ASSESSMENT OF INFERIOR VENA CAVA DIAMETER MEASURED BY ULTRA-SONOGRAPHY IN CORRELATION WITH CENTRAL VENOUS PRESSURE VALUE IN PATIENTS WITH SEPSIS

Yasser Mostafa Mohammed, Ghada Samir El Shahed**, Iman Hassan Elsayed Galal*, Ashraf Adel Gomaa*and Basma Malak Zaki****

*Chest disease department, **Cardiovascular disease department, Ain Shams University and *** Abbassia Chest Hospital , Ministry Of Health, Cairo, Egypt[2].

Corresponding author:

Basma Malak Zaki
Mobile: 01285530928,
E mail:
bosbosel@yahoo.com
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ABSTRACT

Background: *Bedside ultrasound is potentially a useful non-invasive adjunct to estimate the intravascular volume status in sepsis.*

Aim of the work: *Evaluating the correlation between inferior vena cava diameter measured non-invasively with ultrasonography versus central venous pressure in assessment of intravascular volume status in patients with sepsis.*

Patients and methods: *The study was conducted on sixty patients with sepsis (30 ventilated and 30 non-ventilated) in the Respiratory Intensive Care Unit at Abbassia Chest Hospital from January 2018 to September 2018. For all included patients demographic data were collected Recording vital sings, mean arterial pressure and Pao_2/ Fio_2were done. Laboratory investigation including complete blood count, serum lactic acid, arterial blood gas, quantitative C-reactive protein were also done. Sequential Organ Failure Assessment score (SOFA), Qsofa and Acute Physiology And Chronic Health Evaluation II score (APACHE II) were recorded. Finally measurement of IVC, CVP and intra-abdominal pressure were done*

Results: *Males represent 75%while female were 25%withmean age of (47.40±14.49) years. The mean CVP was 12.48±3.78 cmH2O with an IVC maximum diameter of 17.95±3.28 mm and collapsibility index of 50.55±11.83 %. There was statistically significant positive correlation between CVP and IVC dmax and statistically significant negative correlation between CVP and IVC CI (%)in both ventilated and non ventilated groups. Also, CVP and IVC dmax were significantly correlated with outcome in both ventilated and non ventilated patients. The higher values of CVP and IVC dmax and the lower the value of IVC CI, the higher rates of mortality.*

Conclusion: *US assessment of IVC diameter and caval index are simple and non invasive methods to assess intravascular volume status.*

Key words: *Sepsis, Central Venous Pressure, Inferior Vena Cava, Thoracic Ultrasound, Fluid Assessment*

INTRODUCTION:

Sepsis is defined as life threatening organ dysfunction caused by a dysregulated host response to infection. Organ failure definition is identified as an acute change in total Sequential Organ Failure Assessment score (SOFA) ≥ 2 points as a result to infection[(1)]**.** Patient with septic shock are diagnosed by using two criteria**:-**

(A) persisting hypotension requiring vasopressor to main tainmean blood pressure (MAP) ≥ 65 mm Hg.

(B) serum lactate level >2 mmol/L (18mg/dl) in spite of adequate fluid resuscitation[2].

Central venous pressure is used frequently as a guide for fluid assessment and management. The value of CVP is affected by many factors such as cardiac performance, blood volume, vascular tone, increased intrathoracic or intra-abdominal pressure and vasopressor therapy[3].

Ultrasonography is considered a simple bedside, painless, non-irradiating, non-invasive imaging tool in diagnosis of many pulmonary diseases and assessment of intravascular volume[4].

Inferior vena cavais considered the biggest vein of the venous system with low-pressure. Venous pressure changes is reflected by the expansion of the IVC. The change in pressure also gives an idea about the status of intravascular volume. Reasonably, the IVC diameteris considered an important diagnostic tool in evaluation of hypovolemia and hypervolaemia[5]. The vessel contracts and expands with inspiration and expiration, respectively. The collapsing of IVC that occur during inspiration is caused by negative pressure which increases venous return to the heart. Decreased venous return occur during expiration causes IVC to return to its baseline diameter[6].

