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Comparison of accuracy of central venous pressure (CVP) estimation in internal jugular vein (IJV) by ultrasound and conventional method (using saline column): An observational study

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Abstract

Aim & background: Central venous pressure (CVP) is needed in acute resuscitation and in intensive care unit patients to monitor hemodynamics and to guide fluid resuscitation.

The primary objective of our study is to compare the ultrasound (USG) guided measurement of CVP with conventional measurement of CVP using saline column.

Methods: The study is Prospective observational study. The study was conducted at a tertiary care teaching hospital from February 2020 to December 2021.

245 patients were included in this study using convenient sampling technique.

The primary measure in this study is to assess whether the accuracy of USG measurements (non invasive) of CVP is as good as conventional measurements (invasive) of CVP using saline column method.

Results: The CVP measurements measured invasively and non invasively were categorized as below normal, normal, and above normal. Using CVP (saline) as the gold standard, for CVP (USG) and CVP (saline) a 3 x 3 contingency table had been made. To compare the diagnostic accuracy between CVP(Saline) and CVP(USG) where the measurements were categorised, Kappa statistics has been used to measure the agreement between the two {CVP (saline) and CVP (USG)}. The Kappa value was found to be around 96.33% and after weightage was 97.96% which was almost perfect agreement.

Conclusion: Based on our study, we conclude that the USG guided measurement of CVP is as good as conventional measurement of CVP using saline column.

Keywords: Central venous pressure; Ultrasound; Internal jugular vein; Resuscitation

1. Introduction

Central venous pressure monitoring is crucial in emergency department to assess volume status of the critically ill patients[1]. Central venous pressure is needed in acute resuscitation and in intensive care unit patients to monitor hemodynamics and to guide fluid resuscitation which is important to maintain adequate tissue perfusion[2].

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Central venous pressure can be measured invasively and non invasively. The standard practice to measure central venous pressure is by placing a central venous catheter in the right internal jugular vein and by using the water column method we measure central venous pressure which is an invasive method of central venous pressure measurement. Central venous pressure can also be measured by clinical examination of the neck by determining the height of internal jugular vein pulsation which is a commonly applied non invasive strategy to measure central venous pressure bedside[3,4,5,6].

Intravascular volume can also be assessed by newer methods like bioimpedance, ultrasonography and by using biomarkers like NT pro BNP, hematocrit. However, comparing these methods, ultrasonography can rapidly assess intravascular volume status than the other two methods[5].

Our current practice relies on ultrasonographic assessment of IVC (inferior vena cava) as a non-invasive technique to estimate CVP (central venous pressure). But its validity and reliability is questionable and it is extremely difficult to assess IVC in obese patients, patients who has undergone major abdominal surgeries, trauma and in those who has subcostal midline chest drainage tubes[2,3]. The IJV (internal jugular vein) is easily accessible for sonographic evaluation when compared to IVC[3]. The CVP measured from IJV by physical examination has many shortcomings like lack of precision and accuracy- particularly in obese and elderly population, uncertainty in determining the true top of JVP (jugular venous pulse), variations in neck morphology which increases the difficulty in visualizing venous pulsations transmitted to the overlying skin[4,5]. The ultrasonographic assessment of the height of IJV has been described in literature but has not been well validated[4].

Advantages of ultrasound technique to measure CVP:

- It is rapid,
- complications of central venous catheterisation like arterial puncture, pneumothorax and arrhythmias are not seen with this technique[7].

Disadvantages of ultrasound technique to measure CVP:

- It requires proper training to learn and master the technique,
- Ultrasound machines are costly and not available in all centers.

Prospective observational studies done around the world have shown that the non invasive measurement of central venous pressure with ultrasound is as good as invasive measurement of central venous pressure by placing a central venous catheter in the right internal jugular vein. But all those studies have less sample size, none of them were done in the emergency department and very few studies were done in India[8,9].

In our study, our primary objective is to assess whether the accuracy of ultrasonographic assessment of central venous pressure is as good as conventional assessment of central venous pressure using saline column.

2. Materials and methods

The study was conducted at JIPMER, a tertiary care teaching hospital, located in South India. The duration of the study was from February 2020 to December 2021.

2.1. Study design

Prospective observational study to assess diagnostic accuracy

2.2. Study participants

Humans

2.2.1. Inclusion criteria

Patients older than 18 years of age who underwent central venous catheterization in JIPMER Emergency Department resuscitation area.

