

## COMPARISON OF INFERIOR VENA CAVA-COLLAPSIBILITY INDEX OF UTERINE EXTERIORIZATION VERSUS IN-SITU REPAIR IN ELECTIVE LOWER SEGMENT CESAREAN SECTION

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### Abstract

**Background:** Intraoperative hypotension increases 30-day mortality and the risks of myocardial injury and acute renal failure. We hypothesized that collapsibility index of the IVC (IVCCI) as a potential screening tool to identify intraoperative patient discomfort, nausea and vomiting and tachycardia observed after uterine exteriorization or in-situ repair and its association to hypotension during cesarean. **Materials and Methods:** In this prospective observational study, n = 60 women undergoing elective lower segment cesarean section with singleton pregnancy were recruited and IVCCI in supine position (with wedge) was noted by M mode ultrasound (USG) before spinal anesthesia, 15 mins after spinal anaesthesia, after uterine repair and after the end of surgery. Changes in blood pressure and heart rate, pain, nausea and vomiting were noted till the end of surgery. **Result:** USG measurements of IVCCI were obtained in 60 patients where area under the ROC curve of IVCCI to predict hypotension after exteriorizing the uterus was 0.48 (95% CI 0.27, 0.64) and best cut of value was 48.1 with a sensitivity and specificity of 60.9% and 75.5%, respectively. Area under the ROC curve of IVCCI to predict hypotension after in-situ repair of uterus was 0.37 (95% CI 0.19, 0.56) and best cut of value was 34.2 with a sensitivity and specificity of 66.6% and 73.5%, respectively. **Conclusion:** We conclude that IVCCI is a reliable predictor of the incidence of hypotension following repair of uterus exteriorly.

## INTRODUCTION

Cesarean section (CS) being the most common method of delivery worldwide, the trend in India has been on the rise.<sup>[1]</sup> Hence, it is imperative to practice an optimal surgical technique for lower segment cesarean section to decrease the adverse effects and morbidity.

Although uterine exteriorization is popular amongst the obstetricians because of ease of repair of uterine incision by not only improving access, but also decreases blood loss by compressing the uterine blood vessels whereas other proponents opined it is associated with peri-operative complications such as nausea and vomiting, tachycardia, intraoperative pain, blood loss with need for blood transfusion and increased duration of surgery.<sup>[2]</sup>

Maintaining hemodynamic stability is essential for reducing the rate of intra and postoperative complications. Intraoperative hypotension has no universal definition, it has a serious impact on

myocardial injury, acute kidney injury, septic complications,<sup>[3]</sup> the risk of 30-day mortality.<sup>[4]</sup>

However literature on intraoperative patient discomfort, nausea and vomiting and tachycardia observed after uterine exteriorization and its relation to hypotension is limited.

Due to financial constraints, relatively high complication rates, unnecessary invasiveness and known limitations, invasive devices (e.g., pulmonary arterial catheter, PiCCO®, etc.) for evaluating hemodynamic status is not a reasonable option.<sup>[5]</sup> Transabdominal USG measurements of inferior vena cava (IVC) diameter is non-invasive, easy and feasible in pregnant women for assessing a patient's volume status by calculating the IVC collapsibility index (IVCCI) and is not associated with complications.<sup>[6,7]</sup>

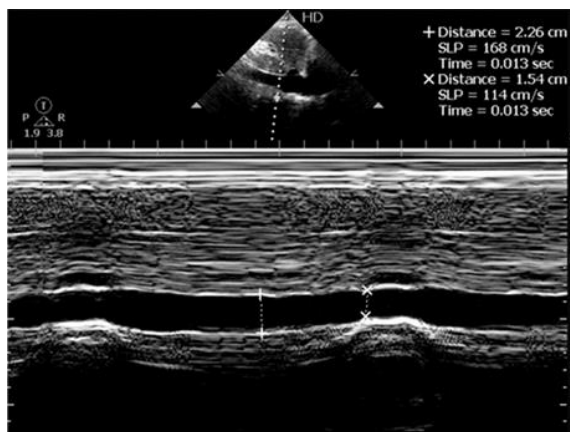
In the present study, we aimed to compare the collapsibility index of the IVC as a potential screening tool to identify intraoperative patient discomfort/pain, nausea and vomiting and

tachycardia observed after uterine exteriorization or in-situ repair and its association to hypotension during elective lower segment cesarean section.

