The effect of ultrasonographic measurement of vena cava inferior diameter on the prediction of post-spinal hypotension in geriatric patients undergoing spinal anesthesia

ABSTRACT

Aims: In our study,we aimed to investigate whether end-expiratory vena cava inferior (expVCI) diameter and vena cava inferior collapsibility index predicted post-spinal hypotension in geriatric patients undergoing spinal anesthesia,the correlation between them and other parameters.

Material and methods: Our prospective study included ASA I-4,73 patients over 65 years of age,who were scheduled for operation using spinal anesthesia.According to the expVCI diameter displayed with USG before spinal anesthesia, patients;those with an expVCI diameter less than 1.8cm previously determined as the threshold value are grouped as 1.(Small-VCI) Group,those greater than 1.8cm as 2.(Large-VCI) Group.Demographic characteristics of the patients,comorbidities,duration and type of operation,basal (preoperative) heart rate,systolic,diastolic, mean blood pressure, peripheral oxygen saturation values before spinal anesthesia and after spinal anesthesia in supine position (0min) and 5th,10th,15th,20th,25th,30th min and preoperative arterial blood gas parameters,amount of peroperative urine and bleeding, inotropic and fluid requirement,complications were recorded.

Results: Hypotension developed in 28(38.4%) patients and bradycardia in 14(19.2%) of patients.The patients who developed hypotension had more ASA2 and ASA3($p=0.01$),shorter height($p=0.02$),and smaller expVCI diameter($p=0.004$).It was observed that they had higher lactate($p=0.03$),lower pH($p=0.006$) values,and more inotropic agents were administered ($p<0.001$).While the rate of developing hypotension was 51.1%(n=23) in the patients in the Small-VCI group,this rate was 17.9%(n=5) in the patients in the Large-VCI group($p=0.004$).

Conclusion: It was concluded that the expVCI diameter value measured by USG before spinal anesthesia in elderly patients is effective in predicting post-spinal hypotension with lactate and pH values,which are among the blood gas parameters,and expVCI can be preferred to invasive methods due to its noninvasive,easy and fast application.

Key Words: Spinal Anesthesia; Geriatric Patients; Vena Cava Inferior Diameter; Vena Cava Inferior Collapsibility Index; Hypotension.

What is already known about this topic?

It is known that there are many methods with some disadvantages to evaluate the volume, but in recent years, ultrasonography, which is a noninvasive method, and expVCI diameter and cVCI measurement have come into use.

What does this article add?

It provides us with information on determining the effectiveness of expVCI diameter, cVCI and arterial blood gas in predicting post-spinal hypotension in geriatric patients, and determining the correlation between them.

INTRODUCTION

Spinal anesthesia (SA) is one of the oldest and most common regional anesthesia techniques used in lower abdominal and extremity surgery. It is advantageous because it provides adequate analgesia and muscle relaxation, is easy to apply, does not affect mental functions, causes less bleeding, patients are mobilized earlier, and the incidence of deep vein thrombosis is low. However, it has some complications such as headache, nausea-vomiting, low back pain, urinary retention, meningitis, hypotension, bradycardia, and neurological sequelae (1).

Post-spinal hypotension is the most common complication of SA. Systemic vascular resistance and cardiac output decrease due to sympathetic blockage after SA, and hypotension and bradycardia are frequently observed (2).The most common method to prevent hypotension; administration of crystalloid and colloid fluids before or during SA (3,4). If we think that hypotension is mostly caused by a decrease in preload, fluid replacement should be the first option. If we think hypotension is caused by vasodilation; treatment with vasoconstrictors and inotropic drugs will be in the foreground.

There is no single parameter that shows the volume status of the patients. Many parameters need to be evaluated together. Central venous pressure (CVP) measurement, thermodilution methods, echocardiography, radial artery pulse pressure, aortic blood flow peak velocity, brachial artery blood flow velocity, dynamic and hemodynamic measurements, blood gas parameters [base deficit (BE), lactate, pH, etc.] are various methods of showing the volume status. Measurement of vena cava inferior (VCI) diameter and vena cava inferior collapsibility index (cVCI) due to respiratory changes in recent years has become an alternative to invasive methods, especially since it is a non-invasive, easy and fast method in the assessment of body volume and determination of fluid response (1,5, 6).

In our study, we aimed to investigate the end-expiratory vena cava inferior (expVCI) diameter and vena cava inferior collapsibility index (cVCI) viewed with USG before the SA predicted post-spinal hypotension and the correlation between them and blood gas parameters in geriatric patients over 65 years of age who will undergo urological, general surgery, orthopedic, plastic and reconstructive surgery.

