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Ultrasonographic Examination of Inferior Vena Cava Collapsibility Index, Inferior Vena Cava Diameter versus Direct Measurement of Central Venous Pressure for Intravascular Fluid Status Assessment

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ABSTRACT

Background and Objectives: Rapid and accurate assessment of intravascular fluid status is critical in postoperative and critically ill patients. Central venous pressure (CVP) monitoring is invasive and associated with complications. Ultrasonographic assessment of inferior vena cava (IVC) diameter and collapsibility index (IVC-CI) provides a potential noninvasive alternative. This study aimed to determine the correlation between IVC diameter and CVP, and between IVC-CI and CVP.
Methods: A cross-sectional study was conducted in 30 mechanically ventilated postoperative ICU patients with a CVP catheter in situ. IVC diameters were measured using ultrasound, collapsibility index was calculated, and CVP was measured by manometer. Correlations were analyzed using Spearman's test.
Results: Mean CVP was 10.97 ± 1.79 cm H2O. Mean maximum IVC diameter was 1.24 ± 0.16 cm, minimum diameter 1.06 ± 0.15 cm, and collapsibility index 0.14 ± 0.04. There was a strong positive correlation between CVP and maximum IVC diameter ($r = 0.896$, $p < 0.001$). A negligible, nonsignificant negative correlation was found between CVP and IVC-CI ($r = -0.119$, $p = 0.532$).
Conclusion: Maximum IVC diameter showed a strong correlation with CVP and may serve as a reliable noninvasive surrogate for assessing fluid status. IVC collapsibility index showed poor correlation with CVP.

Keywords*: Inferior vena cava; collapsibility index; ultrasonography; central venous pressure; intravascular volume status.*

INTRODUCTION

Accurate assessment of intravascular volume is essential in critically ill and postoperative patients. Although CVP is widely used, it is invasive and associated with complications such as pneumothorax and catheter-related infections. Ultrasound measurement of IVC diameter and collapsibility index provides a rapid, bedside, noninvasive alternative. This study evaluated the correlation between IVC-derived indices and directly measured CVP in postoperative ICU patients.

METHODS

Study design and setting: A cross-sectional study was conducted in the postoperative ICU.
Participants: Thirty adult patients (18–80 years) who were mechanically ventilated and had a CVP catheter in situ were included. Exclusion criteria: spontaneous breathing, pulmonary hypertension, severe tricuspid regurgitation, deep vein thrombosis, pregnancy, right-sided pneumothorax, or central line via subclavian/femoral route.

Measurements: IVC diameters were measured using a Mindray Z6 ultrasound system with a curvilinear probe in the subxiphoid long-axis view. Maximum (end-expiratory) and minimum (end-inspiratory) diameters were recorded. Collapsibility index was calculated as (IVCmax − IVCmin) / IVCmax. CVP was measured using a saline manometer zeroed at the level of the right atrium. Statistical analysis was performed using SPSS v26. Bivariate Spearman correlation was used for non-normally distributed data. Significance was set at $p < 0.05$.

Ethical considerations: The study was approved by the Institutional Ethics Committee and informed consent was obtained from patients or their caregivers.

RESULTS

Baseline characteristics and main hemodynamic/IVC measurements are presented in Tables 2 and 3. Correlation results are shown in Tables 4 and 5. Figures 1 and 2 illustrate the CVP–IVC relationships.

Table 1. Distribution of age among study subjects (N = 30)

Parameter	Mean ± SD	Minimum	Maximum
Age (years)	61.50 ± 7.87	49	75

Table 2. Distribution of mean and SD of CVP and IVC parameters (N = 30)

Parameter	Mean ± SD	Minimum	Maximum
CVP (cm H2O)	10.97 ± 1.79	8	14
Max IVC diameter (cm)	1.24 ± 0.16	1.04	1.55
Min IVC diameter (cm)	1.06 ± 0.15	0.85	1.37
Collapsibility index	0.14 ± 0.04	0.078	0.228

Table 3. Correlation between CVP and maximum IVC diameter (N = 30)

Correlation	Coefficient (r)	p-value
CVP vs Max IVC diameter	0.896	<0.001

*Significant correlation (Spearman).

