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# USG GUIDED IVC COLLAPSIBILITY INDEX" POTENTIAL TO REPLACE CONVENTIONAL FLUID THERAPY IN PREVENTING POST SPINAL ANAESTHESIA HYPOTENSION

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**ABSTRACT** **Background:** Hypotension is known common complication due to Spinal Anaesthesia. The high incidence ranges from 20% to 40%. Post Spinal Anaesthesia hypotension, if left untreated can be detrimental to the patient compromising the haemodynamic stability of the patient. Traditional approaches to prevent and manage it include fluid therapy, vasopressors, and patient positioning. The Ultra sonographic (USG) guided Inferior Vena Cava collapsibility index (IVCCI), has emerged as a promising tool for evaluating a patient's fluid status and predicting responsiveness to fluid therapy. Integrating the IVCCI to manage post spinal anaesthesia hypotension could optimize fluid therapy and improve Patient's outcome. **Materials and Methods:** This study investigates the effectiveness of using the USG-guided IVCCI (group USG) (n=45) with conventional fluid therapy (Group CON) (n=45) in preventing post spinal anaesthesia hypotension. **Study Design:** Prospective Randomized controlled trial. **Results:** The incidence of hypotension was significantly higher in Group CON (45.65%) compared to Group USG (23.91%), suggesting that Group USG, which received fluid by USG guided IVCCI before spinal anaesthesia, had better hemodynamic stability. The IVCCI showed a weak negative correlation between the IVCCI and Mean Arterial Pressure (MAP) difference in both groups. The total volume of fluids administered between the two groups was also significantly different, with Group USG receiving 32023.64 ml and Group CON receiving 24485.78 ml. **Conclusion:** We conclude that Group USG, which received fluid with response to IVCCI before spinal anaesthesia, had better hemodynamic stability compared to conventional fluid therapy.

**KEYWORDS :** Ultrasonography, IVCCI, Preloading, post Spinal Anaesthesia hypotension, IV fluids

## INTRODUCTION

Spinal anaesthesia is routinely performed in abdominal, orthopaedics and obstetrics surgeries[1]. It is the recommended method of anaesthesia due to its quick onset, affordability, ease of use, and low risk of side effects. Nevertheless, spinal anaesthesia related complications are hypotension, nausea, vomiting, and bradycardia. Hypotension is due to a reduction in systemic vascular resistance (SVR) in turn leading to reduction of venous return causing decrease in cardiac output.[2,3] Age over 40 years, emergency surgery, a history of hypertension, and a baseline systolic blood pressure below 120 mmHg can all increase a patient's risk of post spinal anaesthesia hypotension. A Routine practice before administering spinal anaesthesia is empirical preloading of crystalloid's to minimize hemodynamic compromise. Patients with poor cardiac reserve are particularly at risk of volume overload and the preloading may not be sufficient in dehydrated patients. Easy and non-invasive, ultrasonography can determine the volume condition of the inferior vena cava (IVC) and its collapsibility index (IVCCI). Conventional methods for preventing and treating hypotension involve the use of vasopressors, fluid therapy and proper patient positioning. The goal of fluid therapy is to raise intravascular volume, which in turn increases venous return to the heart. This is crucial for keeping blood pressure at an adequate level.[4]

Ultrasonography (USG) guided IVCCI has shown promise in determining a patient's fluid status and forecasting the efficacy of fluid treatment .[5] One non-invasive way to monitor the intravascular volume status is via the intravascular collapsibility index, which evaluates the change in the diameter of the IVC with breathing .[6] Hypovolemia and a positive response to fluid administration, which could avoid hypotension, may be indicated by a higher IVCCI.[7] By employing this method fluid overload and its associated complications can be avoided. A more personalized and responsive strategy to managing post spinal anaesthesia hypotension could be achieved by including the IVCCI into fluid therapy.[8] A dynamic and patient-specific strategy could improve the safety and efficacy of anaesthetic care, considering the heterogeneity in individual reactions to spinal anaesthesia and fluid therapy.[9,10]

In order to avoid post spinal anaesthesia hypotension, this study aims to examine how well the USG-guided IVC collapsibility index works alongside traditional fluid therapy. The hope is that by integrating these approaches, we may develop a more accurate means of fluid management for spinal anaesthesia surgeries, which should improve hemodynamic stability and overall clinical results.