MATERIAL and METHODS

Our prospective study was carried out in 73 cases over 65 years of age, who were admitted to our University Hospital between February 1, 2020 and March 31, 2020, who were scheduled to be operated with spinal anesthesia. Those who are 65 years of age or older who are not contraindicated for spinal anesthesia, who are decided to operate under elective conditions and with the consent of the patient, who will undergo lower extremity debridement, fixator placement, inguinal hernia, bladder-prostate resection operations by orthopedics, general surgery, urology, plastic and reconstructive surgery patients were included in the study.

Patients for whom spinal anesthesia was contraindicated, emergency cases, pregnant women, patients under 65 years of age and without their consent, and patients requiring preoperative hydration were excluded from the study. The patients who were planned to be included in the study were informed about our study and their consents were obtained. Our study was conducted at the Department of Anesthesiology and Reanimation of Health Sciences University Kartal Dr. Lütfi Kırdar City Hospital, after obtaining the approval of the Hospital Ethics Committee (Ethics Committee Decision number: 2020/514/169/15).

Demographic data [age, gender, weight, height, body mass index (BMI)] of the patients who were taken to the preoperative room of the operating room, comorbidities and medications used were recorded. In patients without premedication or prehydration, 2-5 megahertz convex (curvilinear) probe was prepared separately for each patient at the sub-xiphoid level in the supine position, accompanied by the Mylab Seven model USG of the Esaote brand, and the VCI location in the horizontal position was determined. Afterwards, the vertical position was switched to B mode and the expiratory and end-inspiratory diameters were measured and noted in M mode (Figure 1).

Heart rate (HR), non-invasive systolic, diastolic, mean blood pressure (SBP, DBP,MBP), and peripheral oxygen saturation (SpO2) were monitored in the patients who were taken to the operation room and recorded as preoperative values. After the Allen test, radial artery catheterization was performed and arterial blood gas was taken. While the patient was in the sitting position, 12.5 mg (2.5 ml) of 0.5% bupivacaine was administered by entering the subarachnoid space from the L3-4 or L4-5 interval with a 25G Quincke spinal needle. HR, SBP, DBP, MBP, SpO2 values were measured and recorded at 5th,10th,15th, 20th, 25th and 30th minutes. During the operation, a decrease in MBP below 30% according to the preoperative values was considered as hypotension, and a HR below 50 beats / min was considered bradycardia. When hypotension developed, 5-10 mg ephedrine and when bradycardia developed 0.5 mg atropine were administered intravenously. Intravenous crystalloid in the supine position after SA administration; it was applied in the first 30 minutes according to the rule of 4-2-1 ml / kg / hour according to the calculated weight. Use of inotropic, urine output, amount of bleeding and crystalloid and colloid administered, blood gas parameters (pH, pCO2, pO2, HCO3, BE, lactate) and complications were recorded.

Power Analysis

Since the study is prospective, power analysis was performed before the study started. G * power program (G * Power 3.1.9.2 for Windows 10) was used to calculate the sample size. When the confidence level (power) is 95%, that is, the alpha level is 5%, the margin error is 5% and the effect size is 0.40, the total number of patients required is 72. The program on the website https://www.randomizer.org/ was used for randomization and the patients were randomized into two groups. In addition, the threshold value determined according to the end-expiratory VCI (expVCI) diameter ROC (Receiver Operating Characteristic) index was found to be 1.8 cm and the groups were classified accordingly (Figure 2).

Groups

1. (Small-VCI) Group: Patients with an expVCI diameter less than 1.8cm: 45 patients

2. (Large-VCI) Group: Patients with an expVCI diameter of 1.8cm and above: 28 patients

Statistical analysis

The demographic characteristics of the patients and the collected data were entered in IBM® SPSS® (the Statistical Package for the Social Sciences) Statistics version 23. Variables were characterized using mean, maximum, and minimum values, percentages were used for qualitative variables. Normal distributions were reported as mean±SD. The reliability of the VCI diameter in predicting hypotension was examined with the ROC curve and the area under the curve (Area Under Curve = AUC) was evaluated. In addition, the data were entered into MedCalc ® Version 12.2.1.0 and the best cut-off value for predicting hypotension was determined. While determining the best threshold value, the best sensitivity and specificity values were taken into consideration. Then, using this threshold value, patients with large and small VCI diameters were determined and grouped. Student t-test was used for comparisons between groups. For the analysis of qualitative variables, Pearson's chi-square test, if the group was small, the Fisher's exact test was used. Nonparametric continuous variables were recorded as median and spatial distribution and compared using Mann-Whitney U tests. A value of $p < 0.05$ was considered statistically significant. In multivariate analysis, independent risk factors were determined using only variables that cause hypotension significantly ($p < 0.05$) in univariate analysis. In addition, in this study, p value between 0.05-0.099 was accepted as close to statistical significance (trend toward).

