Original Research Article

Assessment of fluid responsiveness using inferior vena cava collapsibility index in hypovolemic patients using ultrasound in the emergency department

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Abstract

Assessment of hemodynamic status in a shock state remains a challenging issue in emergency medicine. Ultrasound has expanded to become a rapid, bed-side and non-invasive method for the assessment of patient physiology. The primary utility of bedside ultrasound is to measure the diameter of inferior vena cava for assessment of the intravascular volume status of the patient. This may be of utility in cases of undifferentiated hypotension or other scenarios of abnormal volume states, such as sepsis, dehydration, haemorrhage, trauma or heart failure. changes in volume status will be reflected in sonographic evaluation of the inferior vena cava, where increased or decreased collapsibility of the vessel will help guide clinical management of the patient. The combination of the absolute diameter of the inferior vena cava and the degree of collapse with respiration may give an estimate of central venous pressure and substitute for more invasive measurements. Early recognition and appropriate treatment of shock have been shown to decrease mortality. Incorporation of bedside ultrasound in patients with undifferentiated shock allows for rapid evaluation of reversible causes of shock and improves accurate diagnosis in undifferentiated hypotension

. Key word: inferior vena cava collapsibility index.

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INTRODUCTION

Intravascular volume status is an important clinical consideration in the management of the critically ill. Point-of-care ultrasonography (pocus) has gained popularity as a non-invasive means of intravascular volume assessment via examination of the inferior vena cava (ivc). However, there are limited data comparing different acquisition techniques for ivc measurement by pocus. The goal of this evaluation was to determine the reliability of ivc acquisition techniques for volume assessment: sub-xiphoid transabdominal long axis (la).Intravenous fluid resuscitation is vital in the critically ill; however, excessive fluid administration has been shown to contribute to mortality. Rapid assessment of volume status may reduce over-resuscitation and improve outcomes. As it has been established that clinical examination alone is inadequate, more objective means of intravascular volume assessment have arisen. Of those, point-of-care ultrasound (pocus) of the inferior vena cava (ivc) has gained popularity as a bed-side, non-invasive, easily obtainable and rapid means of intravascular volume assessment.

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MATERIAL AND METHODS

This cross sectional (with exclusion) prospective study was conducted in dr. D Y Patil medical college, hospital and research centre, Nerul, Navi Mumbai by department of emergency medicine over a period of 2 years. The study population included patients both male and female above 12 years of age. Kids below 12 years of age, patients of liver cell failure with portal hypertension and intubated patients were excluded.

OBSERVATIONS AND RESULTS

Table 1:

PARAMETER	MEAN	SD
PULSE (BPM)	108.40	8.5

The average pulse of patients who presented with hypotension was 108.4 ; and the standard deviation was 8.5

Table 2:

PARAMETER	MEAN	SD
PULSE (BPM)	101.46	7.8

The average pulse of patients with hypotension after 1 liter of isotonic fluid was 101.4 ; and the standard deviation was 7.8

Table 3:

PARAMETER	MEAN	SD
SPO2	94.18	3.5

The average spo2 of patients who presented with hypotension was 94.18 ; and the standard deviation was 3.5

Table 4: Comparison of systolic BP

METHOD	MEAN	SD	DIFFERENCE	P VALUE
AT PRESENTATION	81.6	16.8	-10.80	0.003 (S); PAIRED T TEST
AFTER ISOTONIC FLUID	92.4	25.7		

The average systolic bp of patients who presented with hypotension was 81.6 ; and the standard deviation was 16.8
The average systolic bp of patients with hypotension after 1 liter of isotonic fluid was 92.4 ; and the standard deviation was 25.7.

