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*RESEARCH ARTICLE*

# ROLE OF ULTRASONOGRAPHIC INFERIOR VENACAVAL ASSESSMENT IN SURGERIES CONDUCTED UNDER GENERAL ANAESTHESIA-A PROSPECTIVE OBSERVATIONAL STUDY

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## Abstract

**Background:** One of the most frequent side effects following the induction of general anaesthesia during surgery is hypotension. The goal of our study was to determine if there was a connection between the maximum inferior vena cava (IVC) diameter prior to induction, the collapsibility index (CI), and the post-induction decrease in mean arterial blood pressure in patients undergoing operations under general anaesthesia.

**Materials and Methods:** Eighty patients who underwent procedures under general anaesthesia at Gandhi Medical College Bhopal and associated tertiary care hospital were included in a prospective observational research. Prior to starting general anaesthesia, the IVC was evaluated. For each surgical patient, the maximum and minimum IVC diameters (IVCD max and IVCD min) as well as the CI were assessed.

**Results:** According to the criteria of hypotension as defined, 31(38.75%) of the patients developed post-induction hypotension. Four patients had MAP <60 mmHg after induction of anesthesia. Post-induction hypotension was seen in patients with increased age. Patients with smaller $IVCD_{max}$ ($P = 0.02$), smaller $IVCD_{min}$ ($P = 0.003$), and higher CI% ($P = 0.004$) developed hypotension after induction of anesthesia. Percentage drop in MAP was 33.7 ± 4.48% ($P = 0.002$) in patients who developed post-induction hypotension.

**Conclusion:** Predicting post-induction hypotension caused by hypovolemia in surgical patients with IVC measurement using ultrasound is a reliable strategy.



## Introduction:-

With a prevalence of 7.7%–12.6%, hypotension is one of the most frequent consequences after the induction of general anaesthesia (GA). Hypovolemia, advanced age, ASA physical status III and higher, anaesthetic medications, reduced compensatory mechanisms, and decreased heart function are the main risk factors for its development. Intraoperative hypotension has been demonstrated to increase the risk of postoperative acute renal and cardiac injury and can increase morbidity and death during surgical procedures. Post-induction hypotension can be potentially dangerous during various surgical procedures and may have a substantial impact on outcome, even if it may not have clinical significance for short periods of time in patients undergoing general surgery.[1-4]

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Both individuals with intact autoregulation and patients with deficient autoregulation are at risk for negative outcomes from hypotension. Intraoperative hypotension raises the risks of myocardial damage and acute renal failure as well as 30-day mortality. Patients who don't have enough volume reserve before being put under general anaesthesia are at great risk.[2,5,6]

By anticipatorily detecting and treating the hypovolemic condition, the anesthesiologist plays a crucial part in the management of intraoperative hypotension. The diagnosis of hypovolemia was primarily based on clinical indicators (high pulse rate, low pulse volume, oliguria, cold and clammy skin, decreased capillary refill time, decreased skin turgor, etc.) and laboratory results before the development of modern technology and monitoring (hematocrit, serum lactate, plasma osmolarity, urine osmolarity, urine specific gravity, blood urea nitrogen level, etc.). However, while laboratory values are not usually accurate on their own, clinical measurements can be impacted by things like pain and low body temperature.[7-10]

The majority of our volume status estimation in the last ten years has depended on invasive monitors that measure central venous pressure, pulse pressure variation, stroke volume variation, and systemic pressure variation. More recently, inferior vena cava (IVC) diameter ultrasonography has been developed to evaluate intravascular volume status and direct fluid therapy. However, the utility of this method in patients undergoing procedures under general anaesthesia for the anticipation of post-induction hypotension has not been thoroughly studied.[2,11,12]

In order to predict post-induction hypotension in surgical patients, we predicted that preoperative ultrasonographic measurement of intravascular volume status may be used. By patients undergoing procedures under general anaesthesia, we sought to estimate the prevalence of post-induction hypotension based on pre-induction IVC measurement with ultrasonography (USG). This observational study's main goal was to determine the correlation between surgical patients' pre-induction maximum IVC diameter (IVCD max), collapsibility index (CI), and post-induction decrease in mean arterial blood pressure (MAP). Correlating the IVCD max and CI with the length and severity of the post-induction MAP drop was one of the secondary goals. The total amount of mephentermine needed to treat the hypotension was also investigated.

