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ROLE OF ULTRASONOGRAPHIC ASSESSMENT OF INTERNAL JUGULAR VEIN DISTENSIBILITY IN THE PREDICTION OF HYPOTENSION FOLLOWING SPINAL ANAESTHESIA: AN OBSERVATIONAL STUDY

Anaesthesiology

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ABSTRACT

Background: Postspinal anesthesia hypotension (PSH) is a common side effect caused by the reduction of systemic vascular resistance. To prevent this, pre/co-loading of intravenous fluids is usually done. Many studies have used IVC measurements for predicting fluid response but few studies have examined whether measurements of the IJV can predict PSH. Hence, we hypothesized that the right IJV distensibility index measured after preloading using ultrasonography may help to predict PSH. **Methods:** Patients between 18 -65 years, ASA grade I & II who underwent elective infraumbilical surgeries under spinal anaesthesia, were preloaded with IV Ringer Lactate at 10ml/kg over 10 mins. USG examination of IJV was performed before & after preloading. After spinal anesthesia, changes in blood pressure were noted for 30 mins. SBP drop below 100mmHg or 25% decrease of SBP from the baseline value was considered significant. Retrospectively the patients were divided into hypotensive and non-hypotensive groups. **Results:** Out of 61 patients, 39 patients (63.9%) developed PSH. The two groups were similar in all baseline characteristics ($p>0.05$). Receiver operating characteristic curve (ROC) analysis showed that the right IJV distensibility index had a sensitivity of 94.87% and a specificity of 50.00% to predict the PSH at a cut-off point of 16.5% below which hypotension was seen. Area under curve (AUC) was 0.768. **Conclusion:** Right IJV distensibility index, was found to be significant in predicting incidence of PSH upto 30 mins of anaesthesia. IJV distensibility index with a cutoff value of 16.5% can be considered as a predictor of PSH.

KEYWORDS

Internal jugular vein, Postspinal hypotension, Spinal anaesthesia, Ultrasonography

INTRODUCTION

Spinal anaesthesia is a commonly used technique in anaesthesia practice. One of the common side effects of this technique is systemic hypotension caused by to reduction of systemic vascular resistance. Different factors might be related to the risk for hypotensive episodes after spinal block such as block above T5, advanced age, low intravascular volume, co-existing systemic conditions and medications, obesity etc. The clinical importance of this adverse effect has been shown in several studies which proved that hypotension is associated with complications of the cardiovascular, renal system, acute myocardial infarction, stroke, prolonged hospital stay etc.

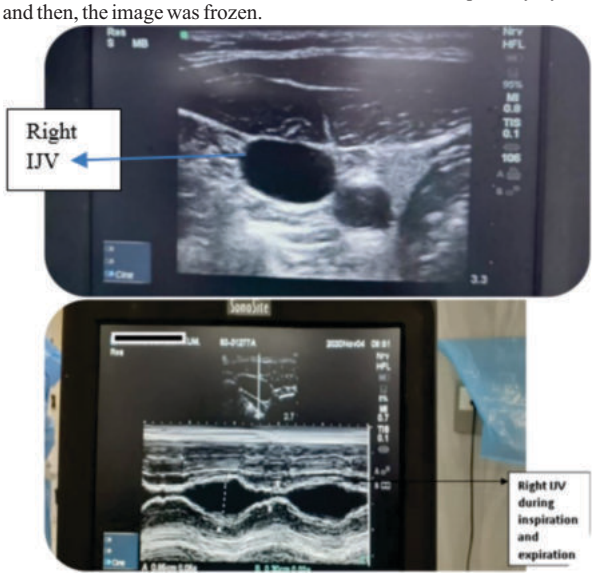
Several measures like preloading or co-loading of intravenous fluids are usually done but both hypervolemia and hypovolemia can be harmful during the perioperative period. Also, despite fluid preloading/co-loading post spinal hypotension may be seen. Noninvasive hemodynamic monitoring is routinely used to monitor changes in heart rate and blood pressure, and in treating them as soon as they are diagnosed. However, it is important to recognize early signs of hypotension and manage them promptly to prevent morbidity from severe hypotension following spinal anaesthesia. CVP (central venous pressure) measurements can be used for assessment of intravascular volume status but it is an invasive modality, time consuming and a static measurement.

Many studies have used noninvasive methods like using-guided IVC measurements for predicting fluid response but few studies have examined whether measurements of the IJV can be used to predict hypotension resulting from anesthetic procedures.[3][4] Hence, we hypothesized that the right Internal jugular vein (IJV) distensibility index measured after preloading using ultrasonography may help to predict post-spinal hypotension.