Table 4. Correlation between CVP and IVC collapsibility index (N = 30)

Correlation	Coefficient (r)	p-value
CVP vs Collapsibility index	-0.119	0.532

Not statistically significant.

Figures

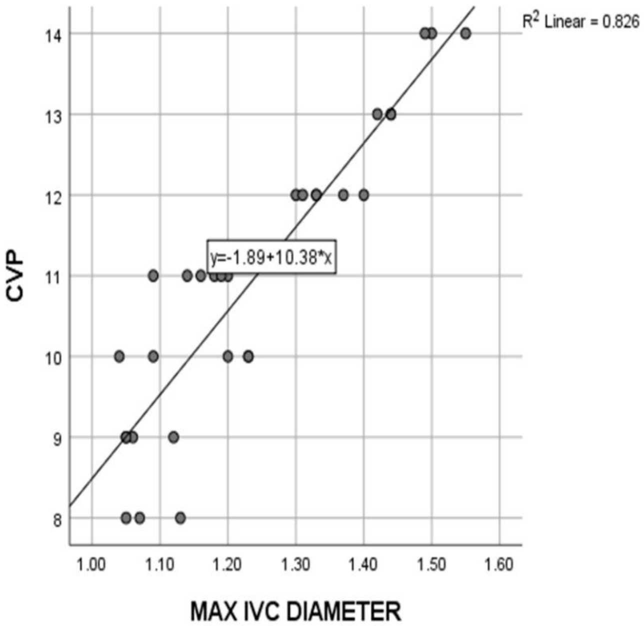

Figure 1. Correlation between CVP and maximum IVC diameter (significant positive correlation)

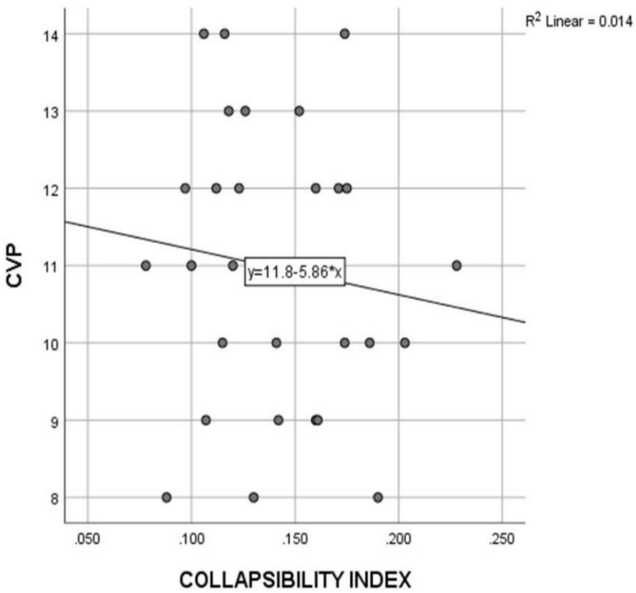

Figure 2. Correlation between CVP and IVC collapsibility index (non-significant correlation)

DISCUSSION

In this study, maximum IVC diameter had a strong positive correlation with CVP, suggesting it may be used as a reliable noninvasive marker of intravascular volume status. IVC collapsibility index showed poor correlation with CVP in this cohort. These results align with several prior studies demonstrating variable performance of IVC-derived indices depending on patient population and ventilation settings. Limitations include single-center design, relatively small sample size, and lack of preoperative fluid status stratification. Future studies should evaluate diagnostic accuracy against a gold standard in larger cohorts.

CONCLUSION

Maximum IVC diameter measured by ultrasonography correlates strongly with CVP and may serve as a noninvasive alternative for assessing intravascular fluid status. Collapsibility index did not show significant correlation in this sample.

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Conflict of Interest: None declared.

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