AIM OF THE WORK:

Evaluating the correlation between IVC diameter measured non-invasively with US versus measured CVP for assessment of intravascular volume status in patients with sepsis.

PATIENTS AND METHODS:

The study was conducted on sixty patients with sepsis (30 ventilated and 30 non-ventilated) in the Respiratory Intensive Care Unit at Abbassia Chest Hospital from January 2018 to September 2018. Patients with increased intra-abdominal pressure over 12 cm H2o (accumulation of blood in the abdomen, massive as cites, peritonitis, intestinal perforation, pregnancy) as well as patients whom we could not visualize the IVC due to obesity, excessive intra-abdominal bowel gas, pneumothorax were also excluded from the study.

The study was approved from the Ethical Committee of Ain Shams university.

Signed written consent was taken from the patients or the relatives of first degree if the patients were disoriented.

For all included patients demographic data were collected. Recording vital sings as well as mean arterial blood pressure, Pao_2/ Fio_2were done. Cardiac output also was measured by Echocardiography. Laboratory investigation including complete blood count, serum lactic acid, arterial blood gas, quantitative C-reactive protein were also done. SOFA score, Qs of a and APACHE II score were recorded. Finally measurement of IVC, CVP and IAP were done as follow:-

(1) Measurement of IVC diameter:

IVC diameter measurements were performed in the supine position with Philips clear vue 350 ultrasound device and 2-6 MHz convex probe. First, ultrasound gel was applied to the subxiphoid region. The IVC was imaged in a longitudinal plane with the transducer in the subxiphoid position. The intrahepatic segment of the IVC was visualized as it entered the right atrium. The IVC diameter was measured 2 cm caudal to the hepatic vein-IVC junction, or approximately 3–4 cm from the junction of the IVC and right atrium. This measurement location was preferred as IVC collapsibility in the intrahepatic segment was not influenced by the activity of the muscular diaphragm. Measurements using M mode were taken at the end of both inspiratory and expiratory phases and were recorded.IVC

collapsibility index was calculated as follow: IVC CI = (IVCmax − IVCmin) / IVCmax[7].

(2) Measurement of CVP:

The level of the right atrium was taken as reference (zero) level. The point at the level of the fourth costal cartilage and on the mid-axillary line was taken as a reference point. A 3-way tap is used to connect the manometer to an intravenous drip set on one side, and, via extension tubing filled with intravenous fluid, to the patient on the other. It is important to ensure that tube is not kinked or blocked with no air bubbles. The 3-way tap is then turned so that it is open to the fluid bag and the manometer but closed to the patient. Once the manometer has filled adequately the 3-way tap is turned again this time so it is open to the patient and the manometer, but closed to the fluid bag. A patient with CVP of less than 8 cmH_2O was considered as hypovolemic. The patients with CVP between 8–12 cmH_2O were considered as euvolemic and patients having CVP > 12 cmH_2O were considered as hypervolemic[8].

(3) Measurement of IAP:

The bladder was drained by a Foley urinary catheter while the patient in supine position before the measurement of IAP. Then 50-100 ml of isotonic fluid was injected to the bladder under sterile conditions and the distal portion was clamped. Then, a 18-gauge needle will be entered into output of urinary catheter. Needle will be connected to a 3-way system and a water manometer. After filled with sterile fluid, the patient side of the manometer is opened. "0" point of the manometer was aligned to patient's pubic symphysis point and the point where the liquid column was read in cm. So, IAP was determined in cm H_2O unit. Patients with an IAP over 12 cm H_2O were excluded from the study[9]. Increased intra-abdominal pressure was associated with a significant smaller maximal IVC diameter and cautions the reliability of IVC diameter in clinical settings that are associated with intra-abdominal hypertension or abdominal compartment syndrome[10].

Statistical analysis:

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

- Independent-samples t-test of significance was used when comparing between two means. Chi-square (x^2) test of significance was used in order to compare proportions between qualitative parameters. Pearson's correlation coefficient (r) test was used to assess the degree of association between two sets of variables. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:
- Probability (P-value):

– P-value $\leq$0.05 was considered significant.
– P-value $\leq$0.001 was considered as highly significant.
– P-value >0.05 was considered insignificant.

