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Estimation of central venous pressure by measuring IVC collapsibility index by sonography

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ABSTRACT

In this paper, the estimation of central venous pressure by measuring the IVC Collapsibility Index has been investigated by Sonography. In this study, the patient was submerged and intravenous pressure was determined by central venous catheter in inhale and exhale mode (CVP). At the same time, the lower anterior posterior vein diaphragm was recorded by Sonography. Inhale and exhale measurements are performed and the collapsibility index is calculated (divergence of the IVC diameter at the inhale and exhale divided by the exhale mode IVC diameter). Finally, the variables were analyzed using statistical software SPSS 22 and statistical analysis. The results of the study showed that the most common cause of patients admitted to the intensive care unit was cancer patients, gastrointestinal bleeding and pneumonia, respectively, with a prevalence of 16%, 12% and 12%. The mean central venous pressure in 50 patients was 10.7 cm in water and the minimum and maximum central venous pressure and standard deviation were 2 and 29 cm water and 6.14%, respectively. In the under study patients, the mean, minimum and maximum diameter of lower vein in the inhale by Sonography were 5.9, 12.4 and 25.5 respectively, with a standard deviation of 3.81. The results of this study showed a direct and significant correlation between IVC collapsibility index and central venous pressure (P-value = 0.009 and r = -0.367). As a result, measuring the lower vein diameter by sonography was used as a non-invasive and reliable method for estimating the volume of intravascular fluid to evaluate the response to treatment in patients admitted to the intensive care unit rather than invasive methods.

Keywords: central vein pressure, lower vein diameter, sonography

INTRODUCTION

The most important function of the venous system is to restore blood from the peripheral blood vessels to the heart. (1) The blood entering the veins is under very low pressure and moves through the contraction of the middle layer (media) and external pressure of the muscles and other organs around the heart.

Zhang et al. (2014) investigated the association between the lower vein diameter via sonography and central venous pressure in measuring intravascular volume in patients undergoing gastrointestinal surgery. In this study, 40 patients undergoing gastrointestinal surgery and 32 volunteers in the control group were used. The lower vein diameter was measured in inhale and exhale conditions as well as the right atrium before giving the fluid and after giving the fluid in the patients.

The results of this study showed that lower vein diameter in inhale and exhale and right atrium diameter was lower than control group. After fluid therapy, the level of lower vein diameter increased in patients with inhale and exhale and right atrium diameter. Lower vein diameter and right atrium diameter before and after surgery had a significant relationship with central venous pressure.

In conclusion, the lower vein diameter and right atrium diameter in people undergoing gastrointestinal surgery are lower than healthy subjects. Measuring the lower vein diameter and right atrium diameter through sonography can estimate central venous pressure before surgery to evaluate the intravascular volume of patients (2).

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Stawicki et al. (2009) assessed a relationship between IVC collapsibility index or IVC-CI to estimate intravascular volume and central venous pressure. In this study, 124 volunteers, of whom 101 had a central catheter, were used. The results of this study showed that IVC-CI was less than 0.2 in the three groups, between 0.2 and 0.6 and more than 0.6, and there was a significant relationship between the reduction of central venous pressure and increasing IVC-CI.

Less than 5% of patients had less than 0.2% of IVC-CI patients, central venous pressure was less than 7 cm, more than 40% had central venous pressure above 12%, and more than 60% of IVC-CI patients were above 0.6% and the central venous pressure was less than 7 cm. In conclusion, IVC-CI measurements by sonography were the appropriate measure for assessing the intravascular volume of patients admitted to the intensive care unit. IVC-CI had a significant relationship with central venous pressure (3).

Ishizaki and his colleagues conducted a study in 2004 to evaluate the IVC diameter for vertigo examination for ten days flatbed. The findings showed that changes in the diameter of IVC lead to different hemodynamic responses. As a result, measuring IVC diameter is appropriate for estimating hemodynamic changes in the body. They showed that there is a linear relationship between central venous pressure and IVC diameter (4).

