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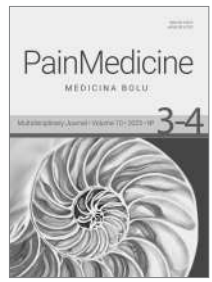

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Sonographic assessment of internal jugular vein and carotid artery to correlate development of spinal hypotension in geriatric patients

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Abstract

Introduction: *Noninvasive and simple methods such as sonographic evaluation of the inferior vena cava (IVC), internal jugular vein (IJV)&carotid artery have gained popularity in recent years. Visualization of IVC is not feasible in some patients due to obesity, intra-abdominal gas distention, intra-abdominal mass or surgical dressings.In elderly patients, atherosclerosis of carotid artery influences blood flow and its evaluation is deemed necessary.*

Methodology: *After approval of ethics committee&after informed consent from patients,Prospective Observational study was conducted for 62 patients (patients>65 years) posted for elective surgeries under spinal Anaesthesia ,at D.Y.Patil Hospital, Kolhapur.During spontaneous breathing, sonographic examination of Right IJV&Carotid artery were done with linear probe in M-mode.* **IJV Collapsibility Index (%)** *= [(max IJV diameter — min IJV diameter)/ max IJV diameter] × 100 Using Standard anesthetic protocol, patient was given spinal anesthesia. Pulse, systolic, diastolic and mean blood pressure values were measured at 5-minute intervals for the first twenty minutes, and then every ten minutes up to one hour. Hypotension is defined as a decrease in the systolic blood pressure by 20 % from baseline.*

Results: *Spinal Anaesthesia Induced Hypotension was shown in 44(70.97 %) of patients. IJV-CI increased significantly in Hypotensive group (mean+/–SD 37.30 +/–7.66) in comparison to Non-Hypotensive group (mean+/–SD 24.71+/–2.87) IJV-CI showed AUROC of 0.978 and 95 % C. I. of 0.950–1 (p value < 0.0001) with cut off value >18.29, 95.50 % sensitivity, 88.90 % specificity, 95.50 % PPV, 88.90 % NPV*

Conclusion: *Preanesthetic IJV-CI was predictor of Spinal Anaesthesia Induced Hypotension. Results suggested that IJV-CI > 18.29 to be the threshold levels, while CIMT could not predict Spinal Anaesthesia Induced Hypotension.*

Introduction

Spinal Anaesthesia is a type of central neuraxial blockade. It can be used for infra umbilical surgeries. Geriatric patients may undergo surgery under spinal anaesthesia. However, post spinal anaesthesia-induced hypotension (PSH) can be encountered in this procedure. PSH has a detrimental effect on patient well-being; in the awake patient, it triggers nausea, dizziness, and vomiting. Age has been identified as an independent risk factor for PSH, which can lead to ischemic myocardial, cerebrovascular and acute renal damage. These injuries eventually extend the hospital stay and increase postoperative morbidity and mortality [1,2].

Spinal anesthesia leads to sympathetic blockade and venodilation, resulting in lower venous return and cardiac output [4]. A measurement of the intravascular volume deficit before administrating spinal anesthesia may aid in anticipating a critical reduction in blood pressure [5]. Empirical volume preloading is done to prevent PSH, which poses an imminent risk of volume overload, particularly for patients with current cardiac and/or renal disorders [3]. Several indices have been suggested to assess intravascular volume.

Non-invasive method to detect fluid deficit are being studied. Imaging of the inferior vena cava (IVC) collapsibility index has proved to have high diagnostic accuracy in predicting PSH under anaesthesia [9, 10].

Obesity, intra-abdominal gas distension, intra-abdominal tumors and surgical dressings render IVC visualization unfeasible in up to 15 % of cases. Instead of IVC, Ultrasonographic examination of the IJV has been used to measure intravascular volume status and predict hypotension following general anesthesia induction, with encouraging results in some studies [11–14] and inconsistent results in others [15–19]. Very few studies on the prediction of PAS in the elderly population using IJV are available in literature.

In elderly patients, atherosclerosis of the carotid artery influences blood flow &its evaluation is deemed necessary. Arterial atherosclerosis elevates carotid intima-media thickness (CIMT), which has already been proven to be a good predictor of atherosclerosis-related events like strokes, myocardial infarctions, and peripheral artery disease [20].