2.2.2. Exclusion criteria

- Patients on mechanical ventilation

- Any type of defect at the site of sonography
- Pregnancy
- Tricuspid regurgitation
- Pulmonary hypertension
- Unable to hold breath
- Younger than 18 years
- Cervical or mediastinal masses
- Proximal venous thrombosis

Informed consent was obtained from all individual participants included in the study

2.3. Sampling

2.3.1. Sampling population

All patients older than 18 yrs of age who underwent central venous catheterization in JIPMER Emergency Department resuscitation area.

2.3.2. Sample size calculation

Considering the sensitivity of ultrasound estimation of CVP using IJV to be 64.3%, sample size was calculated using nMaster software for diagnostic tests – estimating sensitivity of new test keeping absolute precision as 6% as 245. Therefore we recruited 245 individuals into my study.

2.3.3. Sampling technique

Convenient sampling technique

2.4. Study procedure

All patients older than 18 years of age who satisfied inclusion and exclusion criteria were included in this study. Considering the conventional method of CVP measurement using saline column as Gold standard, the CVP was measured using the conventional method and ultrasonographic method applying convenient sampling technique[10]. Initially, the position of the saline column in the central venous catheter was adjusted so that the 3-way locker was at the same level of the cavity of right atrium (5 cm below the angle of Louis). After which 0.9% NS was guided into one of the locker ways to feed the column. Then the 3-way locker was turned in such a way so that the NS solution column empties into the jugular catheter. When the equilibrium is attained, the level at which the NS solution column stopped was taken as CVP. The CVP value (cm H_2O) was recorded as CVP(saline)[11].

After which CVP was measured noninvasively using ultrasound with the patient lying at 45° reverse Trendelenberg position. The collapsing point of the IJV was detected using ultrasound in both longitudinal and transverse view. In the longitudinal view, the average point of IJV oscillation was marked on the neck. With the lowest pressure possible, the ultrasound probe was applied with a large amount of gel on the skin and the height (vertical distance) was measured between the point of collapse and the angle of Louis. After which the CVP was measured by adding 5cm (the mean distance from the cavity of the right atrium to the angle of Louis) to the measured vertical distance of the IJV[3,11]. This CVP value was recorded as CVP(USG).

These central venous catheter placements and measurements were done by emergency medicine physicians.

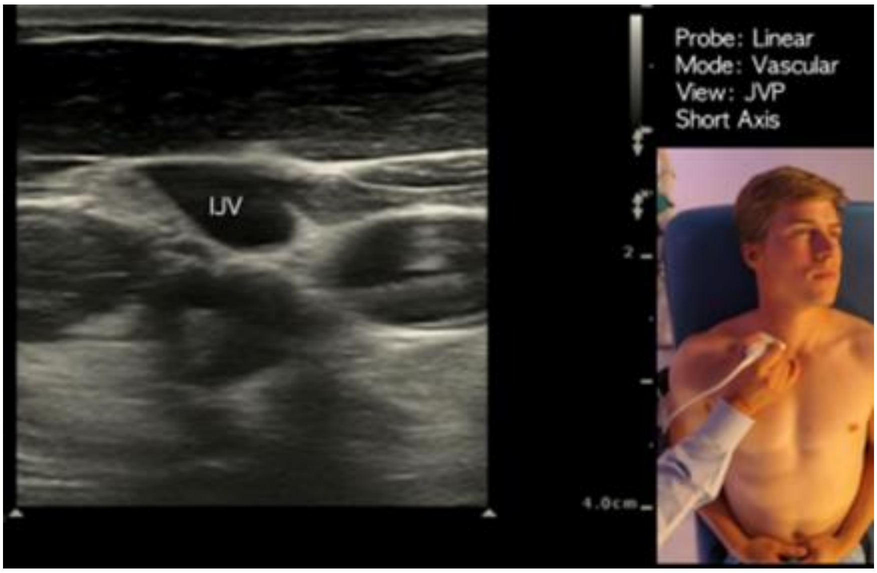

Figure 1 In the above picture, the patient is lying down at 45° reverse Trendelenberg position and the internal jugular vein is visualized using the ultrasound probe.

Figure 2 Internal jugular vein in longitudinal view

Figure 3 Internal jugular vein in transverse view

The arrow mark in figure 2 and 3 indicate the collapsing point of internal jugular vein.

2.5. Data collection methods including settings and periodicity

Data is collected based on clinical and demographic proforma, in hospital settings and the CVP was measured once by both methods.