RESULTS

1. Comparison of Patients in Terms of Demographic and Clinical Characteristics

Seventy three patients over 65 years of age whose expVCI diameter and cVCI were measured by USG before spinal anesthesia were included in the study. The demographic and clinical characteristics of the patients are shown in Table 1.

2. Comparison of Groups in Terms of Vital Parameters

Hypotension developed in 28 (38.4%) patients and bradycardia in 14 (19.2%) peroperative patients. It was observed that hypotension developed in an average of 9.1 ± 5.3 minutes in patients who developed hypotension. Comparison of patients with and without hypotension is shown in Table 2.

3. Vena Cava Inferior Threshold Calculation

When the prediction of the development of hypotension by expVCI diameter was examined by ROC analysis, it was found that the VCI diameter predicted the patients who developed hypotension statistically significantly better (Figure 3) .

In the calculation, it was found that the threshold value with the best sensitivity and specificity for the diameter of the VCI was 1.8 cm. Using this threshold value, patients were grouped as those with small VCI diameter (Small-VCI, n=45) and those with large VCI diameter (Large-VCI, n=28). It was found that patients in the large-VCI group were given less peroperative fluid at a statistically significant level (p value between 0.05-0.099) (p = 0.09) and were taller (p = 0.07). In addition, it was observed that the patients in the Large-VCI group had a statistically higher cVCIof <50.0% and needed less inotropics (Table 3).

While the rate of developing hypotension was 51.1% (n=23) in the patients in the Small-VCI group, this rate was 17.9% (n=5) in the patients in the Large-VCI group, and the difference was statistically significant (p = 0.004, Odds Ratio = 4.807, 95% CI=1.552-14.925) (here the odds ratio shows that the risk of developing hypotension is 4.8 times higher in patients in the small-VCI group).

4. Comparison of Systolic, Diastolic and Mean Blood Pressure Values of Groups

Comparison of Small-VCI and Large-VCI groups in terms of blood pressure measurements is shown in Table 4.

5. Multiple Regression Analysis of Groups

In preoperative univariate analyzes, ASA score (p=0.01), height (p=0.02), expVCI diameter less than 1.8 cm (p = 0.004), pH (p = 0.006) and lactate (p=0.03) were found to have an effect on development of hypotension, it was seen that the only independent variable that had an effect on hypotension was pH (p=0.04, Odds Ratio = 3.201, 95% CI=1.027-9.975) when the analysis had made on with multivariate analyzes. In terms of development of hypotension, it is found that the expVCI diameter is smaller than 1.8 cm (p= 0.06, Odds Ratio = 3.289, 95% CI= 0.910-12.500) and the lactate level (p=0.06, Odds Ratio=2.628, 95% CI= 0.941-7.341)) were found to be statistically significant independent variables (Table 5).

DISCUSSION

Spinal anesthesia is a widely used and reliable anesthesia method. However, as we mentioned before, it can cause complications such as hypotension and bradycardia.

In determining the intravascular volume status; clinical evaluation, blood gas parameters, urine output, CVP are used as a routine guideline. However, clinical evaluation, urine output follow-ups have limited reliability in critical patients, central venous line insertion takes time for CVP impressions, and presence of a number of complications such as pneumothorax, hemothorax, infection, and the need for laboratory facilities for blood gas parameters lead to the development of new alternative methods. Measurement of VCI diameter and cVCI with USG, which is an imaging method in recent years, is also a useful, effective and non-invasive method used for this purpose.

In our study, we aimed to investigate the efficacy of VCI diameter and CVCI, which were previously imaged by USG in patients to undergo spinal anesthesia, in predicting hypotension after spinal anesthesia and the correlation between them with some other parameters.

In the study conducted by Crithley et al. (7) in elderly patients who underwent SA, it was reported that postspinal hypotension developed at a rate of 69%, and that it was more common in patients using antihypertensive drugs. In our study, we determined that additional diseases such as hypertension and diabetes did not increase the risk of postspinal hypotension, however, more post-spinal hypotension was observed in patients with high ASA and this rate was 38.4% in our study. We think that our different rate from the researchers was due to our use of expVCI and cVCV instead of CVP and systemic vascular resistance index, which they used as parameters to predict post-spinal hypotension. Consistent with our study, the same researchers found that hemodynamic changes occur within 6-9 minutes and treatment is required. In our study, we determined this period as 9.1 ± 5.3 minutes.

