaesthesia, twin pregnancies, baseline SBP < 100 mmHg, intrauterine growth restriction, stillbirth, height < 150 cm, antepartum haemorrhage, gestational diabetes, cardiovascular, cerebrovascular, endocrine disease, and those requiring conversion to general anaesthesia.

Preoperative data collected: patient demographic, anxiety level.

The averages of three measurements were recorded as the baseline SBP, HR and SI before administering spinal anaesthesia.

All patients received intrathecal 2.0 ml of 0.5% hyperbaric bupivacaine with 10 µg fentanyl in sitting position.

Immediately after the spinal injection, 1 L of RL was rapidly co-loaded over 10–15 minutes using pressure bag, while a phenylephrine infusion was started at a rate of 25 µg.min⁻¹.

Hypotension (SBP < 80% of baseline) was treated with phenylephrine 50 µg bolus and rapid infusion of RL 200 ml. If the hypotension was associated with bradycardia (HR< 55 beats.min⁻¹), an IV injection of atropine 0.5 mg was given.

Primary outcome

Occurrence of post spinal hypotension, defined as SBP < 80% of the baseline reading or SBP < 100 mmHg from the administration of spinal anaesthesia until the delivery of the baby.

Secondary outcome

Post-delivery hypotension, defined as SBP < 80% of baseline reading or SBP < 100 mmHg observed from the initiation of oxytocin until the end of surgery.

Results

390 parturient were eligible, and the final analysis included 335 parturient. 83.58% had baseline SI < 0.9, while 16.42% had a baseline SI ≥ 0.9 .

In 155 (46.27 %) parturient, hypotension was observed before delivery whereas hypotension after delivery was observed in 114 (34.03%) parturient.

Variables associated with hypotension before and after delivery is depicted in Table 2 & 3.

No significant multicollinearity was observed between variables.

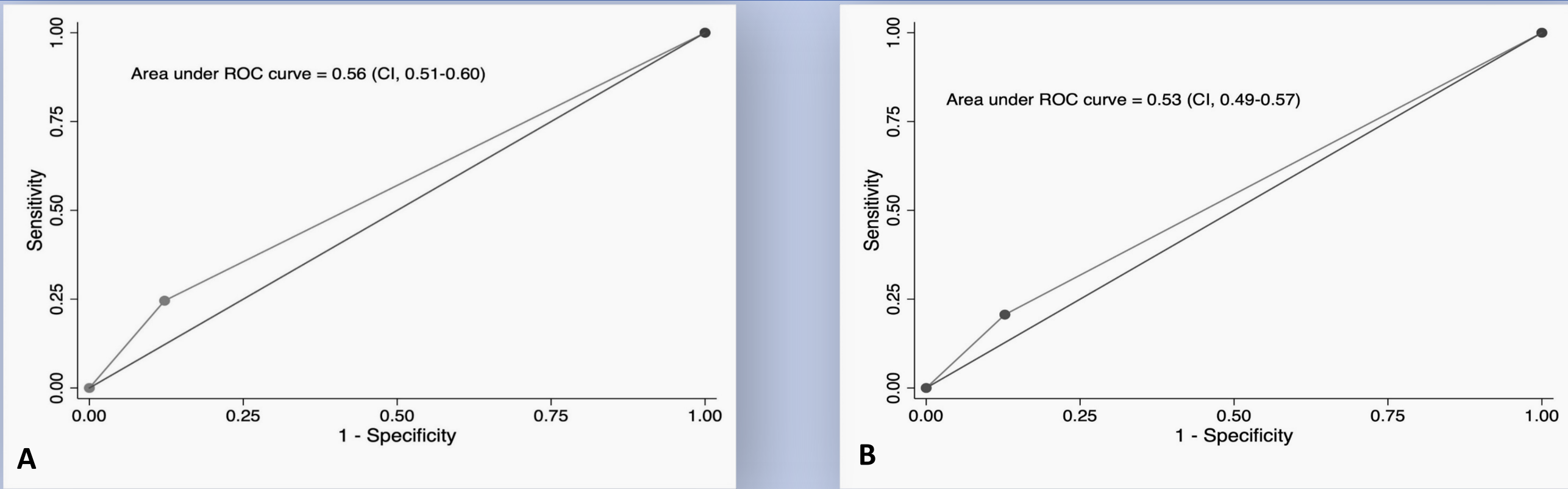
Figure 1 shows the ROC curve for SI predicting hypotension.