**OBJECTIVE-** To compare USG guided IVCCI and conventional fluids therapy in preventing post spinal anaesthesia hypotension.

## MATERIALS AND METHODS

**STUDY DESIGN:** Randomized controlled trial (RCT)

**STUDY SITE:** Basaveshwar Teaching and General Hospital, Kalaburgi

**SAMPLE SIZE:** 90 patients

**STUDY DURATION:** 01/05/2023 to 01/05/2024- 12 months

**SAMPLING METHOD:** After acquiring the institutional ethical clearance certificate (HKES/MRMCK/IEC/202309 dated 24/04/2023) and informed written consent, the participants were selected using a randomized controlled design. Patients were randomly assigned to either the intervention group (Group USG) or the control group (Group CON).

### INCLUSION CRITERIA

- Patients aged 18 to 80 years.
- Patients classified as American Society of Anaesthesiologists (ASA) physical status I or II.

### EXCLUSION CRITERIA

- Patients who refused to participate
- Patients with pre-existing hypotension (defined as systolic arterial pressure <90 mmHg).
- Patients with contraindications for spinal anaesthesia, such as canal stenosis.
- Pregnant patients.

### INTERVENTIONS

**GROUP CON:** Patients in the control group received conventional fluid therapy based on clinical judgment. Based on their weight and in accordance with Holliday-Segar formula

**GROUP USG:** Patients in the intervention group received fluid therapy guided by the USG-measured IVCCI. The patients' IVC diameter was measured during inspiration and expiration, and the collapsibility index was calculated using the formula: IVC Collapsibility Index=IVC max −IVC min/ IVC max × 100% Patients with a high collapsibility index (>40%) indicating hypovolemia received additional fluid boluses to optimize their volume status before and during spinal anaesthesia.

**ANAESTHESIA PROTOCOL:** All patients underwent standard spinal anaesthesia procedures. After ensuring appropriate aseptic conditions, a inj. Bupivacaine 0.5% Heavy 3ml was administered at the L3-L4 or L4-L5 interspace using a 25-gauge needle. Patients were monitored continuously for hemodynamic changes, and blood pressure measurements were recorded at baseline, immediately after anaesthesia, and at regular intervals of 3mins for first 30 mins and every 5 mins till hemodynamic stability was achieved. In case of sustained hypotension vasopressors were used to achieve hemodynamic stability.

**OUTCOME MEASURES:** To measure the incidence of hypotension, defined as a systolic arterial pressure <90 mmHg or a decrease of more than 20% from baseline and measure the total volume of fluids administered between the groups.

**STATISTICALANALYSIS:** We used SPSS 25.0 for all our statistical analysis. Using the Shapiro-Wilk test, we checked if the data were normally distributed. The mean ± standard deviation (SD) was used to express continuous variables, and the appropriate independent t-test or Mann-Whitney U test was used for comparison. We used chi-square or Fisher's exact test to compare percentages and frequencies of categorical variables. The chi-square test was used to compare the two groups' incidence of hypotension. A comparison was made between the total volume of fluids delivered using the independent t-test. Statistical significance was defined as a p-value below 0.05.