## Materials and Methods:-

This prospective observational study was completed at Gandhi Medical College Bhopal and associated tertiary care hospital after receiving approval from the institutional ethical committee. Written and informed consents were obtained after they had been informed of the operation. We looked at adult patients (18–65 years old) who had elective procedures under GA and were in ASA status I–III.

Age groups <18 or >65 years, patients with IVC that could not be visualised, ASA status IV, patients on mechanical ventilation or not breathing naturally on their own, difficult airways or multiple intubation attempts (prolonged intubating time can induce exaggerated stress response precipitating significant increase in blood pressure [BP]), significant cardiac impairment, baseline MAP 65 mmHg (increased risk of post-induction hypotension), and patients with significant cardiac impairment were excluded.

The primary investigator, who was skilled in basic echocardiography, assessed the IVC using a convex array (AC2541) transducer and a My Lab TM Gamma (esaote) equipment (3.5–5 MHz). IVC assessment was carried out when the patient was supine and breathing naturally using a subcostal approach and a long-axis view. IVC diameters were measured perpendicular to the IVC long axis at a distance of 2 cm (20 mm) from the cavoatrial junction. Using measurements of the maximum and minimum IVC diameters and the formula CI = (IVCD max – IVCD min)/IVCD max, respiratory changes in the IVC diameter were evaluated in M-mode. The same researcher measured both diameters twice, and the average of the two readings was chosen to minimise error.

The electrocardiogram (ECG), pulse oximeter (SpO2), and noninvasive blood pressure (NPB) of each subject were all monitored (NIBP). An initial dose of 10 ml/kg/h of intravenous fluid (0.9% isotonic saline) was administered. Fentanyl 2 mcg/kg, thiopentone 5 mg/kg, and vecuronium 0.1 mg/kg were administered intravenously to induce general anaesthesia (GA), which was then followed by endotracheal intubation under direct laryngoscopy. Sevoflurane (minimum alveolar concentration 0.7-1.0) in an oxygen and air mixture was used to maintain anaesthesia.

Heart rate and MAP were measured at several times, including before induction, before intubation, and for 10 minutes after intubation (1, 3, 5, and 10 min). The baseline MAP was identified as the value of MAP measured prior to induction. Changes in the patient's position or any other stimulation were prohibited throughout this time. Mephentermine (3 mg) was administered intravenously as a bolus to treat episodes of hypotension (reduction in MAP by more than 30% or MAP 60 mmHg), and the total dose of mephentermine was recorded for each patient.

Age, sex, clinical diagnosis, radiological finding, surgery, associated illnesses such as obesity, coronary artery disease (CAD), arrhythmias, heart failure, hypertension (HTN), diabetes mellitus (DM), and hypothyroidism (HT), systemic abnormalities such as neurological, cardiovascular, respiratory, and airway, treatment history, and ultrasonographic variables were all collected from the study participants (IVCD max, IVCD min, CI).

Epi info version 7 software was utilized for statistical analysis once the data was tabulated. In comparison to qualitative data, which were expressed as frequency or percentage, quantitative data were expressed as mean standard deviation (SD) or median interquartile range (IQR). The Shapiro-Wilk test was used to determine whether the data were normal. For regularly distributed data, Student's t-test and Chi-square tests were employed, and, when necessary, nonparametric tests such the Mann-Whitney U test and Fischer's test for non-normally distributed data. Using repeated measures analyses of variance, repeated measures were examined (ANOVA). Using Spearman's correlation, the correlation between continuous variables was ascertained. P values under 0.05 were regarded as significant.

## Results:-

In the present study, 94 patients had their eligibility evaluated. On the basis of inclusion and exclusion criteria, 80 patients in total were included in the study. 34 patients were female, whereas 46 patients were men. The median age was 45. (18–62) years.