Methodology

A Prospective Observational study conducted at Department of Anaesthesiology, D. Y. Patil Medical College Hospital and Research Institute, Kolhapur 18 months (March 2023 — September 2024) 62 Patients.

Sample/Patient recruitment

Patient satisfying inclusion & exclusion criteria was evaluated by standard pre-anesthetic protocol. After taking informed valid written consent, Ultrasonographic examinations was performed using a single ultrasound machine by an experienced anesthesiologist. The patient was placed in the supine position with the patient's neck rotated to the left (at approximate 40° to avoid venous occlusion of the opposite side) [19].

IJV measurements

During spontaneous breathing, ultrasonographic examination of the right IJV was conducted. A linear probe with a 7–12 MHz frequency was gently placed over the neck. The sternocleidomastoid muscle was used as an external landmark. The right IJV was identified just below the bifurcation of the sternal and clavicular heads of the muscle. The right IJV was examined over two full respiratory cycles using the M-mode in the transverse axis. The maximum IJV diameter&minimum IJV diameter was recorded during each cycle, and the averages was computed [19].

IJV Collapsibility Index (IJV-CI) was calculated from the formula:

$$\textbf{Collapsibility Index}\ (\%) = (\text{max IJV diameter} - \text{min IJV diameter}) \times 100 \text{ max IJV diameter}$$

Carotid intima-media thickness (CIMT)

Using the B-mode with a linear probe on the right carotid artery in transverse axis at the same level, a cross-sectional view was achieved, allowing for concurrent viewing of the IJV. The probe was turned by 90° for a longitudinal view with the pointer on the probe pointing cranially. The probe was moved alternatingly in the caudal and cranial directions to zero-in on the bifurcation of the common carotid artery. This view represents the ideal vantage point for the desired imaging and conducting the CIMT measurements. [19]

In a longitudinal view of the far wall of the carotid artery, the CIMT appears as two parallel lines, the lumen-intima and media-adventitia interfaces perpendicular to ultrasound beams. The CIMT was taken from the point on the common carotid artery one centimeter below the carotid bifurcation. The distance between the lumen-intima and the media-adventitia was determined using the caliper of the USG machine. The dis-

tance between lumen-intima and media-adventitia was computed and recorded.

Using Standard anesthetic protocol, the patient was given spinal anesthesia. Pulse & systolic, diastolic and mean blood pressure values was measured at 5-minute intervals for the first twenty minutes and then every ten minutes up to one hour. The level of the block was assessed using loss of cold sensation.

Hypotension is defined as a decrease in the systolic blood pressure by 20% from baseline. The data was entered onto a data collection sheet, from baseline until one hour after administration of spinal anaesthesia. Patients were divided into two groups- hypotension and non-hypotension for analysis.

After approval of institutional ethics committee and Informed written consent of the patient, patients posted for elective surgeries, at Dr. D.Y. Patil Medical College Hospital and Research Institute, Kolhapur was chosen. Data collection was done for a duration of 18 months. Patients were selected based on inclusion and exclusion criteria. inclusion criteria: age group > 65 years, elective surgery under spinal anaesthesia. exclusion criteria patient refusal, age group < 65 years, bmi > 30 kg/m^2, patients having central line in situ, patients with disorders like right heart failure, cor pulmonale, right-sided valvular heart lesion. Ethical approval was taken from the Institutional Ethical Committee before commencement of the study.

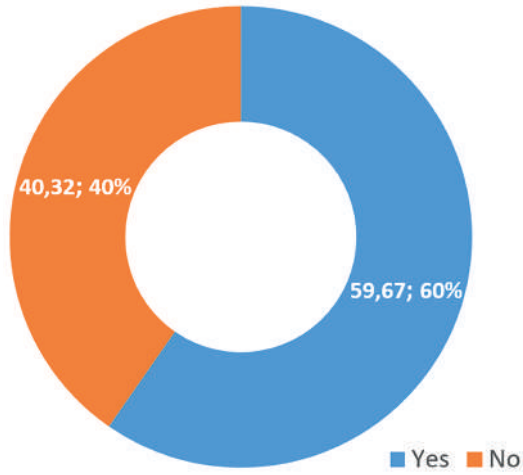
Written informed valid consent was taken from the study subjects before enrolling them in the study. Confidentiality&Privacy of patient was maintained. There was no additional financial burden on the participant end.