Table 5: comparison of diastolic BP

METHOD	MEAN	SD	DIFFERENCE	P VALUE
AT PRESENTATION	55.2	8.1	-16.9	0.004 (S); PAIRED T TEST
AFTER ISOTONIC FLUID	72.1	11.8		

The average diastolic bp of patients who presented with hypotension was 55.2 ; and the standard deviation was 8.1
The average systolic bp of patients with hypotension after 1 liter of isotonic fluid was 72.1 ; and the standard deviation was 11.8

Table 6: Comparison of expiratory diameter

METHOD	MEAN	SD	DIFFERENCE	P VALUE
AT PRESENTATION	1.74	0.35	-0.13	0.098 (NS); PAIRED T TEST
AFTER ISOTONIC FLUID	1.88	0.44		

The average diameter of ivc of patients who presented with hypotension, during expiratory phase was 1.74; and the standard deviation was 0.35. The average diameter of ivc of patients with hypotension after 1 liter of isotonic fluid during expiratory phase was 1.88; and the standard deviation was 0.44

Table 7: Comparison of inspiratory diameter

METHOD	MEAN	SD	DIFFERENCE	P VALUE
AT PRESENTATION	0.54	0.27	-0.53	0.001 (S); PAIRED T TEST
AFTER ISOTONIC FLUID	1.07	0.57		

The average diameter of ivc of patients who presented with hypotension, during inspiratory phase was 0.54; and the standard deviation was 0.27. The average diameter of ivc of patients with hypotension after 1 liter of isotonic fluid during inspiratory phase was 1.07; and the standard deviation was 0.57

Table 8: Comparison of collapsability index

METHOD	MEAN	SD	DIFFERENCE	P VALUE
AT PRESENTATION	69.33	14.9	23.42	0.002 (S); PAIRED T TEST
AFTER ISOTONIC FLUID	45.90	21.2		

The average collapsability index of ivc of patients who presented with hypotension was 69.33; and the standard deviation was 14.9The average collapsability index of ivc of patients with hypotension after 1 liter of isotonic fluid was 45.9; and the standard deviation was 21.2.

DISCUSSION

The primary utility of bedside ultrasound of the ivc is to aid in assessment of the intravascular volume status of the patient. This may be of particular utility in cases of undifferentiated hypotension or other scenarios of abnormal volume states, such as sepsis, dehydration, hemorrhage, or heart failure. Point-of-care ultrasound has been increasingly used in evaluating hypotensive patients including the measurement of inferior vena cava (ivc) diameter. Combining the collapsibility and diameter size will increase the value of ivc measurement. This approach has been very useful in the resuscitation of hypotensive patients, monitoring their fluid demands, and predicting recurrence of shock. Pitfalls in measuring ivc diameter include increased intra-thoracic pressure by mechanical ventilation or increased right atrial pressure by pulmonary embolism or heart failure. The ivc diameter is not useful in cases of increased intra-abdominal pressure (abdominal compartment syndrome) or direct pressure on the ivc.

There are various methods to measure the fluid responsiveness which includes both

- Invasive methods
- Non-invasive methods

Poc-us is a non-invasive method of ivc measurement for the fluid responsiveness in hypotensive patients. The ivc is a thin-walled compliant vessel that adjusts to the body's volume status by changing its diameter depending on the total body fluid volume. The vessel contracts and expands with each respiration. Negative pressure created by the inspiration of the patient increases venous return to the heart, briefly collapsing the ivc. Exhalation decreases venous return and the ivc returns to its baseline diameter.in states of low intravascular volume, the percentage collapse of the vessel will be proportionally higher than in intravascular volume overload states. This is quantified by the calculation of the caval index: ivc expiratory diameter - ivc inspiratory diameter, divided by ivc expiratory diameter × 100 = caval index (%).the caval index is written as a percentage, where a number close to 100% is indicative of almost complete collapse (and therefore volume depletion), while a number close to 0% suggest minimal collapse (i.e., likely volume overload).the diameter of the ivc for calculation of the caval index should be measured 2 cm from where it enters the right atrium an alternative way to visualize respiratory variation is to use m-mode, with the beam overlying the ivc 2 cm from the right atrium. The inspiratory and expiratory diameter can then be measured on the m-mode image, at the smallest and largest locations, respectively

CONCLUSION

Measuring ivc collapsabilty index using ultrasound is a good non invasive bedside tool which can be used in critically ill patients presenting in emergency; not only to determine shock but also as a guidance in resuscitating patients in the hands of a well trained emergency physician.

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