**RESULTS:**

The anthropometric details of both groups show no statistically significant difference . These results were comparable between the two groups

**Table 1:** Anthropometric, baseline hemodynamic and IV fluids administered details of the study participants

| Parameter | Group USG n=45 (%) | Group CON n=45 (%) | p-value |
|---|---|---|---|
| Age in years (Mean ± SD) | 64.62 ± 12.13 | 64.95 ± 8.72 | 0.881 |
| Gender<br>Male<br>Female | <br>26 (57.8)<br>19 (42.2) | <br>24 (53.3)<br>21 (46.7) | 0.671 |
| Weight | 62.77 ± 5.46 | 63.20 ± 5.10 | 0.752 |
| Hemodynamic baseline | Group USG (Mean ± SD) | Group CON (Mean ± SD) | P value |
| Pulse rate | 92.38 ± 7.06 | 94.58 ± 5.79 | 0.11 |
| Systolic blood pressure (in mmHg) | 142.02 ± 10.17 | 141.64 ± 8.79 | 0.851 |
| Diastolic blood Pressure (in mmHg) | 86.16 ± 5.98 | 86.27 ± 4.85 | 0.923 |
| Fluid Administered Before Spinal | Mean | SD | p-value |
| Group USG | 478.47 | 12.39 | 0.000 |
| Group CON | 95.02 | 1.97 | |

The Mean IVCCI was 42.73 ± 5.79.

**Figure 1:** IVC collapsibility index

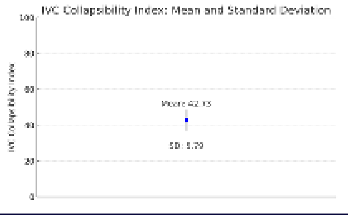
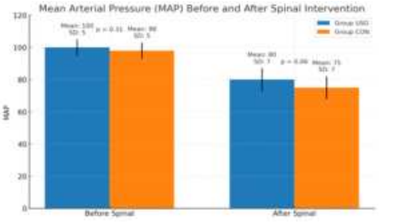



**Figure 2:** Comparison of Mean Arterial Pressure (MAP) between the two groups

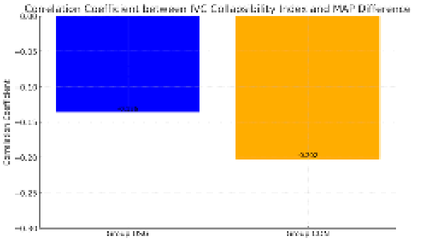



The incidence of hypotension was significantly higher in Group CON (45.65%) compared to Group USG (23.91%). This suggests that Group USG, which received USG guided fluid before spinal anesthesia, had better hemodynamic stability.

**INCIDENCE OF HYPOTENSION:**

- Group USG: 23.91%
- Group CON: 45.65%

**Figure 3:** Correlation results between the IVC collapsibility index and MAP difference



The total fluids administered between the two groups. Group USG received a total of 32023.64 ml, while Group CON received 24485.78 ml, with a significant p-value of 0.000. The average fluids administered were 696.17 ml for Group USG and 532.30 ml for Group CON, also showing a significant difference (p = 0.000).

**DISCUSSION**

The results of this study provide significant insights into the effects of fluid therapy on preventing spinal anesthesia-induced hypotension.

**BASELINE HEMODYNAMIC AND ANTHROPOMETRIC PARAMETERS**

Table 1 indicates that the baseline hemodynamic parameters, including pulse rate, systolic blood pressure, and diastolic blood pressure, were comparable between the two groups, with p-values of 0.11, 0.851, and 0.923 respectively. Similarly the baseline anthropometric parameters like age, gender distribution, and weight. The lack of significant differences in these parameters noted(p-values: 0.881 for age, 0.671 for gender, and 0.752 for weight) This homogeneity further supports the validity of comparing the outcomes between Group USG and Group CON.

Fluid Administration Before Spinal Anaesthesia

Table 1 highlights a significant difference in the volume of fluid administered before spinal anaesthesia. Group USG received significantly more fluid compared to Group CON, with a p-value of 0.000. This substantial difference in preloading likely contributed to the observed differences in hemodynamic stability post-anaesthesia.