Result

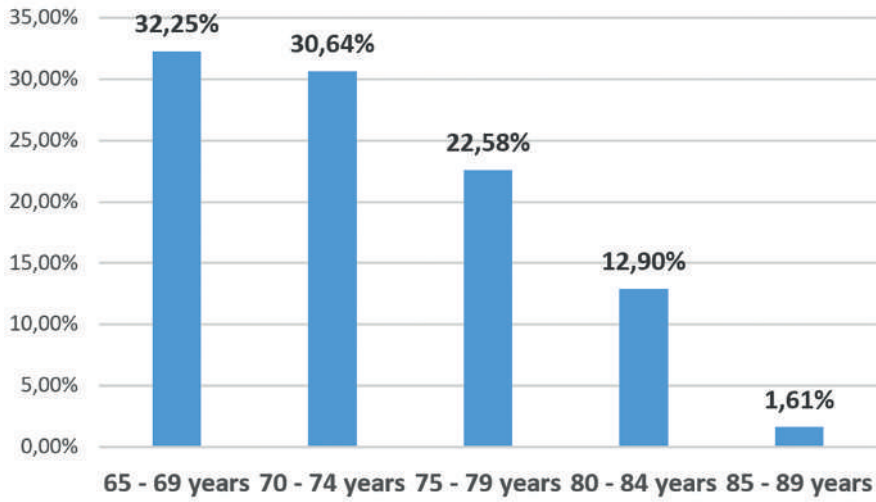
In current observational study, we had enrolled total 62 participants for evaluation of IJV maximum and minimum diameter management to find out collapsibility index (CI) and Carotid Intima-Media Thickness.

The current study was conducted only on elder/Geriatric patients for the detection of post-spinal hypotension. We had recruited all the participants above the age of 65 years.

Comorbid condition can play an important role in any medical treatment and procedure. Hypertension, Diabetes and kidney disease were the commonest comorbidity in our enrolled patients. Out of total 62 patients, 37 (59.67%) elder patient had one or more comorbid condition.



Graph 2: Comorbidity wise distribution of the participants



Graph 1: Age-wise distribution of the Participants (%)

Table 1. Duration of the comorbidity in the patients

Category	Number	Percentage	Confidence Interval (95 %)
1 month	3	8.1	2.10–21.50
2 month	7	18.91	8.67–33.88
3 month	6	16.21	6.85–30.71
4 month	4	10.81	3.53–24.05
5 months	1	2.70	0.14–12.61
6 months	4	10.81	3.53–24.05
6 < X < 12 months	8	21.62	10.58–36.96
More than 12 months	4	10.81	3.53–24.05

Among 37 comorbid patients, 8 (21.62 %) were diagnosed it between 6 to 12 months followed by 7 (18.91 %) were diagnosed within 2 months.

Table 2. ASA grading wise distribution of the participants

ASA Grade	Number	Percentage	Confidence Interval (95 %)
Grade II	47	75.80	64.02–85.23
Grade III	15	24.19	14.77–35.98
Total	62	100 %	

Among the 62 patients, 47 (75.80 %) were categorized as Grade II, while the remaining 15 (24.19 %) were categorized as Grade III as per the ASA guidelines

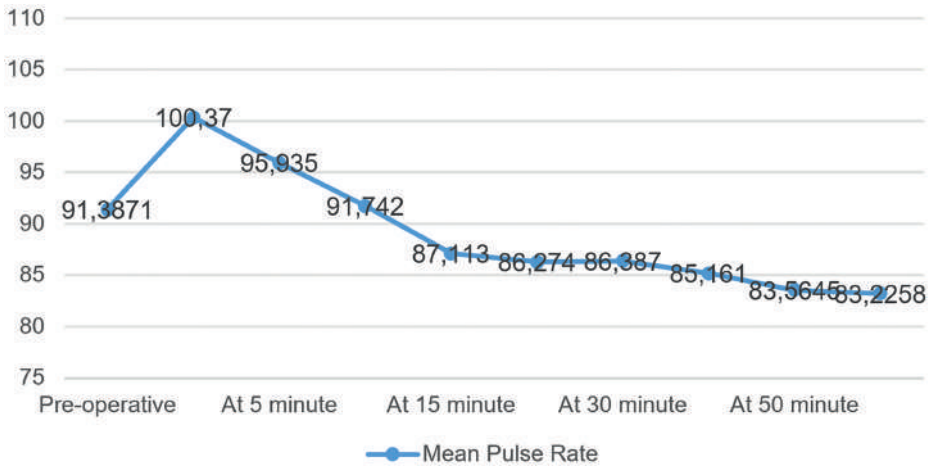
Table 3. Comorbidity in Participants

Comorbidity	Hypotensive patient	Non hypotensive Patient	CHI-SQUARE TEST
Yes	35	09	Chi-Square: 24.8613 *P value:* < 0.0001*
No	2	16	
Total	37	25	