RESULTS:

Sixty patients with sepsis were enrolled in the study (30 ventilated and 30 non ventilated). 45 (75%) of these patients were males, while females were 15(25%). The mean age was (47.40±14.49) years. The mean arterial blood pressure was 62.04±7.57 mmHg. Mean heart rate was 119.68 ±13.78 beat/m and mean respiratory rate was 26.42 ± 5.31 breath / m. Co-morbidity represented 43.3%, most of them were diabetic 26.7%. The most common diagnosis was pneumonia 26%. Mean ICU stay was9.37±3.18 days. A

high mortality rate 80% was found among the study group. The mean CVP was 12.48±3.78 cmH_2O with an IVC dmax of 17.95±3.28 mm, IVC CI was 50.55±11.83% and the mean IAP was 6.47±1.05 cmH_2O.

There was no statistically significant difference between both ventilated and non-ventilated groups as regards age, sex, co-morbidity medical conditions, diagnosis, and outcome. Results also showed no statistically significant difference as regards laboratory investigation, COP, ICU stay, day of examination and APATCH II score. Table (1 & 2), while SOFA score showed highly statistical significant difference between both groups. Table (3)

Table (1): Comparison between ventilated and non-ventilated as regards COP, ICU stay, day of examination and APATCH II score

	Ventilated *(n=30)*	Non-ventilated *(n=30)*	Total *(n=60)*	x2	p-value
COP (litre/minute)					
Low	5 (16.7%)	2 (6.7%)	7 (11.7%)	1.456	0.228
Normal	25 (83.3%)	28 (93.3%)	53 (88.3%)	2.488	0.120
Mean±SD	4.43±0.84	4.71±0.53	4.57±0.71		
Range	2.5-5.5	3.2-5.3	2.5-5.50		
ICU stay (day)					
Mean±SD	8.80±3.29	9.93±3.02	9.37±3.18	1.931	0.170
Range	2-15	5-15	2-15		
Day of examination (day of devoloping sepsis)					
Mean±SD	2.85±1.17	2.60±1.13	2.78±1.64	1.520	0.271
Range	1-6	1-5	1-6		
APACHE II score%					
Mean±SD	53.13±23.02	54.60±17.42	53.87±20.25	0.077	0.782
Range	8-85	24-85	8-85		

COP cardiac output, ICU intensive care unit, APACHE II: Acute Physiology and Chronic Health Evaluation II

Table (2): Comparison between ventilated and non-ventilated as regards laboratory investigations.

Laboratory Investigation	Ventilated *(n=30)*	Non-ventilated *(n=30)*	Total *(n=60)*	t-test	p-value
Total leucocytic count (10^9/ litre)					
Mean±SD	18.80±4.50	17.17±2.69	17.99±3.77	2.884	0.095
Range	13-33	13.5-22	13-33		
c- reactive protein (mg/ litre)					
Mean±SD	181.97±77.16	193.47±52.35	187.72±65.63	0.456	0.502
Range	60-350	108-314	60-350		
Serum Lactic Acid (mmol)					
Mean±SD	3.79±0.73	4.10±0.62	3.94±0.69	3.131	0.082
Range	2.5- 5.2	3- 5.4	2.5-5.4		

Table (3) Comparison between ventilated and non-ventilated as regards SOFA score

	Ventilated *(n=30)*	Non-ventilated *(n=30)*	Total *(n=60)*	t-test	p-value
SOFA score					
Mean±SD	12.37±3.35	2.07±0.25	7.22±5.70	282.402	<0.001**
Range	4-18	2-3	2-18		

SOFA score: Sequential Organ Failure Assessment.