## MATERIALS AND METHODS

The present study was approved by Institute Ethics Committee and written informed consent was obtained from the participants.

**Patients:** 60 full term (37 week completed singleton pregnancy) primigravida women with American Society of Anesthetists (ASA) score of I–II, aged 18–45 years undergoing elective lower segment cesarean section (LSCS) under subarachnoid block were included in this single center prospective observational study. Patients with pre-existing hypotension (defined as systolic arterial pressure <90 mmHg or mean arterial pressure of <60mmHg) (8) or nausea and vomiting or tachycardia (HR>100bpm), inadequately visualized IVC, duration of surgery >90mins, posted for emergency LSCS, associated cardiovascular, respiratory, renal and endocrine diseases, contraindication for spinal anesthesia, canal stenosis, body mass index (BMI) >30 kg/m<sup>2</sup>, women with pre-eclampsia, gestational diabetes mellitus were excluded from this study. After subarachnoid administration, some patients may receive vasoactive drugs due to hypotension, which may affect the results of the study. To eliminate this effect, all cases of transient hypotension were excluded in this study.



**Figure 1:** showing IVC diameter during inspiration and expiration in M-mode

**Study protocol:** Primigravida women undergoing elective cesarean section were advised for nil per oral after midnight after a detailed pre-anaesthetic check-up and IV fluid RL started in morning hours in the ward. On arrival in operating room, standard monitoring devices were attached (pulse oximeter, noninvasive blood pressure and 3 lead electrocardiography). USG scans were performed by adequately trained independent anesthesiologists who had undergone institutional training for ultrasound use in anaesthesia with at least 2 years of experience in the field. A curvilinear USG probe (3.5 5 MHz, Sonosite Turbo) was used to measure IVC

diameter in supine position with customised wedge with an angle of 15° (as measured by goniometer) during inspiration and expiration. Doppler waveform and phasic collapse with respiration were used to differentiate the IVC (Fig 1). M mode imaging was performed 2 to 3 cm distal to the right atrium in the long-axis subcostal view to measure the maximum (IVCdmax) and minimum (IVCdmin) diameter of IVC at the end of expiration and inspiration respectively during the same respiratory cycle(9). The IVC Collapsibility Index (IVCCI) was calculated using the formula:  $IVCCI = (IVCdmax - IVCdmin) / IVCdmax \times 100\%$  (10). Four scans were performed for each patient: before spinal anaesthesia, 15 mins after spinal anaesthesia, after uterine repair and after the end of surgery.

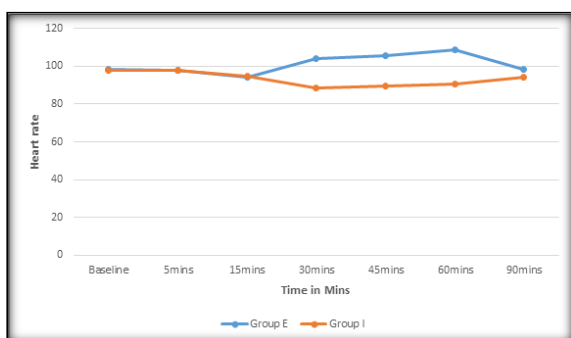
Subarachnoid block (SAB) was performed in sitting position at L3-L4/L2-L3 intervertebral level in the midline approach. After local infiltration with 2% lignocaine, 25 G Quincke's spinal needle was used to administer SAB with 2 ml of hyperbaric bupivacaine (0.5%) after confirmation of free flow of cerebrospinal fluid (CSF) at the hub of the needle. Patients were co-loaded with 10ml/kg of Ringer's Lactate (RL) solution (over 15mins) at the time of SAB and then the patients were placed in supine position with wedge under the right hip. Meanwhile HR, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and SpO<sub>2</sub> were recorded every 3 min till 15 min of SAB and every 15mins till the end of surgery. Level of sensory block was assessed by response to cold touch with the aim to achieve T6 level block. Hypotension with reduction in MAP more than 20% and/or MAP <65 mmHg, treated with 6mg of injection ephedrine and bradycardia (HR < 50 beats/min) treated with 0.6 mg of injection atropine were excluded from the study. Patients (n=90) were randomly allocated into two groups with 45 in each: Group E where uterus was exteriorized and repaired and Group I where uterus is repaired in-situ. Patients complaining of pain, nausea and vomiting or increase in HR (>20 % from the baseline) during the uterus repair were noted. Pain was assessed using NRS (Numeric rating scale) ranging from 0 to 10 (0- no pain, 10- worst pain imaginable) (11). Nausea and vomiting were graded from 0 to 3 [0-no nausea/vomiting; 1- nausea without vomiting; 2- nausea with vomiting (less than 2 times); 3-nausea with vomiting (more than 2 times)] (12). Also other complications like shivering, allergic reaction, etc were noted.