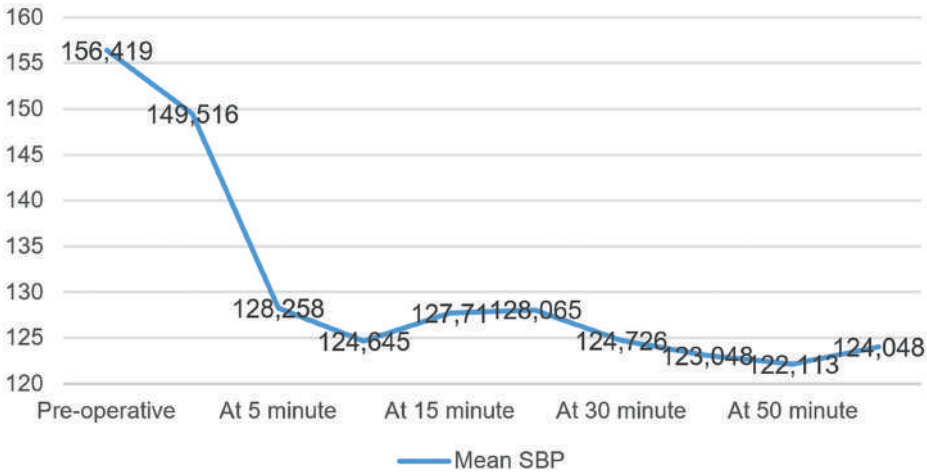
Among all 62 patients, 44 had comorbidity, while 18 did not. Correlation between PSH and comorbidity was checked and found Chi-square is 24.8613 and p-value is <0.0001, which is statistically significant. (for significant p<0.05).

Pulse rate was continuously monitored pre-operative as well as during the surgery at regular intervals. At the beginning of surgery, the mean pulse rate was increased, though it decreased with time passed and surgery progress. Pre-operative mean pulse rate was 91.3871 ± 12.7119, which increased to 100.37 ± 14.972. Later, it decreased gradually and at 60 minutes of the surgery process, the mean pulse rate was 83.2258 ± 20.0068.

Systolic Blood Pressure (SBP) was continuously monitored pre-operative as well as during the surgery at regular intervals. Surgery beginning time, mean SBP was decreased with time passed and surgery progress. Pre-operative mean SBP was 156.419 ± 24.9196 mmHg, which decreased gradually, and at 60 minutes of the surgical process, mean SBP was 124.048 ± 24.3346 mmHg.



Graph 3. Mean pulse rate of patients pre-operative and during the surgery



Graph 4. Mean systolic Blood Pressure of patients pre-operative and during the surgery

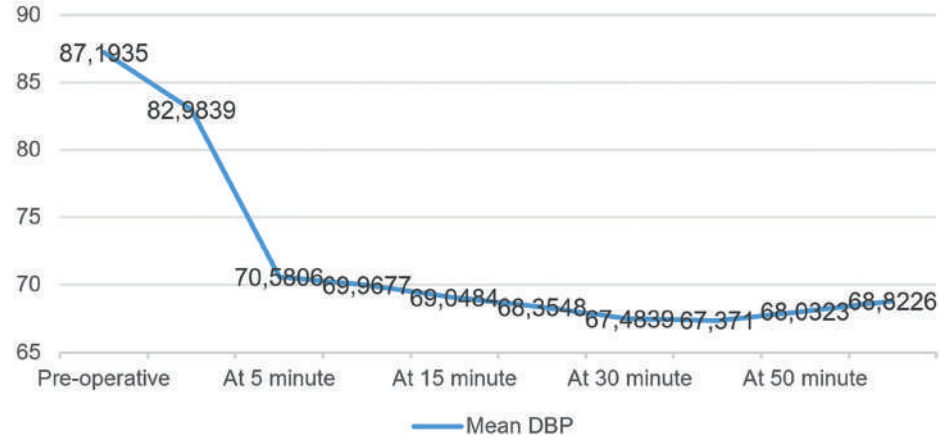
Diastolic Blood Pressure (DBP) was continuously monitored pre-operative as well as during the surgery at regular intervals. Surgery beginning time, mean DBP was decreased with time passed and surgery progress. Pre-operative mean DBP was 87.1935 ± 17.3371 mmHg, which decreased gradually, and at 60 minutes of the surgery process, mean DBP was 68.8226 ± 17.1262 mmHg.