The model performance as reflected by ROC curve for the multivariate logistic regression analysis was 0.623 for post-spinal hypotension and 0.679 for post-delivery hypotension.

Table 1: Comparison of demographic characteristics and perioperative profiles between low and high shock index (SI) groups. Values are mean (SD), number (proportion)

Variable	Total (n= 335)	SI < 0.9 (n=280)	SI $\geq$ 0.9 (n= 55)	p-value
Age; y	27.07 (5.06)	26.97 (5.13)	27.56 (4.73)	0.43
Height; cm	155.60 (3.49)	155.73 (3.58)	155.01 (2.95)	0.16
Weight; kg	68.29 (10.07)	68.37 (9.71)	67.89 (11.82)	0.74
BMI; kg.m ²	28.20 (4.11)	28.19 (3.92)	28.25 (4.97)	0.91
Indications for caesarean section				
Failed induction	85 (26%)	73 (26%)	12 (22%)	0.45
NRNST	84 (25%)	66 (23%)	18 (33%)	
Previous LSCS	96 (29%)	81 (29%)	15 (27%)	
Oligohydramnios	29 (9%)	27 (10%)	2 (4%)	
Breech/ transverse lie	21 (5%)	16 (6%)	5 (9%)	0.79
Others	20 (6%)	17 (6%)	3 (5%)	
Gestational age; wk	39.37 (1.33)	39.37 (1.37)	39.32 (1.12)	
Haemoglobin; g.dL ⁻¹	12.04 (0.98)	12.07 (0.98)	11.88 (1.01)	0.19
Preoperative anxiety scores; APAIS	6.05 (1.8)	5.98 (1.81)	6.41 (1.93)	0.11
Baseline HR; beats.min ⁻¹	90.52 (13.95)	86.23 (9.69)	112.34 (11.80)	<0.001
Baseline SBP; mmHg	122.13 (7.68)	122.57 (7.47)	119.0 (8.77)	0.01
Baseline DBP; mmHg	74.12 (8.58)	74.40 (8.57)	72.72 (8.57)	0.18
Time taken to reach T6; min	3.50 (1.19)	3.51 (1.20)	3.45 (1.16)	0.75
Sensory level > T4	38 (11.34%)	33 (17.79%)	5 (9.09%)	0.81
Hypotension before delivery	155 (46 %)	123 (44 %)	32 (58 %)	0.05
Hypotension after delivery	114 (34 %)	86 (31 %)	28 (51%)	0.004
Lowest SBP; mmHg	101.17 (10.10)	101.73 (10.10)	98.01 (9.70)	0.01
Bradycardia; HR< 55 beats.min ⁻¹	14 (4 %)	10 (4 %)	4 (7 %)	0.25
Nausea	59 (18 %)	49 (17 %)	10 (18 %)	0.84
Vomiting	2 (0.60 %)	2 (0.71%)	0 (0%)	0.69
Shivering	54 (16 %)	41 (15 %)	13 (24 %)	0.10
Pethidine used for shivering	41 (12 %)	30 (11 %)	11 (20%)	0.07
Fluid administered; ml	1537.91 (132.49)	1533.21 (129.18)	1561.81 (147.18)	0.14
Blood loss; ml	457.20 (96.21)	456.12 (99.89)	462.72 (75.23)	0.64
Duration of surgery; min	37.21 (7.08)	37.25 (7.13)	37.02 (6.87)	0.83
Oxytocin received; IU	8.13 (1.30)	8.10 (1.33)	8.30 (1.16)	0.27
Carboprost used	48 (14 %)	40 (14 %)	8 (15 %)	0.55
APGAR score < 7; 1 min	48 (14 %)	39 (14 %)	9 (16 %)	0.67
APGAR score < 7; 5 min	9 (3 %)	7 (2 %)	2 (4 %)	0.64
Neonatal resuscitation needed	35 (10 %)	26 (9 %)	9 (16 %)	0.14
NICU admission	30 (9 %)	23 (8 %)	7 (13 %)	0.30