Eight of the 80 individuals had recognised hypertension and were on thiazide diuretics or calcium channel blockers. None of them were taking ACEI, ARB, or beta-blockers. Six patients had HT, while four patients had DM. None of the patients had any further systemic or cardiovascular conditions.

All patients had noninvasive blood pressure checks. The mean MAP at baseline was 92.2 11.8 mmHg. No patient had a MAP at rest that was less than 75 mmHg. 31 individuals (38.75%) experienced post-induction hypotension as indicated by the hypotension criterion. MAP was below 60 mmHg in four cases after anaesthetic induction. All episodes of hypotension were treated with an intravenous dose of 3 mg mephentermine, and each patient's cumulative total dose of mephentermine was determined.

Patients with greater age showed post-induction hypotension. After the onset of anaesthesia, patients with smaller IVCDmax (P = 0.02), smaller IVCDmin (P = 0.003), and higher CI% (P = 0.004) experienced hypotension. Patients who experienced post-induction hypotension experienced a percentage decline in MAP of 33.7 4.48% (P = 0.002).

| **Variables** | **Hypotension** | | **p value** |
|---|---|---|---|
| | **Yes (n=31)** | **No (n=49)** | |
| Age (Years) | 48 (18-63) | 43(18-59) | 0.04 |
| Gender (M/F) | 18/13 | 28/21 | 0.93 |
| $IVCD_{max}$ | 1.28±0.23 | 1.46±0.34 | 0.02 |
| $IVCD_{min}$ | 0.73± 0.22 | 1.01±0.37 | 0.003 |
| CI (%) | 42.8±16.4 | 29.2±10.3 | 0.004 |
| Baseline MAP | 96.9±12.41 | 91.4±9.12 | 0.06 |
| % Decrease in MAP | 33.7±4.48 | 20.5±7.62 | 0.002 |

**Table 1:-** Comparison of patients and clinical variables between patients who did or did not develop hypotension after induction of anesthesia.

In our study, hypotension occurred in patients with small IVCDmax, IVCDmin, and greater CI%. While there was a good correlation between CI% and post-induction hypotension, there was a poor correlation between IVCDmax and IVCDmin and the frequency of post-induction hypotension. The percentage of MAP drop was positively connected with CI (r = 0.13, P = 0.03) but negatively correlated with IVCDmax (r = 0.17, P = 0.02) and IVCDmax (r = 0.15, P = 0.01).

Significant correlations were seen between the post-induction percentage drop in MAP and IVCDmax (rho = 0.172, P = 0.03), IVCDmin (rho = 0.196, P = 0.03), and CI (rho = 0.104, P = 0.02). Even the length of post-induction hypotension as a whole was impacted by IVCDmax (rho = 0.232, P = 0.02), IVCDmin (rho = 0.28, P = 0.01), and CI (rho = 0.231, P = 0.02).

The typical dose of mephentermine needed by patients who had post-induction hypotension was 8 mg. Mephentermine dose significantly correlated with the IVCDmax (rho = 0.232, P = 0.02), IVCDmin (rho = 0.313, P 0.01), and CI (rho = 0.219, P = 0.02) measurements.

## Discussion:-

In this investigation, we discovered that CI and IVC diameters preoperatively measured were reliable indicators of post-induction hypotension. IVC diameters and post-induction hypotension were negatively connected, but CI and post-induction hypotension were positively correlated.

Negative outcomes can result from mistakes in the management of intravascular volume status, which can raise the risk of intraoperative hypovolemia or hypervolemia. Because absolute hypovolemia reduces preload due to the smaller circulation volume, it can produce hypotension. Identification of patients with hypovolemia who were more likely to experience post-induction hypotension was the main objective of this ultrasound-guided IVC assessment.[13,14]