As regards measurements of IVC, CVP, IAP in both ventilated and non-ventilated groups results found no statistically significant difference between both groups. Table (4)

Table (4):Comparison between ventilated and non-ventilated as regards IVC diameter, CVP and IAP

IVC diameter (mm)	Ventilated *(n=30)*	Non-ventilated *(n=30)*	Total *(n=60)*	t-test	p-value
Max					
Mean±SD	18.36±3.61	17.55±2.93	17.95±3.28	0.904	0.346
Range	11-23.7	11.5-22.7	11-23.7		
Min					
Mean±SD	9.16±3.22	8.44±1.98	8.80±2.67	1.091	0.301
Range	5-19.2	5.6-15.2	5-19.2		
Index%					
Mean±SD	50.10±13.87	51.00±9.60	50.55±11.83	0.085	0.771
Range	10-72	22-66	10-72		
CVP (cm H_2O)					
Mean±SD	12.93±3.71	12.03±3.85	12.48±3.78	0.848	0.361
Range	5-23	1-17	1-23		
IAP (cm H_2O)					
Mean±SD	6.70±1.09	6.23±0.97	6.47±1.05	3.072	0.085
Range	5-8	5-8	5-8		

IVC: inferior vena cava, CVP central venous pressure, IAP intra abdominal pressure

The study showed significant positive correlation between CVP and IVC max and CVP also had significant negative correlation with IVC index in ventilated group as well as in non-ventilated group. Table (5&6) diagram (1,2, 3 &4).

Table (5) Correlation between CVP and IVC, in ventilated group.

Ventilated	CVP	
	R	p-value
IVC Max (mm)	0.248	0.018*
IVC Min (mm)	0.099	0.604
IVC Index%	-0.292	0.017*

IVC: inferior vena cava, CVP central venous pressure

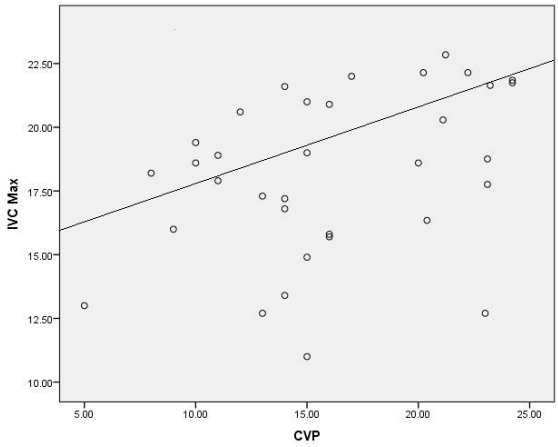

Diagram (1): Scatter plot, between CVP and IVC max, in ventilated group.

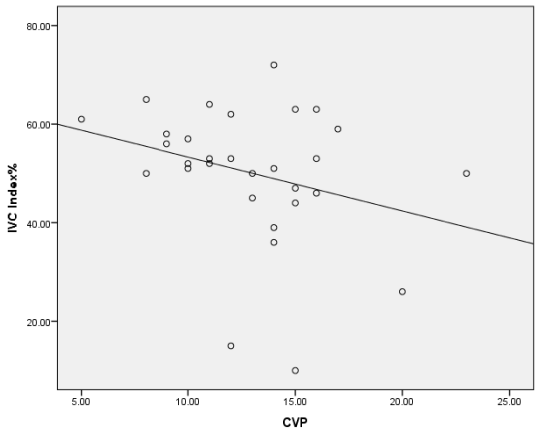

Diagram (2): Scatter plot, between CVP and IVC index%, in ventilated group.

Table (6): Correlation between CVP and IVC in non-ventilated group.

Non-ventilated	CVP	
	R	p-value
IVC Max (mm)	0.268	0.049*
IVC Min (mm)	0.094	0.621
IVC Index%	-0.276	0.048*

IVC : inferior vena cava, CVP : central venous pressure

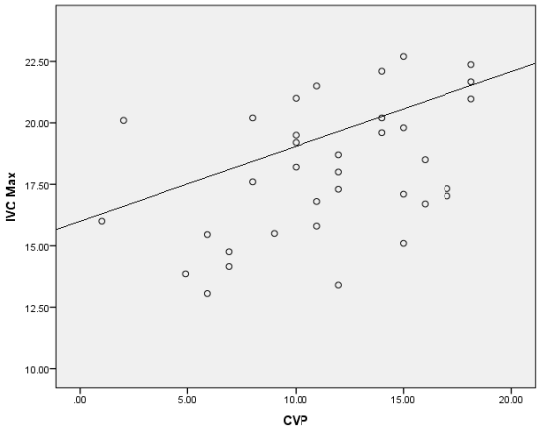

Diagram (3): Scatter plot, between CVP and IVC max, in non-ventilated group.