Yangagawa et al. (2005) conducted a study to investigate the early diagnosis of hypovolemic shock by measuring the diameter of IVC by sonography in patients with trauma. In patients who had been shocked, IVC diameter was significantly lower than the control group (non-shocked patients). Significant changes were also found between the IVC diameter of the patients experiencing shock at the time of admission to the hospital and the fifth day of hospitalization. Therefore, measuring IVC diameter is effective in diagnosing patients with hypovolemic shock (5).

Adjusting the volume of intravascular fluid in patients with severe injuries or admission to the intensive care unit is very difficult. Many factors are effective in maintaining the balance between hydrostatic pressure of vessels and osmolality of extracellular fluid, which ultimately regulates the volume of body fluids. Reducing the volume of intravascular fluid can disrupt digestive, urinary, nervous, and cardiovascular and devices ultimately leads to shocking. The amount of body fluid requirement can be estimated by clinical examinations, pulse changes and blood pressure and urine control (6-7).

In clinical examinations, unconfirmed intravascular volume measurement has been shown to require an objective method to examine the intravascular volume. Currently, the exact method for estimating fluid need for fluid (CVP) is to measure the central venous pressure of the catheter in the upper vena vein through the internal jugular vein or subclavian, although it can directly measure central venous pressure, but it is invasive and may have complications such as pneumothorax, hemotoxa, vascular rupture, venous thrombosis, pulmonary embolism and cardiac tamponade (8, 9).

In this study, the estimation of central venous pressure by measuring the IVC Collapsibility Index by sonography is investigated. Long-term measurement of venous diameter was made by sonography as a simple method and (IVC) an underlying cavity available to estimate the volume of intravascular fluid. Technological advances have made the sonography device more little, portable, easy to use and affordable, and sonography studies around the bed are available 24 hours a day and can be used for initial review and next treatment tips.

PROBLEM STATEMENT

Here, we determine the type of illness referred to, determine the IVC Collapsibility Index in patients, estimate the central venous pressure of the patients using the lower inferior vein diameter (IVC) in all three cases, estimate the central venous pressure of patients using the IVC Collapsibility Index, Estimation of intravascular volume using IV in all three cases, intraocular volume estimation using the IVC Collapsibility Index, obtaining a formula for calculating central venous pressure in referring patients, obtaining a formula for calculating the rate of Intravascular volume in patients referring to these results can be obtained proper estimation from central venous pressure and using sonography, and its results can be used if appropriate for emergency situations and patients' conditions without invasive methods.

RESEARCH METHODOLOGY

Population under Study

This study was a descriptive cross-sectional study in a hospitalized hospital in Imam Khomeini Hospital, which was based on its causes, central venous catheter, between 2015 and 2016.

Methodology for the Implementation of the Design and Techniques Used

This descriptive cross-sectional study was conducted in a hospitalized hospital in Imam Khomeini Hospital between 2015 and 2016.

Criteria for entering the study: Central venous catheter, and in clinical examinations and screening of the chest wall and echocardiography, there are signs of a cardiovascular or pulmonary disease that leads to an increase in right atrial pressure.

Criteria for exiting the study: Patients with some underlying illnesses (heart failure, arrhythmias and COPD), patients with increased intra-abdominal pressure such as pregnancy and ascites, patients who are not in any way able to measure sonography.

In this study, the patient was slept behind and intravenous pressure was determined by central vein catheter in central inhale and exhale mode (CVP). The anterior posterior diameter of the lower inferior vein was recorded by sonography. Measurements were performed by a physiologist using a 3-MHz/ 260 model sonography device and using a 5 Pie Medical probe, the right paraxagital section, the supraperitoneal part of the lower vein was marked and its diameter was exactly above the location of the liver vein separation. Measurements are performed on inhale and exhale and the collapsibility index is calculated (the difference in IVC diameter in inhalation and exhale divided by IVC diameter in exhale state). Finally, the variables were analyzed by statistical software SPSS 22 and statistical analysis.