Mean Arterial Pressure (MAP) was continuously monitored pre-operative as well as during the surgery at regular intervals. Surgery beginning time, Average MAP was decreased with time passed and surgery progress. Pre-operative average MAP was 110.29 ± 19.0232 mmHg, which gradually decreased and at 60 minutes of the surgical process, was 87.1935 ± 13.3373 mmHg.

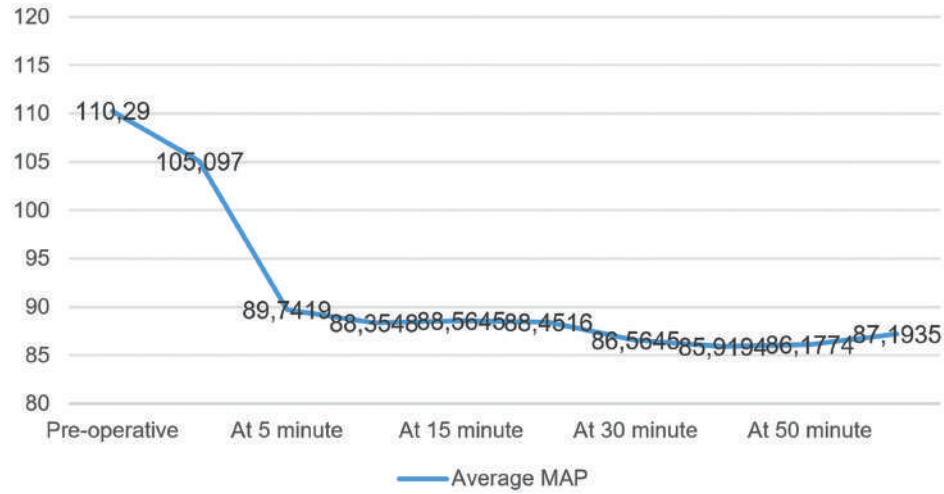
IJV diameter measurements were done twice for the maximum as well as the minimum diameter in each. Maximum and minimum results were required for the calculation of the Collapsibility index (%). Two readings for each patient and their average were calculated to reduce the errors. Among the 62 participants, the mean IJV maximum diameter was 1.065, and the Standard Deviation was 0.2392 cm, while for minimum diameter measurement, the mean minimum diameter was 0.6966 cm and the standard deviation was 0.1337 cm.

Among the 44 hypotensive participants, the mean IJV maximum diameter was 1.109 and the Standard Deviation was 0.254 cm while for minimum diameter measurement, the mean minimum diameter was 0.686 cm and the standard deviation was 0.1376 cm

Among the 18 non-hypotensive participants, the mean IJV maximum diameter was 0.9588 and the Standard Deviation was 0.1512 cm while for minimum diameter measurement, the mean minimum diameter was 0.7225 cm and the standard deviation was 0.6966 cm



Graph 5. Mean Diastolic Blood Pressure of patients preoperative and during the surgery



Graph 6. Average Mean Arterial Pressure of patients pre-operative and during the surgery

P values for the Mean IJV maximum group as well as the Mean IJV minimum group were 0.3137 and 0.7171 respectively. those p-values are not statistically significant.

The collapsibility index in adult patients has a normal range between 20 % to 50 %. Among a total 62 patients, 56 (90.32 %) patients have normal CI %.

A normal carotid intima-media thickness (CIMT) range for geriatric patients is typically considered to be between 0.07 cm and 0.08 cm or higher, as CIMT naturally increases with age, with values above this range potentially indicating increased cardiovascular risk; however, it's crucial to consult with a healthcare professional to interpret results based on individual factors like age, gender, and medical history. Among 62 patients, 39 (62.09 %) patients had low CIMT while 3 (4.83 %) patients had more thickened Carotid Intima-Media

Chi square test was run for the above value and found 1.7353 along with *p*-value 0.4199 which is statistically not significant. R2 linear regression was check which show complete straight line linear graph.