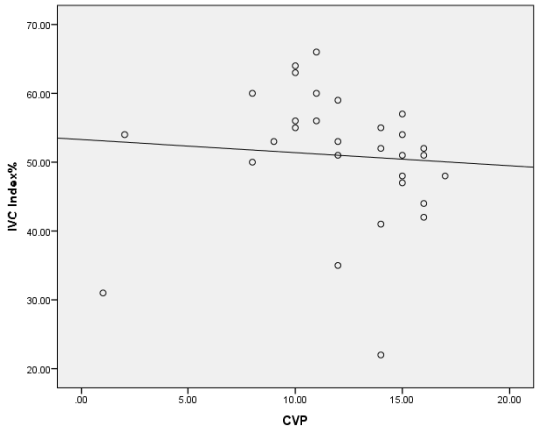

Diagram (4): Scatter plot, between CVP and IVC index%, in non-ventilated group.

Results also found that CVP, IVC dmax and IVC index were significantly different between survivors and non-survivors in both ventilated and non ventilated patients, the higher the values of CVP and IVC dmax and the lower the value of IVC CI, the higher rates of mortality. Table (7) diagram (5).

Table (7): Comparison between patients outcome as regards IVC and CVP in ventilated group.

Ventilated	Outcome		t-test	
	Died *(n=23)*	Survived *(n=7)*	T	p-value
IVC Max(mm)	19.83±3.85	17.80±2.23	2.320	0.097*
IVC Min (mm)	9.53±3.59	7.97±0.83	1.124	0.271
IVC Index%	46.78±14.96	57.43±9.00	-5.941	<0.001**
CVP	13.26±3.99	11.86±2.54	3.872	0.044*

IVC inferior vena cava, CVP central venous pressure.

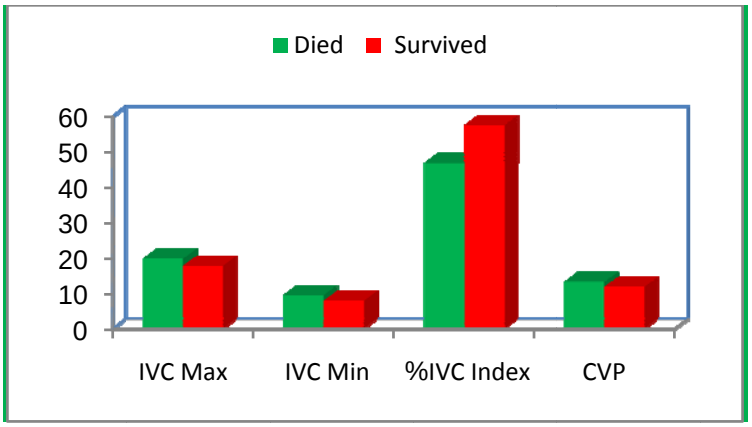

Diagram (5): Comparison between patients outcome as regards IVC and CVP in ventilated group.

The study results statistically significant difference between survivors and non-survivors as regards severity scores (SOFA and APATCH II score) serum lactic acid, pao2/ FiO2 and CRP in both groups and as well as SOFA score in ventilated group Table (8 & 9)

Table (8): Comparison between patients outcome as regards Serum Lactic Acid (mmol), Pao_2 / FiO_2%, CRP and severity scores (APATCH II and SOFA sore) in ventilated group.

Ventilated	Outcome		t-test	
	Non survivor *(n=23)*	Survivor *(n=7)*	t	p-value
Serum Lactic Acid (mmol)	3.93±0.73	2.83±0.56	1.985	0.047*
Pao2 / FiO_2%	129.65±38.72	179.86±54.19	-2.736	0.011*
CRP (mg / litre)	197.91±73.30	129.57±69.97	2.181	0.038*
SOFA score	13.09±3.26	10.00±2.58	2.287	0.030*
APACHE II score%	59.09±21.14	33.57±18.42	2.871	0.008*

po_2: Partial pressure of oxygen, FiO2 fraction of oxygen, *CRP: c-reactive protein* SOFA score: Sequential Organ Failure Assessment, APACHE II: Acute Physiology And Chronic Health Evaluation II

Table (9) Comparison between patients outcome as regards Serum Lactic Acid (mmol), Pao_2 / FiO_2%, CRP and severity index in non-ventilated group.