Method for Calculating Sample Size and How to Sampling

According to the referral study with α = 0.05 and power = 95%, the values of $z_{1-\beta}$ =2.75 and $z_{1-\beta}$ = 1.65, respectively, were obtained according to the referral study. In this study, the number of N was calculated with the sample size of 50 according to the T-test formula.

Statistical Methods for Analyzing the Results

Descriptive statistics are expressed in terms of percentage, cumulative percentage and presentation of appropriate charts. The statistical tests of regression and Pearson correlation coefficient were analyzed and P-value of less than 0.05 is considered significant and is analyzed by SPSS software and the results were presented as percentages and cumulative percentages and charts.

Table 1: *Variables*

Variable Specification	Independent	Dependent	Quantitative		Qualitative		Practical definition	Scale
			Continuous	Discrete	Nominal	Rating		
Age	*			*			The past number of years of life,	Year
Sex	*				*		Based on patient biography	Male / Female
lower inferior vein diameter (IVC)	*			*			Using a 3MHz sonography device	Relative
IVC Collapsibility Index	*			*			Divergence of IVC diameter in inhale and exhale divided by IVC diameter in exhale mode	Relative
Central venous pressure	*			*			Based on the diameter calculations and IVC Collapsibility Index	Relative
Intravascular volume	*			*			Based on the diameter calculations and IVC Collapsibility Index	Relative

RESULTS

Table 2: *Diagnosis of disease, patients under study*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	↓LOC	4	8.0	8.0	8.0
	GI bleeding	6	12.0	12.0	20.0
	seizure	1	2.0	2.0	22.0
	peritonitis	5	10.0	10.0	32.0
	post CPR	2	4.0	4.0	36.0
	MI	3	6.0	6.0	42.0
	Pneumonia	6	12.0	12.0	54.0
	COPD	1	2.0	2.0	56.0
	PTE	1	2.0	2.0	58.0
	Sleep apnea	2	4.0	4.0	62.0
	TB	1	2.0	2.0	64.0
	Cancer	8	16.0	16.0	80.0
	Hemothorax	5	10.0	10.0	90.0
	Pancreatitis	2	4.0	4.0	94.0
	sepsis	2	4.0	4.0	98.0
	meningitis	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