Özdemir et al. (8), in their study including 115 patients aged 18-75 years, ASA 1-2, undergoing orthopedic surgery, measured the transverse diameter of the VCI with USG before spinal anesthesia and classified the cases into 3 groups according to their diameters: Group 1: VCI diameter <1.5 cm, Group 2: VCI diameter: 1.5-2 cm, Group 3: VCI diameter> 2cm. They found that hypotension developed in 23 (20%) of the cases, especially observed within 5 minutes after spinal anesthesia, and that hypotension was detected in 52% in group 1, 34.8% in group 2, and 13% in group 3. Consistent with the results of the researchers, we observed that the rate of hypotension development was 51.1% in those with an expVCI diameter <1.8 cm, and 17.9% in those with an expVCI diameter> 1.8 cm. Similar to the results of our study, they also reported that more hypotension was observed in short stature and ASA 2 patients. As a result, the same researchers stated that the measurement of the VCI diameter by USG may be an indicator in determining the volumetric status of the patient, but it cannot be sufficient alone to predict hypotension that may develop after spinal anesthesia, and patients should be evaluated together with their chronic diseases and clinical parameters.

In the randomized, prospective studies of Ceruti et al. (9) involving 160 patients who were scheduled for surgery under spinal anesthesia, the patients were divided into 2 groups as patients who were examined under USG before spinal anesthesia and those who were not looked after in accordance with our results, It has been reported that the need for vasoactive drugs is lower and the total fluid requirement is higher. As a result, they stated that the application of fluids under the guidance of VCI diameter measurement with USG before spinal anesthesia reduces the risk of hypotension after spinal anesthesia, but more studies are needed in postspinal elderly patients with high cardiovascular risk.

Ayyanagouda et al. (10) divided 80 patients who will undergo inguinal hernia and hydrocele surgery under spinal anesthesia into 2 groups, where VCI diameter and CVCI were measured under USG guidance (= VCI group) and non-measured (= control group). They reported lower incidence of hypotension, less vasopressor requirement and more total fluid in the control group compared to the control group. As a result, they found that, in correlation with the results of our study, VCI diameter measurements with USG before spinal anesthesia and accordingly fluid regimen decreased the incidence of hypotension due to spinal anesthesia.

In the studies conducted by Maciulene et al (11) by using ASA 1-2 and 15-17 mg levobupivacaine in 100 cases with an average age of 69 years who will undergo knee prosthesis operation, it has been shown that expVCI diameter and CVCI are not a predictive factor for the development of post-spinal hypotension. In addition, in this study, unlike ours, the threshold value of the expVCI diameter was reported as 1.45 cm. In our case, this value has been determined as 1.8 cm. The difference of the results of the researchers from our results; We believe that the fluid balance is not disturbed by allowing the patients to drink fluids up to 2 hours before the surgery, and this may be due to differences in the patient population.

Jaremko et al. (12), in their prospective study involving 60 patients undergoing knee prosthesis under spinal anesthesia, after spinal anesthesia performed by giving 500 ml of fluid before spinal anesthesia, expVCI diameter, inspVCI diameter and CVCI were measured at 15 minutes, and unlike our study, hypotensive. There was no statistically significant difference in these values in patients with and without hypotensive patients. The same researchers reported that these parameters are not predictive in determining hypotension that develops after spinal anesthesia in spontaneously breathing patients. We think that these different results may arise from the type of surgery and different age groups. In addition, it should not be forgotten that VCI is a large-diameter vessel and may be affected by many internal and external factors, and many individual characteristics such as elasticity can also be effective in these measurements.

In the studies of Akıllı et al. (13), which included 28 hemorrhagic shock patients and 50 volunteer patients, the groups were compared by measuring the VCI diameter, shock index, SAP, DAP, HR, serum lactate and bicarbonate levels, and base differences. Consistent with the results of our study, it was determined that the diameter of SAP, DAP, VCI diameter was lower and the shock index was higher in patients with shock compared to the control group. Similarly, in parallel with our study, they reported that VCI diameter measurement by

USG can be a non-invasive and effective technique in evaluating the hemodynamics and volume status of critical patients.