**Data Collection:** Anesthesiologists who were not part of this study and blinded to the values of IVC diameter or IVCCI recorded all hemodynamic measurements. The continuous variables (such as age, BMI, etc.) were expressed as mean and standard deviation (SD). Binary variables were expressed as absolute numbers and proportions. Independent sample t test was used to compare continuous variables in two groups and paired sample t test was used to compare variables within the group. All statistical analyses were done in STATA 12 software

for Mac OS (StataCorp. 2011. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP.)

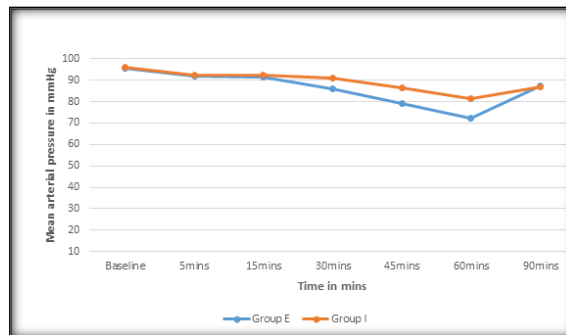
## RESULTS

The data of 60 pregnant women undergoing elective LSCS under SAB was analyzed. Comparison of demographic and baseline hemodynamic parameters of the patients is depicted in [Table 1]. Baseline HR and MAP was statistically similar between the Group E and Group I (P = 0.86; P=0.61 respectively). Heart rate was statistically significant between Group E and Group I at 30mins (103.81±3.8, 88.48±2.6); at 45mins (105.74±2.6, 89.28±2.9); at 60mins of surgery (108.45±1.4, 90.34±2.3) respectively. (P <0.0001). [Figure 2]



**Figure 2: Comparison of heart rate between Group E and Group I.**

MAP was significantly low in Group E at 30mins (85.933±3.23), 45mins (79.30±2.9) and 60mins (72.467±4.07) as compared to Group I (90.767±2.63; 86.60±3.8; 81.234±3.8 respectively), P<0.0001. [Figure 3]. No significant changes in heart rate and MAP were observed at 5, 15, 90mins between the two groups. SpO2 and respiratory rate were comparable at all time periods between the groups.



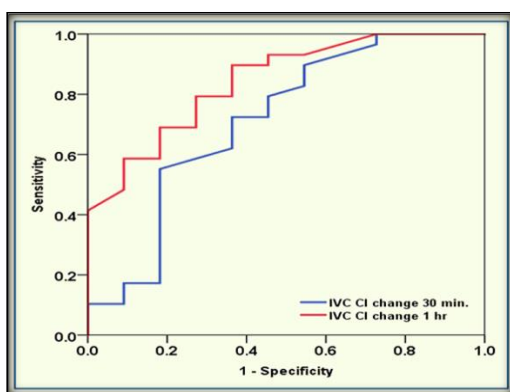
**Figure 3: Comparison of mean arterial pressure between Group E and Group I.**

### ROC Curve Analysis for All Patients

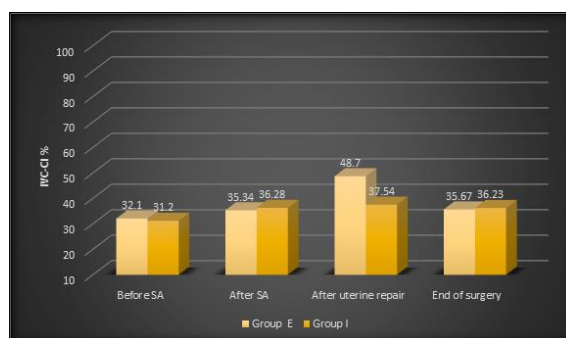
Area under the ROC curve of IVCCI to predict hypotension after exteriorizing the uterus was 0.48 (95% CI 0.27, 0.64) and best cut of value was 48.1 with a sensitivity and specificity of 60.9% and 75.5%, respectively. Area under the ROC curve of IVCCI to predict hypotension after in-situ repair of uterus was 0.37 (95% CI 0.19, 0.56) and best cut of value was 34.2 with a sensitivity and specificity of 66.6% and 73.5%, respectively [Figure 4,5].