Non-ventilated	Outcome		t-test	
	Non survivor*(n=25)*	Survivor *(n=5)*	t	p-value
Serum Lactic Acid (mmol)	4.21±0.60	3.04±0.38	2.365	0.025*
Pao_2 / FiO_2%	160.24±53.25	241.20±60.83	-3.038	0.005*
CRP (mg/litre)	207.52±45.12	123.20±15.77	4.079	<0.001**
qSOFA score	2.08±0.28	2.00±0.00	0.637	0.529
APACHE II score%	58.20±16.05	36.60±13.03	2.817	0.009*

po_2:partial pressure of oxygen, CRP: c-reactive protein, FiO2 fraction of oxygen, *CRP: c-reactive protein,* qSOFA score: quick sequential organ failure assessment, APACHE II: Acute Physiology And Chronic Health Evaluation II

DISCUSSION:

Sepsis, a syndrome of physiologic, pathologic, and biochemical abnormalities induced by infection. It is a compact host response to an infecting pathogen. Sepsis is considered a life-threatening condition caused by the response of body tissues and organs to an infection injures[(1)]. Shock is one of the most frequently diagnosed. However it is poorly understood condition in the critically ill patients. There is variable presentation and multifactorial etiology of the term "shock" so, that causes the definition of this term become controversial. The challenge is to avoid organ failure and dysfunction through identification of the hypoperfusion and rapid restore to perfusion state[(11)].

The Surviving Sepsis Campaign Guidelines (SSCG) recommend the use of CVPas a marker of intravascular volume status. Despite CVP is used to assess fluid status, its value as a tool for guiding fluid resuscitation is a matter of debate[(12)].

IVC measured by US represents an effective and non invasive method of estimating CVP. During respiratory cycle measurements the maximum IVC diameter (IVCmax) and the minimum IVC diameter (IVCmin) are recorded. Also, IVC CI can be calculated with the following formula: (IVCmax – IVCmin)/IVCmax [(13)].

The present study included 60 patients with sepsis divided into two groups. (Group A) included 30mechanically ventilated patients and (Group B) included 30 non-mechanically ventilated patients. Both groups were matched for age, sex, co-morbidity, medical conditions initial diagnosis, laboratory investigation and outcome. APATCH II score also, had similar scores for both groups. SOFA score showed significant difference between ventilated and non ventilated group being higher in ventilated group. This is because we used Qs of ascorein non-ventilated group which is calculated by 3 points only (conscious level, blood pressure, respiratory rate). Mechanical ventilation did not affect neither patient's cardiac output nor ICU stay. Pointing to US guided IVC diameter, CVP and IAP, their measurements were not affected by MV.

In the ventilated group there was positive correlation between CVP with IVC max and negative correlation between CVP and IVC index.

Thus the sonographic determination of IVC diameter seems useful in the early assessment of fluid status in mechanically ventilated septic patients as it correlated positively with CVP. Increase IVC dmax correlated with high CVP which sequentially indicates volume overload. IVC-CI > 50% signifies compliant vessel state and a good response to fluid therapy. High CI is often associated with low CVP. Thus it provides a

useful guide for non-invasive intravascular volume status assessment and a possible justification for the beneficial role of giving more fluid without volume overload. These results were in agreement with Karacabey *et al.*[14] who studied the relationship between CVP and IVC in the assessment of intravascular fluid in patients with sepsis. IVC inspiratory measurements showed a statistically significant positive correlation with CVP. While IVC CI measurements showed a negative correlation with CVP. Similarly, *Ilyas et al.*[7] who studied the correlation of IVC diameter and collapsibility index With CVP, results showed positive correlation between CVP and maximum IVC diameter but an inverse correlation with IVC CI. Results also matched with *Thanakitcharu et al.*[15] who studied the IVC diameter and IVC CIin patients with sepsis, results showed a significant positive correlation between CVP and inspiratory IVCD and a significant negative correlation between the CVP and IVC-CI. Conversaly, *Citilcioglu et al.*[9] studied the relationship between IVC diameter measured by bedside US and CVP. Results showed nonsignificant correlation between IVC diameters measured by US at the end of expiration and inspiration and measured CVP values at the same phases. A possible explaination was the limited number of mechanically ventilated patients, different ventilator modes and settings.