In the meta-analysis performed by Elst et al. (14) in patients with blunt injury to the thorax and abdomen at the age of 16 years and above, in hypovolemic patients, VCI diameter, aortic diameter, shock intestine and liver, pancreas, kidney and adrenal gland, pancreas, kidney and adrenal gland with increased fluid appearance. blood parameters were compared. It has been reported that pH is low and lactate and base deficits are high in patients with CT findings supporting hypovolemia. In line with the results of the researchers, we found that the pH was lower and the lactate level was higher in hypotensive patients. We think that the development of hypotension after SA is caused by hypovolemia.

Limitations

Our study contains some limitations. While VCI diameter measurement is a reliable assessment tool with measurements in inspiration and expiration, in our study, measurements were taken at the end of expiration. Our second limitation; It is the use of the same dose of local anesthetic for all our patients. We need studies involving more patients in the future.

Conclusion

In our study, it was concluded that expVCI diameter measured by USG before spinal anesthesia, lactate and pH values among blood gas parameters are effective in predicting post-spinal hypotension, and expVCI can be preferred to invasive methods because it is noninvasive, easy and fast to be applied. We think that conducting more comprehensive studies in different patient populations on this subject may be beneficial and necessary.

ETHICAL APPROVAL: Ethical approval from our University Hospital Ethics Committee was obtained prior to initiation of the research work. This study was approved by the Ministry of Health and Ethics Committee of our University (Ethics Committee decision no: 2020/514/169/15).

CONSENT FOR PUBLİCATION: Not applicable.

AVAILBILITY OF DATA AND MATERIALS: All data are publicly available or listed in the results of the paper.

COMPETING INTERESTS: The authors declare that they have no competing interests.

FUNDING : No funding is associated with this report.

ACKNOWLEDGEMENTS: Not applicable.

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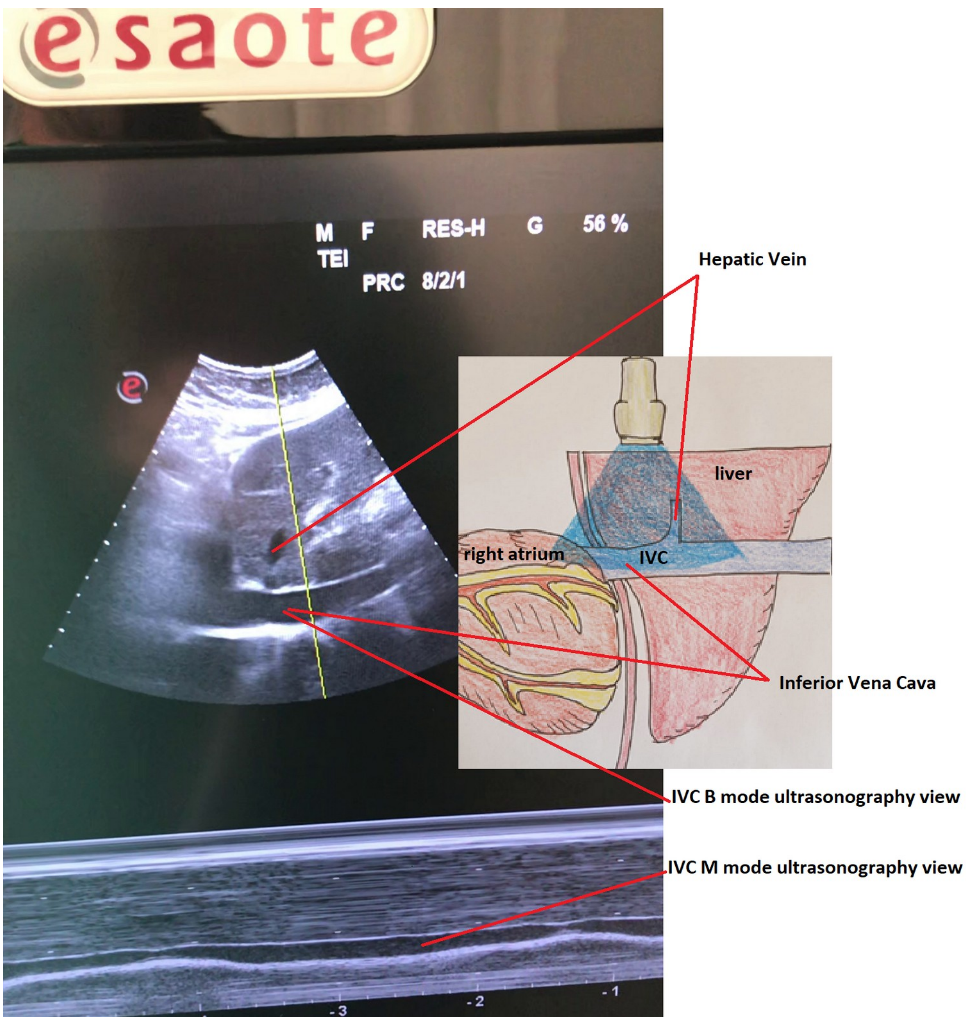