Fig. 1: ROC curve showing the ability of preoperative SI to predict post-spinal hypotension (A) and post-delivery hypotension (B)



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Table 2: Univariate and multivariate analysis of risk factors associated with hypotension before delivery

Variable	Univariate		Multivariate	
	OR (95% CI)	p- value	(OR (95%CI)	p- value
Age; y	1.00 (0.96- 1.04)	0.78	0.99 (0.95- 1.04)	0.84
BMI; kg.m ²	0.96 (0.91- 1.01)	0.19	0.95 (0.90-1.01)	0.14
Gestational age; wk	0.90 (0.76- 1.05)	0.20	0.90 (0.76-1.07)	0.26
Preoperative anxiety; APAIS	0.92 (0.81- 1.03)	0.18	0.93 (0.82-1.06)	0.28
Baseline HR; beats.min ⁻¹	1.00 (0.98- 1.01)	0.68	0.98 (0.96- 1.00)	0.25
Baseline SBP; mmHg	0.99 (0.96- 1.02)	0.80	1.00 (0.97- 1.03)	0.71
Baseline SI				
SI < 0.9	1 (ref)		1 (ref)	
SI $\geq$ 0.9	1.77 (0.98- 3.18)	0.05	2.77 (1.15- 6.66)	0.02
Sensory block height				
$\leq$ T4	1 (ref)	0.02	1 (ref)	0.02
> T4	2.17 (1.08- 4.36)		2.33 (1.14- 4.76)	

Table 3: Univariate and multivariate analysis of factors associated with hypotension after delivery

Variable	Univariate		Multivariate	
	OR (95% CI)	p- value	OR (95%CI)	p- value
Age; y	1.00 (0.95 – 1.04)	0.91	1.02 (0.97- 1.07)	0.40
Height; cm	0.90 (0.84- 0.97)	0.01	0.91 (0.84-0.98)	0.02
BMI; kg.m ²	1.00 (0.94- 1.06)	0.90	0.99 (0.93-1.05)	0.85
Gestational age; wk	1.19 (1.00- 1.41)	0.04	1.18 (0.97-1.42)	0.08
Preoperative anxiety score; APAIS	1.20 (1.06- 1.36)	0.004	1.22 (1.06-1.40)	0.004
Baseline HR; beats.min ⁻¹	1.00 (0.99- 1.02)	0.24	0.97 (0.95- 0.99)	0.05
Baseline SBP; mmHg	1.00 (0.97- 1.03)	0.58	1.02 (0.99- 1.05)	0.20
Baseline SI				
SI < 0.9	1 (ref)	0.004	1 (ref)	0.002
SI $\geq$ 0.9	2.33 (1.30- 4.20)		4.34 (1.72- 10.94)	
Sensory block height				
$\leq$ T4	1 (ref)	0.28	1 (ref)	0.30
> T4	0.66 (0.3- 1.4)		0.65 (0.29- 1.46)	

Conclusion

Baseline SI of ≥ 0.9 was associated with post-spinal and post-delivery hypotension in parturients undergoing emergency CS.

The study also found that sensory block height above 4th thoracic dermatomes was significantly associated with an increased odds of developing pre-delivery hypotension, while patient height and preoperative anxiety were significantly associated with hypotension after delivery.

We did not observe substantial diagnostic capability of SI alone for predicting hypotension.

Our findings provide novel evidence that SI may be a useful tool in identifying parturient who are more likely to develop hypotension, and as a result aggressive preventive strategies can be undertaken at the early stage.