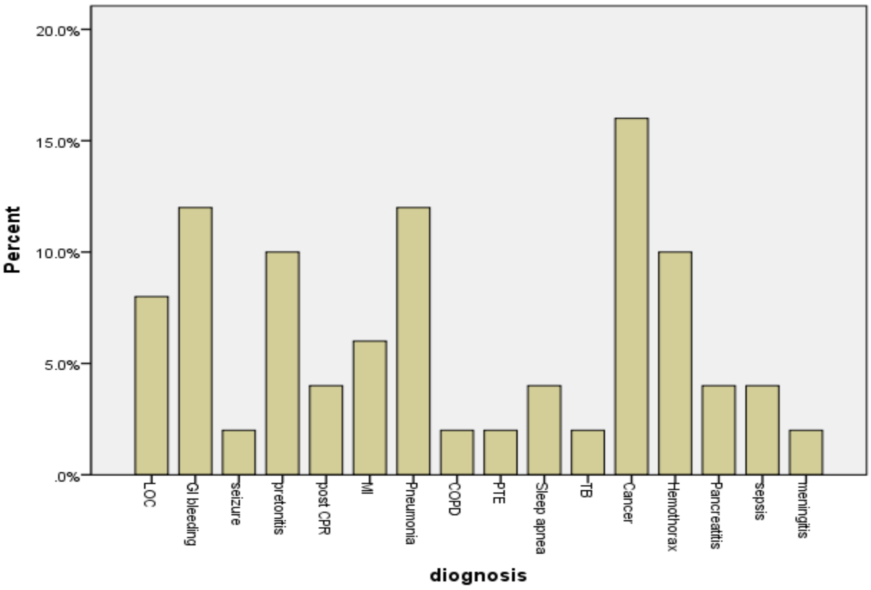

Figure 1: *Diagnosis of disease, patients under study*

Table 3: *Central venous pressure through catheter*

Number	Mean	Median	Minimum	Maximum	Std. Deviation
50	10.7	9	2	29	6.14

Table 4: *At least the lower vein diameter through sonography*

Number	Mean	Median	Minimum	Maximum	Std. Deviation
50	12.4	11.6	5.9	25.5	3.81

Table 5: *Maximum lower vein diameter through sonography*

Number	Mean	Median	Minimum	Maximum	Std. Deviation
50	14.3	14.1	7.2	27	3.81

Table 6: *Relationship between central vein diameter and lower vein diameter in inhalation*

Correlations			
		CVP pressure	**Min sonography**
CVP pressure	Pearson Correlation	1	.135
	Sig. (2-tailed)		.351
	N	50	50
Min sonography	Pearson Correlation	.135	1
	Sig. (2-tailed)	.351	
	N	50	50

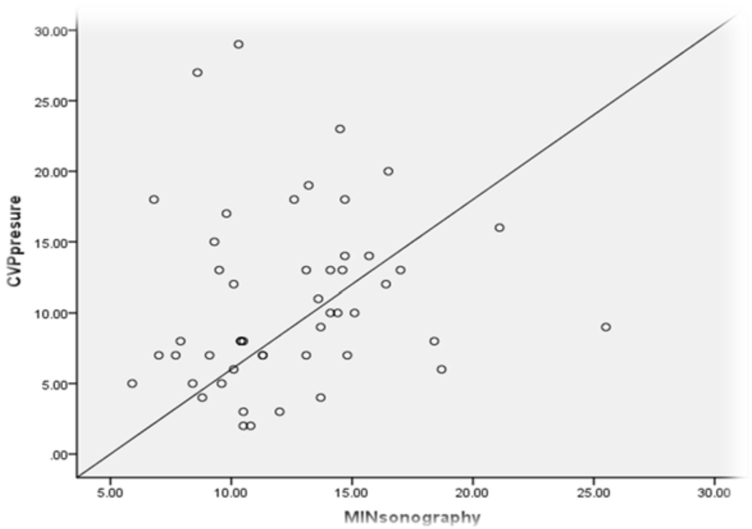

Figure 2: *Regression relationship between central venous pressure and lower vein in exhale*

Table 7: *Relationship between central venous pressure and lower vein diameter in exhale*

Correlations			
		CVP presure	**Max sonography**
CVP presure	Pearson Correlation	1	.281*
	Sig. (2-tailed)		.048
	N	50	50
Max sonography	Pearson Correlation	.281*	1
	Sig. (2-tailed)	.048	
	N	50	50

*. Correlation is significant at the 0.05 level (2-tailed).

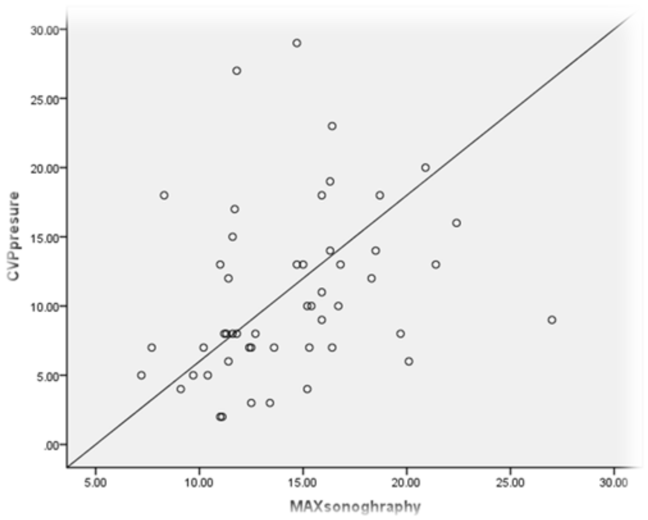

Figure 3: *Regression relationship between central venous pressure and lower vein in exhale ϖ Determine IVC Collapsibility Index in Patients IVC collapsibility index formula: [(maximum IVC diameter - minimum IVC diameter) / maximum IVC diameter] = 0.10*