Chi square test was run for the above value and found 4.5376 along with *p*-value 0.1034 which is statistically not significant. R2 linear regression was check which show complete straight line linear graph

As per the AUC values. IJV area has no accuracy (0.571), CIMT has poor accuracy (0.65) while the Collapsibility index (%) has Excellent accuracy (0.978).

Discussion

The study was conducted to an evaluate Post spinal hypotension in elder patients. We recruited patients who had visited a hospital for elective surgical procedures.

Table 4. Internal Jugular Vein (IJV) diameter measurement at supine position

	Hypotensive (n=44)		Non-Hypotensive (n=18)		Total (n=62)		P. value
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	
Maximum 1	1.157	0.290	0.995	0.167	1.11	0.2711	0.1873
Maximum 2	1.061	0.228	0.9227	0.137	1.02	0.2159	0.5477
Average	1.109	0.254	0.9588	0.1512	1.065	0.2392	0.3137
Minimum 1	0.6865	0.1408	0.7127	0.1286	0.6941	0.1378	0.461
Minimum 2	0.6854	0.1442	0.7322	0.1222	0.6990	0.1398	0.3953
Average	0.6860	0.1376	0.7225	0.1197	0.6966	0.1337	0.7171
IVJ Area (CM^2)	0.6203	0.2992	0.5577	0.189	0.6021	0.2733	0.3696

Geriatric patients are more susceptible to get infections and they have more chance to get illness. In the study, 47(75.80 %) which include 25 non-comorbid and 22 comorbid patients were fit during the first assessment while rest 15 found unfit which found fit during the reassessment before the surgical procedure [50,51] In study, the mean IJV maximum was 1.065 $\pm$ 0.239 cm; the mean IJV minimum was 0.6966 $\pm$ 0.1337 cm. The collapsibility index (CI %) is important for the prediction of post-spinal hypotension development.In study, the mean collapsibility index for hypotensive, non-hypotensive and overall group patients was 37.30 $\pm$ 7.57 %; 24.71 $\pm$ 2.79 %, and 33.649 $\pm$ 8.692 % respectively.CIMT for hypotensive, non-hypotensive, and overall group patients,0.0675 $\pm$ 0.0201;0.0577 $\pm$ 0.0103 and 0.06467 $\pm$ 0.0183 respectively.In the current study, 70.97 % of patients developed post-spinal hypotension. A chi-square test was run for the collapsibility index (%) and post-spinal hypotension development. In study, the chi-square was 1.7353 along with a p-value of 0.4199, which is statistically insignificant. R2 linear regression was checked which shows a complete straight-line linear graph.A chi-square test was run for carotid Intima-media thickness and post-spinal hypotension development.The chi-square was 4.5376 along with a p-value of 0.1034, which is statistically not significant.

Table 5. Collapsibility index (CI) wise distribution of the participants

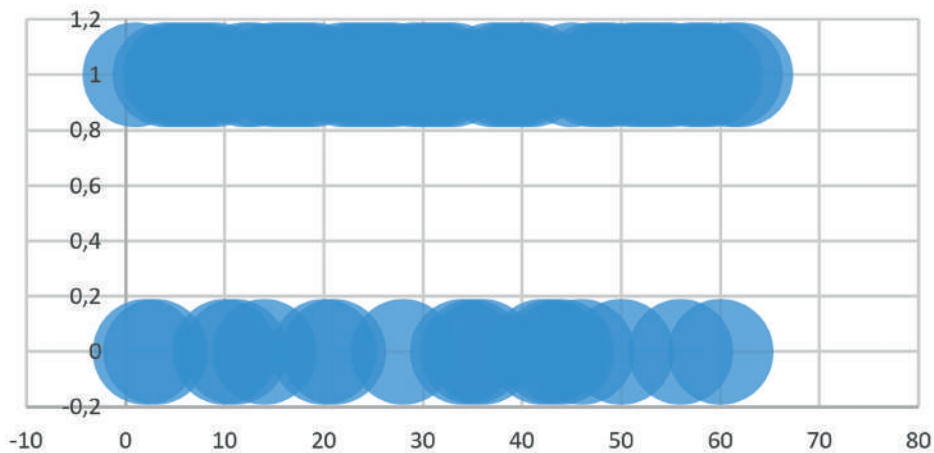
CI %	Range	Number	Percentage	Confidence Interval (95 %)
Low (Below 20)	< 20	1	1.61	0.8–7.70
Normal (20–50)	20–29.99	26	41.93	30.16–54.45
	30–39.99	23	37.09	25.79–49.59
	40–49.99	7	11.29	5.07–21.06
High (Above 50)	$\geq$ 50	5	8.06	3.01–16.97
Total		62	100 %	