Figure 1. Vena Cava Inferior Subxiphoid Long Axis B Mode and M Mode Ultrasonography Image and Vena Cava Inferior Anatomy (*https://radiologykey.com/inferior-vena-cava-4/).*

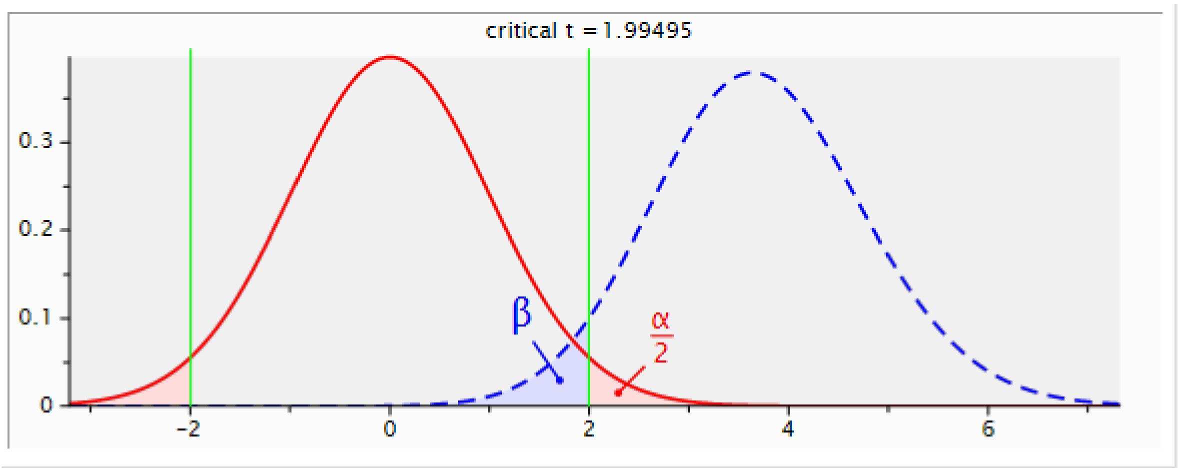

Figure 2. Power Analysis.

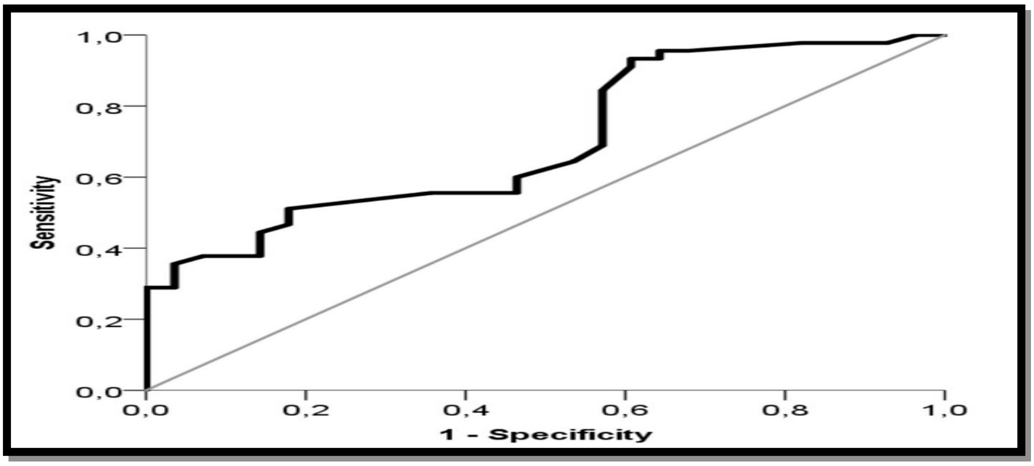

Figure 3. Investigation of the Predictability of the Development of Hypotension of the Vena Cava Inferior Diameter at the End of Expiratory by ROC Analysis.

Table 1. Demographic and Clinical Characteristics of Patients.