In the non-ventilated group a significant positive correlation was found between CVP and sonographic IVC max and negative correlation between CVP and IVC index. In patients with spontaneous breathing, IVC diameter measurement by non-invasive bedside US method provides an idea about CVP. Increase IVC dmax is associated with increase of CVP and fluid overload. Increased IVC-CI is a good sign for fluid reponse and this appears to be negatively correlated best with CVP. High IVC-CI associated with low CVP value. Understanding the changes in IVC diameter and IVC-CI will provide a good clinical adjustment of fluid therapy in spontaneously breathing patients. These results were in accordance with *Mostafa et al.*[16] who studied the correlation between CVP and the diameter of IVC by using US for the assessment of the fluid status among hypovolemic patients. The study showed positive correlation between CVP and IVC dmax (expiration diameter), there was a significant negative correlation between CVP and IVC CI. Similarly, *Worapratya et al.*[17] studied the correlation between CI, IVC, and CVP in shocked patients and found matching results as regards positive correlation between CVP and IVC end expiratory diameter (d max) and negative correlation between CVP and IVC index

In the present study CVP, IVC dmax and IVC index were significantly correlated with the outcome in both ventilated and non ventilated patients, the higher values of CVP and IVC dmax, the higher rates of mortality and poor outcome. Similar results were obtained in the study by *Li et al.*[18] and *Boyd et al.* [19] who found that elevated CVP level correlated with poor outcome and prolonged treatment in critical care settings. Also, *Alsafadi et al.*[20], studied IVC diameter as a predictor of mortality in septic shock. Results demonstrated that increased IVC diameter is a predictor of mortality inseptic shock patients

Besides the sonographic data of IVC and CVP, the study included a comparison between patients outcome in both ventilated and non-ventilated groups as regards namely: severity scores (APATCH II score and SOFA score), serum lactic acid, pao_2/ Fio_2 and CRP. The study showed that APATCH II score, serum lactic acid, pao_2/ Fio_2 and CRP as well as SOFA score in ventilated group were higher in non survivors compared with survivors group and associated with poor outcome and higher mortality rate.

In a study conducted by *sadaka et al*[21] and *Garnacho-Montero et al.*[22]among septic patients. APACHE II score was higher in non survivors than those who survive also. The study considered APACHE II score as the best predictor of hospital mortality in patients with sepsis.

Moreover, *Jone et al.*[23] and *Lie et al.*[24]who studied the SOFA score for predicting outcome in patients with severe sepsis, demonstrated fair to good accuracy for predicting in-hospital mortality total SOFA score of those non-survivors was significantly higher than that of survivors.

Filhoet al.[25], was found that initial blood lactate more than 2.5 mmol/L were at increased risk of death in severe sepsis or septic shock patients, matching with the results of *Tang et al.*[26] whose results showed that severe sepsis patients with lactate levels 2–4 mmol/L had a higher rate of developing an adverse outcome

The study showed higher values of CRP in non survivor group than survivors groups. This matches with *Suhua et al.*[27]who studied the prognostic value of serum CRP, in patients with sepsis. The study found that serum concentrations of CRP in the death group were significantly higher than those of the survivors group. Similarly in another study conducted by *Devran et al.*[28] persistently high CRP values correlate with even poorer outcome. The overall mortality rate had significantly higher CRP levels than survivors.

In conclusion, sonographic assessment of IVC correlated significantly with CVP and outcome in critically ill patients with sepsis. Thus the change in IVC diameter and CI provide a good clinical adjustment for assessment of intravascular volume status and guidance of fluid therapy for critically-ill patients with sepsis

Finally, it is recommended that Intensivists should be encouraged to practice thoracic ultrasound for assessment of IVC in an attempt to accurately and non-invasively monitor the volume state and the responsiveness among critically ill patients in general and in septic patients in particular.