Table 6. Carotid intima-media thickness (CIMT) wise distribution of the participants (%)

CIMT	Range	Number	Percentage	Confidence Interval (95 %)
Low (≤ 0.06)	≤ 0.06	39	62.09	50.41–74.21
Normal (0.07 to 0.09)	0.07	11	17.74	9.70–28.74
	0.08	5	8.06	3.01–16.97
	0.09	4	6.45	2.08–14.83
High (≥ 0.1)	≥ 0.1	3	4.83	1.25–12.60
Total		62	100 %	

Table 7. Hypotension development on base of Collapsibility index

CI %	Yes	No	Total	Chi-Square
High	5 (100.00 %)	0 (0.00 %)	5 (8.06 %)	
Low	0 (0.00 %)	1 (100.00 %)	1 (1.61 %)	Chi-Squared — 1.7353
Normal	39 (69.64 %)	17 (30.36 %)	56 (90.32 %)	*P* value — 0.4199
TOTAL	44 (70.97 %)	18 (29.03 %)	62	
Average	37.30	24.71	33.649	
SD	7.57	2.79	8.692	

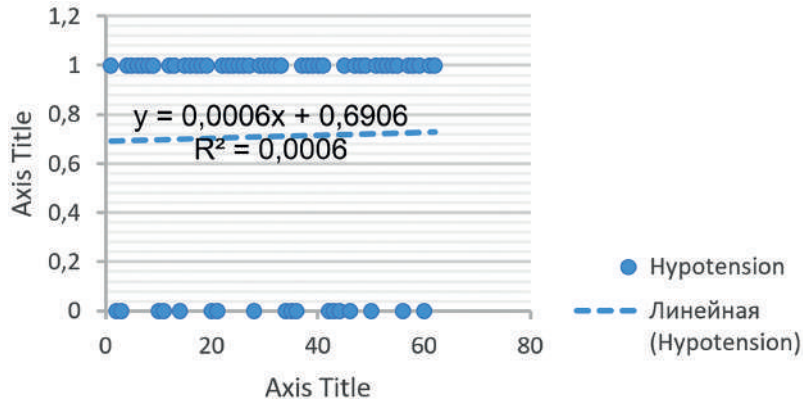


Graph 7. R2 linear regression between CI (%) and Hypotension development

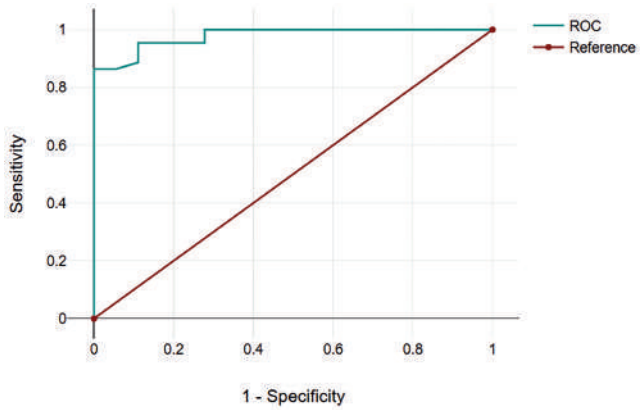
As per the AUC values,IJV area has no accuracy(0.571), CIMT has poor accuracy (0.65), while the Collapsibility index (%) has Excellent accuracy (0.978).