Variables	**Data**

Age, year±SD	73.5±8.0
Sex, n (%)	
Male	35 (%47.9)
Female	38 (%52.1)
Weight, kg±SD	74.3±16.0
Height, cm±SD	162.8±7.5
BMI, kg/m2 ±SD	28.0±6.0
Duration of operation, min±SD	59.3±25.1
ASA, n (%)	
2	27 (%37.0)
3	39 (%53.4)
4	7 (%9.6)
Comorbidity, n (%)	
No	22 (%30.1)
DM	5 (%6.8)
HT	31 (%42.5)
DM+HT	15 (%20.5)
Type of operation, n (%)	
Orthopedics and Traumatology	39 (%53.4)
Urology	15 (%20.5)
General Surgery	14 (%19.2)
Plastic and Reconstructive Surgery	5 (%6.9)
ekspVCI diameter, cm±SD	1.74±0.36
cVCI, n (%)	
<50.0%	42 (%57.5)
≥50.0%	31 (%42.5)
Amount of peroperative fluid, ml±SD	1246.5±409.2
Amount of bleeding, n (%)	

<500 ml	70 (%95.9)
≥500 ml	3 (%4.1)
The need of inotropics, n (%)	
No	58 (%79.5)
Yes	15 (%20.5)

BMI; *body mass index,* ***n;*** *number,* ***ASA;*** *American Society of Anesthesiologists* ***cm;*** *centimeters,* ***kg****; kilogram,* ***SD****; standard deviation,* ***VCI;*** *vena cava inferior,* ***cVCI****; vena cava inferior collapsibility index,* ***expVCI:*** *End expiration vena cava inferior*

Table 2. Comparison of Patients with and without Hypotension.

Variables	**Patient group without hypotension (n=45)**	**Patient group with hypotension (n=28)**	**p values**
Age, year±SD	72.4±7.2	75.2±9.0	0.179
Sex, n (%)			
Male	24 (%53.3)	11 (%39.3)	0.243
Female	21 (%46.7)	17 (%60.7)	
Type of operation, n (%)			
Orthopedics and Traumatology	21 (%46.7)	18 (%64.3)	
Urology	12 (%26.7)	3 (%10.7)	0.583
General Surgery	10 (%22.2)	4 (%14.3)	
Plastic and Reconstructive Surgery	2 (%4.4)	3 (%10.7)	
Duration of operation, min±SD	58.6±27.3	60.3±21.5	0.561
ASA, n (%)			
2	21 (%46.7)	**6 (%21.4)**	
3	22 (%48.9)	**17 (%60.7)**	**0.011**
4	2 (%4.4)	5 (%17.9)	
Comorbidity, n (%)			
No	15 (%33.3)	7 (%25.0)	
DM	1 (%2.2)	4 (%14.3)	0.677
HT	17 (%37.8)	14 (%50.0)	

DM+HT	12 (%26.7)	3 (%10.7)	
Weight, kg±SD	76.6±16.0	70.7±15.6	0.301
Height, cm±SD	164.4±7.3	**160.2±7.2**	**0.029**
BMI, kg/m2 ±SD	28.4±6.4	27.3±5.3	0.605
ekspVCİ diameter, cm±SD	1.84±0.36	**1.57±0.29**	**0.004**
cVCİ, n (%)			
<50.0%	28 (%62.2)	14 (%50.0)	0.304
≥50.0%	17 (%37.8)	14 (%50.0)	
Amount of peroperative fluid, ml±SD	1277.7±406.6	1196.4±415.8	0.538
Amount of bleeding, n (%)			
<500 ml	42 (%93.3)	28 (%100.0)	0.281
≥500 ml	3 (%6.7)	0 (%0.0)	
The need of inotropics, n (%)			
	44 (%97.8)	14 (%50.0)	**<0.001**
No	1 (%2.2)	**14 (%50.0)**	
Yes			
pH, n (%)			
<7.34	33 (%73.3)	15 (%53.6)	
7.35-7.44	9 (%20.0)	12 (%42.9)	**0.006**
>7.45	3 (%6.7)	1 (%3.6)	
pCO2, n (%)			0.576
<34	11 (%24.4)	9 (%32.1)	
35-44	29 (%64.4)	16 (%57.1)	
>45	5 (%11.1)	3 (%10.7)	
Lactate, mmol/L±SD	1.44±0.56	**1.83±1.11**	**0.039**
BE, mEq/lt ±SD	0.51±2.51	1.44±2.39	*0.077*

BMI; *body mass index,* ***n;*** *number,* ***ASA;*** *American Society of Anesthesiologists cm; centimeters,* ***kg;*** *kilogram,* ***SD;*** *standard deviation,* ***VCI;*** *vena cava inferior,* ***BE;*** *base deficit,* ***cVCI****, vena cava inferior collapsibility index****, expVCI****; end expiration vena cava inferior*

Table 3. Comparison of Patients After Grouping As Small and Large-Vena Cava Inferior According to Threshold Value.