METHODOLOGY

After institutional scientific and ethics committee approval the study was registered with the Clinical Trials Registry of India (CTRI/2021/08/035840), 61 patients aged 18 to 60 years, with ASA score 1 or 2, who underwent elective infraumbilical surgery under spinal anaesthesia in the supine position, were included in the study. Informed consents were obtained from all participants before the procedure. Patients age, gender, American Society of Anaesthesiologists (ASA) physical status, procedural data, and perioperative complications related to anaesthesia were recorded. All patients were fasted for 8 hours before the surgery. In the operating room, standard monitoring included non-invasive blood pressure, five-lead electrocardiogram, and pulse oximetry. The measurements of baseline systolic (SBP), diastolic (DBP), mean arterial pressures (MAP) and heart rate (HR) were recorded. All patients were examined for baseline ultrasound measurements of the right IJV in supine position with head in a neutral position.

Ultrasound measurements were done at the level of cricoid cartilage using a high-frequency linear transducer probe 6–13 MHz of the SONOSITE EDGE. The right IJV diameter was measured using B mode and the M mode by gentle handling of the well-lubricated probe. Right IJV was identified by its anatomical relation with carotid artery and differentiated between the 2 vessels by compressibility and colour flow. An M-mode scan was recorded over a whole respiratory cycle, and then, the image was frozen.



The maximum anteroposterior diameter of the IJV was measured at the end of inspiration [AP max (cm)], and the minimum diameter was measured at the end of expiration [AP min (cm)]. The baseline right IJV distensibility index was calculated

$$\text{IJV DISTENSIBILITY INDEX} = \frac{AP\,\text{max} - \text{APmin} \times 100}{AP\,MIN}$$

Then the patients were preloaded with IV Ringer Lactate at 10ml/kg using a pressure bag over 10 minutes and again IJV distensibility index during one respiratory cycle was measured. HR, SpO2, and blood pressure were recorded before and after preloading. Spinal anaesthesia was performed under all aseptic precautions using 3cc of 0.5% bupivacaine heavy and spinal level T8 and below was considered. Noninvasive blood pressure measurements were carried out every 5 minutes for 30 minutes. A systolic blood pressure (SBP) drop below 100mmhg or 25% decrease of SBP from the baseline value was considered significant. This was treated with IV Ephedrine and fluid bolus. An association between the distensibility index and hypotension was noted and also distensibility index before and after preloading was compared.

Sample Size Estimation And Plan For Statistical Analysis

The sample size was calculated using OpenEpi calculator, Version 3 using following inputs. The anticipated frequency of hypotension in spinal anaesthesia= 24%, Absolute Precision= 10.9%, Confidence Level= 95%, Level of Significance=5%. The required minimum sample size obtained was 61 patients.-Frequency, Percentages, Cross tables, Bar diagrams, and Pie charts were used for data summarization and presentation. Descriptive and Inferential statistical analysis was carried out and results on continuous measurements were presented as Mean ± SD and results on categorical measurements in Percentage. Statistical analysis was done by Chi-Square and Paired t-test as Test of Significance. Multiple logistic regression analysis was performed using minimum/maximum diameter and distensibility Index of right IJV after preloading for prediction of a patient having post-spinal hypotension. ROC curve analysis was used to assess the ability of the right IJV distensibility index to predict the post spinal hypotension. P value <0.05 was considered significant.

RESULTS

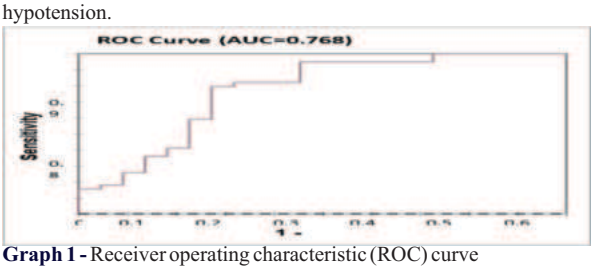
Depending on occurrence of hypotension after spinal anaesthesia, patients were divided into two groups Hypotensive and Non-Hypotensive. 63.9% of patients had hypotension with a significant fall in SBP *(p=0.0001)*, DBP *(p=0.0478)* and MAP *(p=0.0014)* at 15 minutes. The demographic variables viz. age, gender, ASA grading, and weight were comparable in both hypotensive and non-hypotensive groups.

Average of min diameter in right IJV before preloading was 0.30cms+/- 0.25cms in hypotensive group while in non-hypotensive group it was 0.62cms+/-0.35cms). After preloading average min diameter was 0.85cms+/- 0.27cms in hypotensive group and 0.72cms +/-0.23cms in non-hypotensive group. Intragroup comparison showed significant difference in hypotensive group *(p< 0.0001).*

The average distensibility index in right IJV before preloading was 50.50% +/- 39.57% in hypotensive group while in non-hypotensive group it was 50.20% +/-32.52%. After preloading average distensibility index was 23.17% +/- 17.15% in hypotensive group and 26.98% +/-18.30% in non-hypotensive group. Intragroup comparison showed that IJV distensibility index reduced significantly after preloading in both groups *(p <0.0001)*

Multiple Logistic Regression Analysis

Multiple logistic regression analysis was performed using minimum/maximum diameter and distensibility Index of right IJV after preloading for prediction of a patient having post spinal hypotension. The variable, IJV distensibility index after preloading was found to be significant *(p=0.046)* in determining occurrence of hypotension after preloading till 30 mins of post spinal anaesthesia. Also, minimum diameter of right IJV after preloading was found to be significant in determining occurrence of post spinal hypotension. The Odds ratio for distensibility index and minimum diameter of right IJV had positive association for determining occurrence of post spinal hypotension.