Conclusion

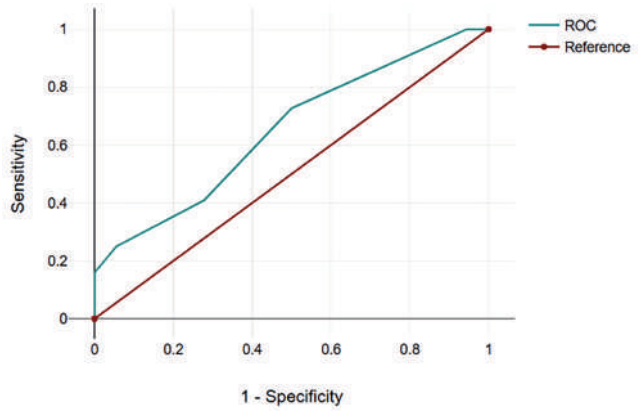
General anaesthesia is not needed for such procedures because spinal anaesthesia produces excellent results



Graph 8. R2 linear regression between CIMT and Hypotension development



Graph 9. ROC curve between Collapsibility Index and Hypotension



Graph 10. ROC curve between Carotid intima-media thickness (CIMT) and Hypotension

while avoiding complications such as airway management, ventilation, intraoperative awareness, polypharmacy, extubation and mechanical postoperative nausea and vomiting. Hypotension is one of the clinical conditions that should be prevented and treated as early as possible pre-surgical, post-surgical and during the surgical processes. There are so many chances of several adverse events occurring during the post-spinal anaesthesia stage. It may be more into geriatric patients, though it can be prevented due to pre-anaesthetic workup/ evaluation and management. The current study has a higher rate of post-spinal hypotension development in geriatric patients, which indicates more intervention towards patients during the post-spinal phases. Preoperative sonographic assessments of internal jugular vein diameter and area changes following Trendelenburg position may accurately predict post-spinal hypotension in elder patients. We recommended investigating the ability of sonographic evaluation of the internal jugular vein parameters to guide fluid transfusion before spinal anesthesia.

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Сонографічна оцінка внутрішньої яремної вени та сонної артерії для прогнозування розвитку спінальної гіпотензії у геріатричних пацієнтів

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Анотація

Вступ: *Неінвазивні та прості методи, такі як сонографічна оцінка нижньої порожнистої вени (IVC), внутрішньої яремної вени (IJV) і сонної артерії, набули популярності в останні роки. Візуалізація IVC може бути неможливою у деяких пацієнтів через ожиріння, газове роздуття черевної порожнини, внутрішньочеревні новоутворення або післяопераційні пов'язки. У пацієнтів похилого віку атеросклероз сонної артерії впливає на кровотік, тому його оцінювання є важливим.*

Методологія: *Після схвалення етичного комітету і отримання інформованої згоди пацієнтів було проведено проспективне спостережне дослідження за участю 62 пацієнтів віком > 65 років, які планувалися для виконання планових операцій під спінальною анестезією у лікарні Д. Ю. Патіл, Колхапур. Під час спонтанного дихання проводили сонографічне дослідження правої IJV і сонної артерії лінійним датчиком у режимі M-mode. IJV Collapsibility Index (CI) (%) = [(макс. діаметр IJV — мін. діаметр IJV) / макс. діаметр IJV] × 100. Після цього пацієнтам вводили спінальну анестезію за стандартним протоколом. Пульс, систолічний, діастолічний та середній артеріальний тиск вимірювали кожні 5 хвилин протягом перших 20 хвилин, а потім — кожні 10 хвилин до однієї години. Гіпотензію визначали як зниження систолічного артеріального тиску на 20 % від вихідного значення.*

Результати: *Гіпотензія, індукована спінальною анестезією, спостерігалася у 44 (70,97%) пацієнтів. Індекс колапсованості IJV (IJV-CI) був значно вищим у групі з гіпотензією (середнє ± SD: 37,30 ± 7,66) порівняно з негіпотензивною групою (24,71 ± 2,87). IJV-CI продемонстрував AUROC 0.978 та 95% ДІ 0.950–1 (p < 0.0001) з пороговим значенням > 18.29, чутливістю 95,50 %, специфічністю 88,90%, позитивною прогностичною цінністю 95,50% та негативною прогностичною цінністю 88,90%.*

Висновок: *Переданестезіологічний індекс колапсованості IJV (IJV-CI) є предиктором гіпотензії, індукованої спінальною анестезією. Отримані результати свідчать, що порогове значення IJV-CI > 18.29 може бути значущим маркером ризику, тоді як товщина комплексу інтима–медіа сонної артерії (CIMT) не передбачала розвитку спінальної гіпотензії.*