**Table 1: Comparison of demographic and baseline hemodynamic parameters.**

Parameters	Group E (n=30)	Group I(n=30)	Significance
Age(years)	29.57(3.19)	29(4.1)	P=0.55
BMI	24.07(1.8)	24.09(1.9)	P=0.96
Period of gestation(weeks)	38.4(1.2)	38.6(1.6)	P=0.58
ASA status(I/II)	19/11	18/12	P=0.75
Baseline HR(bpm)	98.17(7.55)	97.83(7.84)	P=0.86
Baseline MAP(mmHg)	95.6(3.39)	96.03(3.06)	P=0.61



**Figure 4: Receiver operating characteristics (ROC) curve of IVC collapsibility for the prediction of hypotension**



**Figure 5: Comparison of IVC collapsibility index (IVCCI) before spinal anaesthesia (SA), after spinal anaesthesia(SA), after uterine repair and end of surgery**

Out of 30 patients in each group assessed by NRS scale, 5 patients in Group I had mild pain during in-situ repair while in Group E 18 patients experienced moderate pain and 4 had severe pain during uterine repair which was significant ( $P < 0.001$ ). 23 patients in Group E had grade I- II nausea/vomiting while 3 patients in Group I experienced grade 0-I nausea/vomiting ( $P < 0.001$ ). No other adverse events were noted during the study.

## DISCUSSION

Our prospective observational study compared the hemodynamic response following repair of uterus in patient groups defined on the basis of exteriorization and in-situ repair. We evaluated the diagnostic value of a high IVCCI value in the prediction of hypotension and its association with tachycardia, pain, nausea and vomiting. The important differences between the two groups, verifying that a high IVCCI values was associated with profound changes in mean arterial pressure, which is consistent with the concept of IVCCI can detect volumic changes. A study conducted by Mueller et al. showed IVCCI had high specificity and low sensitivity,<sup>[13]</sup> consistent with our study. Also cut off level of  $>40\%$  was used to predict volume responsiveness.

Most of the previous studies from intensive care settings have used IVC diameter and the IVCCI to identify volume-responsive patients in circulatory shock.<sup>[13-18]</sup> A recent retrospective analysis in patients undergoing non cardiac surgery conducted by Monk et al. described an association between perioperative hypotension and 30 day postoperative mortality.<sup>[19]</sup> Despite this evidence, most anesthesiologists still use blood pressure and HR as primary measurements for haemodynamic monitoring during surgery even in high risk patients although IVC ultrasound is a non-invasive, quick approach to predict hypotension.<sup>[20]</sup>

A study conducted by Zhang and Critchley found that preoperative ultrasonographic IVCCI measurements could predict the occurrence of hypotension after induction of general anesthesia at a cut-off value of 43%.<sup>[8]</sup> Also Salama and Elkashlan found a cut-off value of 44.7% for predicting hypotension after induction of spinal anesthesia.<sup>[21]</sup>

Sonographic measurement of the IVC diameters and calculation of the IVCCI provide a reliable non-invasive tool to predict hypotension peri-operatively and post-operatively. IVCCI measurements should be performed to screen patients during exterior repair of uterus to evaluate hypotension and its association with tachycardia, pain, nausea and vomiting.

### Limitations of the study

The present study has some limitations. Firstly, although changes in the IVCCI after spinal anesthesia were included in this research. More studies are needed to define the impact of postspinal anesthesia hemodynamic status on the changes in IVCCI. Salama and Elkashlan (21) found that the IVC/aorta diameter index is more helpful than IVCCI in

predicting hypotension following spinal anesthesia. However, this index was not included in our study. Second, we have recruited only elective LSCS patients, so our results could not be extrapolated in patients undergoing emergency LSCS.

## CONCLUSION

IVCCI determined using ultrasound peri-operatively is a reliable predictor of the incidence of hypotension following repair of uterus exteriorly at a cut-off point of  $>48\%$ . The potential involvement of the IVCCI in multifactorial models can be a field of future studies.

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