Graph 1 - Receiver operating characteristic (ROC) curve

ROC curve analysis seen in Graph 1 was used to assess the ability of the right IJV distensibility index in predicting the post spinal hypotension. Right IJV distensibility index was found to have a sensitivity of 94.87%, specificity of 50.00%, and accuracy of 78.69% to predict the post-spinal hypotension with a cutoff value of 16.5 %, Area under curve (AUC) is 0. 768.

DISCUSSION

Predictor	Wald Chi-Square	P value	Significance	Odds ratio	95% CI for Odds ratio
Max diff	5.780	0.016	*	0	(0-0.118)
Min diff	6.995	0.008	**	7500485.6	(60.274-933355079600.8)
Index diff	3.966	0.046	*	1.090	(1.009-1.178)

This study was aimed to investigate whether right IJV distensibility index measured with the help of ultrasonography can predict the risk of hypotension after spinal anaesthesia. Post spinal hypotension is common, with an incidence of 15-33%, and is an important cause of concern for anaesthesiologists.[1] Therefore, the search for predictors of post spinal hypotension is becoming necessary to avoid blind volume loading and to reserve it only for patients who are expected to develop post spinal hypotension.[9] Many studies have used IVC measurements for predicting fluid response but few studies have examined whether measurements of the IJV can be used to predict hypotension resulting from anesthetic procedures.[3] [4] Hence, we selected preoperative ultrasound IJV measurements as a predictor of post spinal hypotension. In our study, 39 out of 61 patients developed post spinal hypotension. We tried to correlate post spinal hypotension with IJV distensibility index to find whether we could predict post spinal hypotension.

In our study, we found distensibility index of right IJV to be significant in determining occurrence of post-spinal hypotension with a sensitivity of 94.87% and specificity of 50%. We got an accuracy of 78.69% with an AUC: of 0.768. The cut off for distensibility index value was found to be 16.5% below which incidence of hypotension was observed. We also found that minimum diameter of right IJV correlated significantly in predicting post spinal hypotension. Similarly in a study by **Yeliz Kilic et al**, they found that IJV collapsibility index had a sensitivity of 64% and a specificity of 63.6% to predict the post spinal hypotension at a cut-off point of 22.6%.[4] Area under curve was 0.709 Our results correlate with the above study for using distensibility index for predicting post spinal hypotension with a higher sensitivity found in our study. In another study by **Okamura *et al***, sonographic IJV measurements in prediction of hypotension following general anaesthesia induction were studied. They calculated IJV area and found it to be an independent predictor of hypotension in Trendelenburg position. (The AUC was 0.595 with sensitivity: 75.7%, specificity: 44.4%).[3]

In our study, we included spontaneously breathing relatively healthy adults and found significant difference in the mean distensibility index of right IJV before & after preloading with 10ml/kg IV fluid in all patients suggesting that sonographic measurements of right IJV distensibility index is a useful predictor of fluid responsiveness. Similar results were found in study by **Guarracino et al**, that IJV distensibility accurately predicted volume responsiveness in mechanically ventilated septic patients.[17]

In a study by **Salama *et al.,*** it was found that IVC collapsibility index and IVC: aorta index were reliable predictors for the occurrence of post-spinal anaesthesia hypotension.[9] In another study by **Broilo *et al.***, it was found that the respiratory variation of the inferior vena cava and the right internal jugular veins were associated with predicting fluid response.[15] The above studies have used IVC measurements for predicting fluid response. In our study, we focused on the determination of IJV distensibility in the prediction of post spinal hypotension because compared to IVC imaging, sonographic evaluation of IJV is easier and time- saving.[22] Additionally, IVC imaging cannot be possible in a group of patients due to abdominal gas shadow and obesity.

In many studies, different IJV indices such as the IJV collapsibility index, cross-section area of IJV, ultrasound-derived IJV variability etc. via B mode of ultrasonography were used.[12] In our study, we used right IJV distensibility index via M mode of ultrasonography. The advantage of using M mode was that measurements of both diameters could be taken

in a single respiratory cycle. This facilitated us to exclude variations in readings due to different cycles seen in B mode and give better accuracy. This gives us an added advantage over conventionally used hemodynamic parameters like heart rate and blood pressure which detect post-spinal hypotension after its occurrence.

Limitations

The study population consisted of participants with ASA 1 and II grades. Therefore, the results cannot be extrapolated to other patient groups such as ASA III and IV and pediatrics, geriatrics, obstetrics patients. Also, we did not correlate our findings with dynamic parameters like stroke volume cardiac output, which are usually used to assess intravascular volume

CONCLUSION

IJV distensibility index with a cut off value of 16.5% is an effective, easily performed, non-invasive method of predicting post spinal hypotension.

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Conflicts of interest There are no conflicts of interest.

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