**MEAN ARTERIAL PRESSURE (MAP)**

The comparison of MAP between the two groups, as shown in Figure 2, reveals that while there was no significant difference in MAP before spinal anaesthesia (p = 0.31), the post-anaesthesia MAP was lower in Group CON compared to Group USG, with a borderline significant p-value of 0.06. This suggests that the greater fluid administration in Group USG might have helped in maintaining a higher MAP after spinal anaesthesia.

**INCIDENCE OF HYPOTENSION**

The incidence of hypotension was significantly higher in Group CON (45.65%) compared to Group USG (23.91%). This finding underscores the efficacy of adequate preloading in preventing spinal anaesthesia-induced hypotension. The lower incidence in Group USG indicates better hemodynamic stability, likely due to the higher volume of fluids administered before the procedure.

Correlation between IVC Collapsibility Index and MAP Difference Figure 3 presents the correlation results between the IVC collapsibility index and MAP difference. Both groups exhibited a weak negative correlation, with correlation coefficients of -0.136 in Group USG and -0.202 in Group CON. This suggests that higher IVC collapsibility was associated with a greater drop in MAP, reinforcing the role of the IVC collapsibility index as a predictive tool for fluid responsiveness.

**TOTAL FLUIDS ADMINISTERED**

The total and average fluids administered between the two groups. Group USG received a significantly higher total volume of fluids compared to Group CON, with a p-value of 0.000. The average fluids administered also showed a significant difference, with Group USG receiving 696.17 ml on average compared to 532.30 ml in Group CON (p = 0.000). This significant difference in fluid administration is likely a key factor in the better hemodynamic outcomes observed in Group USG.

Because of all the above, it is reasonable to assume that Group USG patients received more fluids overall, which helped with MAP maintenance and decreased the occurrence of hypotension. By increasing the intravascular volume, fluid preloading improves venous return to the heart. Particularly following the vasodilatory effects of spinal anaesthesia, this elevated preload aids in keeping blood pressure and cardiac output stable.[6]

Agarwal et al. (2022)[11] found a significant correlation between preoperative inferior vena cava (IVC) diameter and IVCCI under General Anaesthesia. IVC collapsibility index had a sensitivity of 80% and specificity of 85% in predicting hypotension.

Ayyanagouda et al. (2020) [12] demonstrated that ultrasonographic assessment of the IVC can effectively guide fluid management to prevent spinal anesthesia-induced hypotension during hernia and hydrocele surgeries. The incidence of hypotension was 20% in the ultrasonographic assessment group compared to 45% in the control group. Using IVC measurements helped in tailoring fluid therapy to maintain hemodynamic stability.

Ceruti et al. (2018) [13] found that the risk of arterial hypotension during spinal anaesthesia was substantially decreased when fluid management was guided by vena cava ultrasonography. Guided hydration control decreased the occurrence of hypotension from 50% to 25%.

Chowdhury et al. (2022) [14] shed light on how changes in carotid artery peak systolic velocity and the intravenous collapsibility index can be used to forecast hypotension following spinal anaesthesia. When it came to predicting hypotension, the IVC collapsibility index was 80% specific and 75% sensitive

Lal et al. (2023) [15] evaluated the caval aorta index and the intravenous collapsibility index for their ability to predict hypotension following spinal anaesthesia.

Jaremko et al. (2019) [16] investigated if patients breathing on their own could be predicted to experience hypotension while under spinal anaesthesia using the IVC collapsibility index.

**LIMITATIONS OF STUDY:** The study has been done on ASA 1 and 2(controlled hypertensive patients) patients only. Although the USG guided IVCCI was done by trained anaesthesiologists, but it can be associated with subjective biases.

**CONCLUSION:**

The fluid administration based on USG guided IVCCI results in reduced incidence of hypotension, higher mean arterial pressure and greater hemodynamic stability compared to conventional fluid therapy. Thus patients undergoing spinal anaesthesia may benefit from optimal haemodynamic stability and better outcomes when the IVC collapsibility index is used to guide fluid management.

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