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العلاقة بين قياس قطر الوريد الأجوف السفلى بالموجات فوق الصوتية وقيمة ضغط الوريد المركزى لدى المرضى المصابين بتسمم الدم

ياســـر مصطفـــى محمـــد*وغـادة سميـر الشاهـدو إيمان حسن السيد جلال* و أشـرف عـادل جمعـة* وبسمه ملاك زكي*****

*قسم الامراض الصدريه - كليةالطب- جامعةعين شمس ** قسم القلب والاوعيه الدمويه- كليه الطب –جامعه عين شمس *** مستشفى صدر العباسيه - وزاره الصحه

المقدمه : تعتبر الموجات فوق الصوتية إحدى أدوات الفحص الغيرتداخلية وغير المؤلمة والتي يمكن استخدامها لقياس السوائل المتواجدة بالجسم لدى المرضى المصابين بتسمم الدم.

الهـــدف من الدراســـة : تقييم العلاقة بين قياس قطر الوريد الأجوف السفلى باستخدام الموجات فوق الصوتية وبين ضغط الوريد المركزي في تحديد حجم السوائل المتواجدة بالجسم لدى المرضى المصابين بتسمم الدم.

المرضى وطرق البحث :سيتم إجراء هذه الدراسة لستون مريضاً ممن يعانون من تسمم الدم داخل وحدة العناية المركزة للجهاز التنفسي بمستشفى صدر العباسية من الفتره يناير ٢٠١٨ الى سبتمبر ٢٠١٨ .وتشمل الدراسه مجموعتين(٣٠مريضاً من الخاضعين لجهاز التنفس الصناعى و٣٠ مريضاً يتنفسون بطريقة تلقائية من غير الخاضعين لجهاز التنفس الصناعى) وقد خضع جميع المرضى المشاركين فى الدراسة لتسجيل النوع والعمر والتشخيص ومده البقاءبالمستشفى. وتم قياس العلامات الحيوية (ضغط الدم الشرياني ومعدل ضربات القلب ودرجة الحرارة ومعدل التنفس ومتوسط الضغط الشرياني) .وتسجيل الاختبارات المعملية(صورة دم كاملة وحامض اللاكتيك في الدم والبروتين التفاعلى سى). وايضا تسجيل مقياس فشل الأعضاء المتتابع ومقياس تقييم الحالة الصحية فى الأمراض المزمنة والحادة .واخيرا تم قياس قطر الوريد الأجوف السفلى باستخدام الموجات فوق الصوتية أثناء الشهيق والزفير وقياس ضغط الوريد المركزى في وضع الاستلقاء وايضا قياس الضغط داخل البطن.

النتائج :شملت الدراسة ٤٥ ذكورو ١٥ إناث ،بمتوسط عمر٤٧,٤ سنه. وقد كان متوسط ضغط الوريدى المركزي ١٢.٤٨±٣.٧٨سم مائي, متوسط قطر الوريد الأجوف السفلي١٧.٩٥ ± ٣.٢٨ ميواخيرا متوسط مؤشر الوريد الأجوف السفلى ٥٠.٥٥ ± ١١.٨٣وكان هناك علاقة إحصائية ايجابيه ذات دلالة بين قياس ضغط الوريدى المركزي وقطر الوريد الأجوف السفلي وعلاقة احصائيه سلبية ذات دلالة إحصائية بينقياس ضغط الوريدالمركزي ومؤشر الوريد الأجوف السفلى في كل من المجموعتين . وايضا زياده قياس ضغط الوريد المركزي وقطر الوريد الأجوف السفلي قد ارتبطت بشكل ايجابي بارتفاع معدل الوفيات .

الاستنتاج : يعتبر استخدام الموجات فوق الصوتية لقياس قطر الوريد الأجوف السفلى ومؤشر الوريد الاجوف السفلي من الطرق البسيطة لتقييم حالة السوائل بالجسم في المرضى الذين يعانون من تسمم الدم.