In emergency and intensive care situations, IVC assessment has frequently been utilised to evaluate the volume status and forecast fluid response. Numerous studies have demonstrated that IVC diameter is an accurate predictor of intravascular volume status and that variations in IVC diameter during respiration might foretell fluid responsiveness. The European Association of Cardiovascular Imaging and the American Society of Echocardiography both recommend using CI and IVC diameter to predict fluid responsiveness because these parameters reflect right atrial pressure. IVC diameter 21 mm with collapsibility >50% reliably indicates hypovolemic condition.[15,16]

Under general anaesthesia, hypotension is a common occurrence, and different writers have used different thresholds to define it in the literature. Since MAP represents the bottom bound of cerebral autoregulation and can influence CPP, we defined hypotension as a MAP reduction of greater than 30% or a MAP value of 60 mmHg. To prevent any external stimuli or other confounding factors (pain, blood loss, diuresis, etc.) from producing hemodynamic alterations, hemodynamic variables were monitored from the time anaesthesia was induced until 10 min following endotracheal intubation. Thiopentone's promise for brain protection and institutional protocol led us to adopt it as the induction agent in our investigation.[17,18]

In order to determine the association between pre-induction IVC diameters, CI, and post-induction hypotension, we assessed the value of ultrasonographic IVC evaluation. Similar findings were also reported by the study done by Goyal A et al.[2] According to Zhang et al[16], CI is a better predictor of post-induction hypotension than IVCDmax, which is in line with our findings.

A separate predictor of post-induction hypotension was age. The age of the patients who developed hypotension was higher (P = 0.04). The results of Reich et al[19] who discovered that ageing was a significant predictor of post-induction hypotension were comparable to this one.

Patients who experienced post-induction hypotension experienced a percentage decline in MAP of 33.7 4.48% (P = 0.002). It had a positive correlation with CI and a negative correlation with IVCDmax and IVCDmin. However, in individuals with smaller IVC diameters and higher CI, the duration of hypotension and the need for mephentermine dose were greater. Each episode of hypotension was treated with a fixed dose of mephentermine, which may not have been enough for all patients given their varied body weights. The required amount of mephentermine and, thus, the length of post-induction hypotension may vary since each person's response to mephentermine may differ depending on their noradrenaline levels and metabolism by the enzyme monoamine oxidase.[2,20]

However, it is uncommon in routine practise for anesthesiologists to employ different invasive or noninvasive monitors prior to surgery to evaluate fluid responsiveness. Ultrasound is a quick, painless, noninvasive, and simple examination technology that is widely used in modern medicine. Due to its usage in nerve blocks, vascular access, and point-of-care systemic assessment, it has recently gained popularity in perioperative care. In surgical patients who frequently experience hypovolemia and hypotension, we assessed its effectiveness for post-induction hypotension prediction. We discovered that pre-induction IVC measurement is an effective way to detect hypovolemia in patients before to surgery and to foretell post-induction hypotension.

**Limitations:-**

Our study has a number of drawbacks. First, there was only one BP measurement made to establish the baseline MAP before to induction, which could have been a potential source of bias. Some individuals may overestimate their genuine baseline BP because of high blood pressure brought on by anxiety. Second, only 10 minutes after induction did BP data start to be gathered. However, because of the impact of outside stimuli or other confounding factors like pain, blood loss, diuresis, and other factors on hemodynamic changes, data collection after that point may have had an impact on the outcome. Third, due to the change in breathing mode, IVC assessment was not done during the post-induction phase during the episodes of hypotension. Fourthly, our study lacked a control group.

## Conclusion:-

To sum up, perioperative blood pressure control is crucial to the success of surgeries performed under general anaesthesia since its lability may be linked to unfavorable outcomes. Predicting post-induction hypotension caused by hypovolemia in surgical patients can be done with high accuracy using pre-induction ultrasonographic IVC measurement. CI, IVCDmax, and IVCDmin were revealed to be reliable indicators of post-induction hypotension in our investigation. A separate predictor of post-induction hypotension was age. Preoperative awareness of these precautions will enable efficient intervention and stop post-induction hypotension. To confirm these findings and establish the standards for precise post-induction hypotension prediction and timely prevention in patients undergoing surgeries under general anesthesia, additional multicenter, larger trials are necessary.\

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