Variables	Small-VCI group (n=45)*	Large-VCI group (n=28)*	p value
Age, year±SD	73.1±8.0	74.0±8.1	0.599
Sex, n (%)			
Male	20 (%44.4)	15 (%53.6)	0.448
Female	25 (%55.6)	13 (%46.4)	
Type of operation, n (%)			
Orthopedics and Traumatology	28 (%62.2)	11 (%39.3)	
Urology	5 (%11.1)	10 (%35.7)	
General Surgery	9 (%20.0)	5 (%17.9)	0.359
Plastic and Reconstructive Surgery	3 (%6.7)	2 (%7.1)	
Duration of operation, min±SD	63.7±22.4	**52.1±27.8**	**0.010**
ASA, n (%)			
2	15 (%33.3)	12 (%42.9)	
3	25 (%55.6)	14 (%50.0)	0.373
4	5 (%11.1)	2 (%7.1)	
Comorbidity, n (%)	31 (%68.9)	8 (%71.4)	0.677
Weight, kg±SD	72.7±16.8	77.0±14.6	0.244
Height, cm±SD	161.5±7.4	**164.8±7.3**	**0.073*
BMI, kg/m2±SD	27.8±6.1	28.4±5.8	0.589
cVCI , n (%)			
<50.0%	18 (%40.0)	**24 (%85.7)**	**<0.001**
≥50.0%	27 (%60.0)	4 (%14.3)	
Development of hypotension, n (%)	23 (%51.1)	**5 (%17.9)**	**0.004**
Time to develop hypotension, min ±SD	9.1±5.6	9.0±4.1	1.000
Bradycardia development, n (%)	11 (%24.4)	3 (%10.7)	0.223
The amount of fluid peroperatively, ml ± SD	1311.1±402.9	**1142.8±404.9**	*0.094
The amount of bleeding, n (%)			
<500 ml	43 (%95.6)	27 (%96.4)	1.000
≥500 ml	2 (%4.4)	1 (%3.6)	
The need of inotropic, n (%)	13 (%28.9)	**2 (%7.1)**	**0.036**

P values in italics indicate values that are close to significance. **BMI; body mass index, **n**; number, **ASA;** American Society of Anesthesiologists **cm;** centimeters, **kg;** kilogram, **SD;** standard deviation, **VCI;** vena cava inferior, **cVCI**; vena cava inferior collapsibility index.*

Table 4. Comparison of Systolic, Diastolic and Mean Blood Pressure Values of Small-Vena Cava Inferior and Large-Vena Cava Inferior Groups.

Variables	**Small-VCI group (n=45)**	**Large-VCI group (n=28)**	**p value**
Systolic BP, mmHg±SD			
Preoperative	148.1±23.4	156.3±26.0	0.164
0. min	131.7±29.5	149.4±28.7	**0.015**
10.min	120.2±29.0	136.3±27.7	**0.028**
20.min	116.2±29.7	131.5±28.4	**0.032**
30. min	119.2±26.6	132.9±24.5	**0.037**
Diastolic BP, mmHg±SD			
Preoperative	79.2±13.4	90.6±24.8	**0.037**
0. min	70.0±14.4	80.1±16.5	**0.009**
10.min	62.8±14.9	70.7±17.5	**0.022**
20. min	63.6±15.8	71.3±13.0	**0.034**
30. min	64.9±14.3	71.1±13.2	**0.048**
Mean BP, mmHg±SD			
Preoperative	102.2±14.8	112.5±22.6	**0.054*
0. min	90.6±18.2	103.1±19.2	**0.007**
10. min	82.0±18.6	92.5±18.8	**0.030**
20. min	81.1±19.3	91.4±17.3	**0.020**
30. min	66.4±16.5	67.5±18.5	0.820

** P values in italics indicate values that are close to significance.* ***BP****; blood pressure,* ***SD****; standard deviation,* ***min;*** *minute.*

Table 5. Multiple Logistic Regression Analysis Performed with Variables Determined to Affect Development of Hypotension in Univariate Analyzes.

Variables	Odds Ratio	95%CI	p values
ASA	2.198	0.802-6.023	0.125
Height	0.941	0.867-1.021	0.145
EkspVCİ diameter≤1.8 cm	3.289	0.910-12.500	**0.06*
pH	3.201	1.027-9.975	**0.04**
Lactate	2.628	0.941-7.341	**0.06*

CI; *confidence interval,* ***VCI;*** *vena cava inferior,* ***ASA;*** *American Society of Anesthesiologists. * p values in italics indicate values that are close to significance.*

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