Table 8: *Relationship between IVC Collapsibility Index and central venous pressure*

Correlations			
		CVP presure	**IVC-CI**
CVP pressure	Pearson Correlation	1	-.330*
	Sig. (2-tailed)		.019
	N	50	50
IVC-CI	Pearson Correlation	.330*	1
	Sig. (2-tailed)	.019	
	N	50	50

*. Correlation is significant at the 0.05 level (2-tailed).

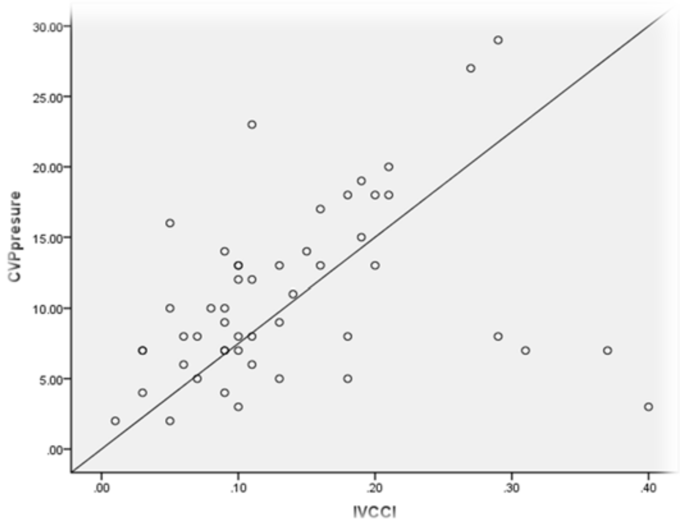

Figure 4: *The relationship between IVC collapsibility index and central venous pressure*

CONCLUSION

In this paper, the evaluation of central venous pressure was assessed by measuring the IVC Collapsibility Index by sonography. The results of this study showed that the most common cause of patients admitted to the intensive care unit were cancer patients, gastrointestinal bleeding and pneumonia, respectively, with prevalence rates of 16%, 12% and

12% . Other causes of hospitalization were prevalence of the following diseases: Hemoturase (10%), peritonitis (10%), decreased consciousness (8%), MI (6%), (after CPR (4%), sleep apnea (4%), sepsis (4%), pancreatitis (4%) and seizure, meningitis, tuberculosis, COPD 1%.

The mean central venous pressure in 50 patients was 10.7 cm water and the minimum and maximum central venous pressure and standard deviation were 2 and 29 cm, respectively. In the studied patients, mean, minimum and maximum lower vein diameter in inhale by sonography was respectively equal to 12.4, 5.9, and 25.5, with a standard deviation of 3.81. Also, the mean, minimum and maximum of lower vein diameter by sonography in exhale was respectively equal to 14.3, 7.2 and 27, with a standard deviation of 3.81.

The results of this study showed a relationship between central venous pressure and lower vein diameter in inhale that there was no direct and significant correlation between central venous pressure and lower vein diameter in the inhale (Pvalue = 0.135 and r = 0.3). However, there was a direct and significant relationship between central venous pressure and lower vein diameter in exhale (Pvalue = 0.04 and r = 0.281).

Also, the IVC collapsibility index was equal to 10 in the patients under study. The results of this study showed a direct and significant correlation between IVC Collapsibility Index and central venous pressure (Pvalue = 0.009 and r = 0.367).

Measuring the lower vein diameter by sonography is a non-invasive and reliable method for estimating the volume of intravascular fluid. Also, the IVC-CI index to be used to evaluate the response to treatment in patients admitted to the intensive care unit rather than invasive methods.

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