2.6. List of variables and their measurement methods with standardization techniques

2.6.1. Independent variables

- Age
- Gender
- BP
- Pulse
- Respiratory rate
- MAP
- Diagnosis
- Spo2

- Height
- Weight
- BMI
- Neck girth (measured at the level of cricoid cartilage)

2.6.2. Outcome variables

- CVP (USG)
- CVP (saline)

2.7. List variable wise statistical tests to be used for data analysis

Continuous variables like age, blood pressure, pulse, respiratory rate, mean arterial pressure, SpO_2, height, weight, BMI and neck girth were expressed as mean with standard deviation or median with Interquartile range after checking for the normality. BMI was categorized according to Asia-Pacific BMI category. Categorical variables like gender, diagnosis were summarized as frequencies with proportions. The primary outcome variables, the central venous pressure measurement obtained using the new test (USG guided), and the reference test (saline column) was categorized into 3 categories- below normal (<8 cm H2O), above normal (>12 cm H2O) and normal (8 to 12 cm H_2O). Then a 3 x 3 table was made keeping CVP measured using central venous catheter as a gold standard. Then by using Kappa statistics we tried to study whether CVP measured using USG was as good as CVP measured using central venous catheter. All the data was entered in Epicollect5 software and analyzed using SPSS v19.

3. Results

This study was a single-center, prospective observational study conducted in the Department of Emergency Medicine, JIPMER, Pondicherry, India from February 2020 to December 2021. 245 patients who presented to the Emergency Medicine department were included in the study taking into account inclusion and exclusion criteria.

All the data was entered in Epicollect5 software and analyzed using SPSS v19.

3.1. Independent variables of the study

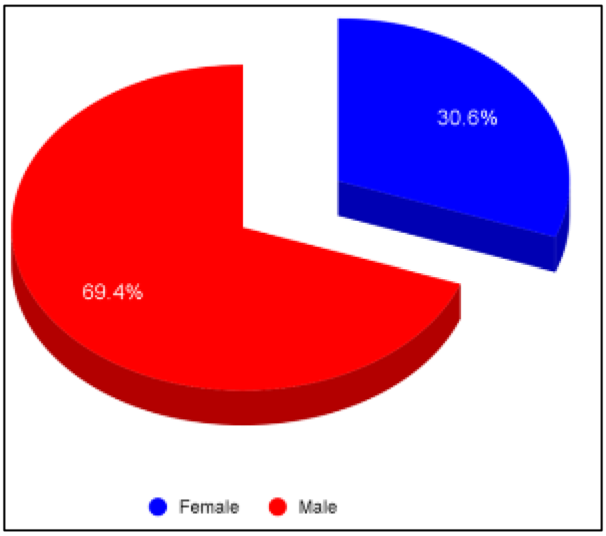

Figure 4 Gender distribution of the study population (n = 245)

This study included 245 patients. Figure 4 shows the gender distribution in our study subjects. Among the 245 patients included in the study, 170(69.39%) were males and 75(30.61%) were females.

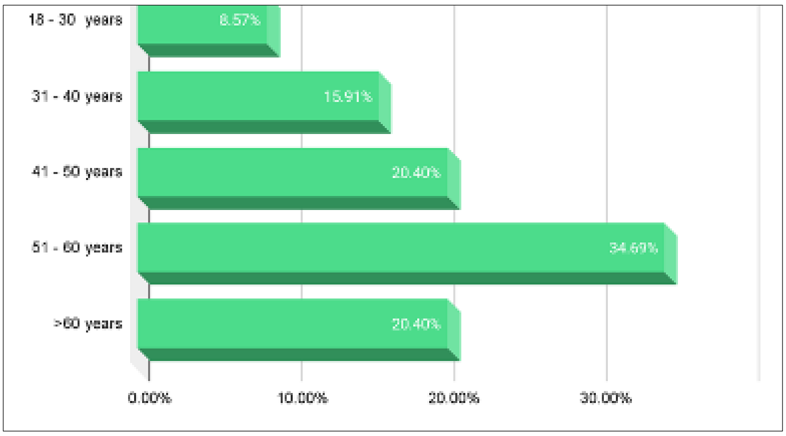

Figure 5 Age distribution of the study participants (n=245)

Figure 5 shows the age group distribution of the patients included in the study. The mean age (in years) of the patients included in this study was 51 ±14.35. The 51 - 60 years age group constituted around 34.69% followed by 41 - 50 years and > 60 years, both constituted around 20.4% each.

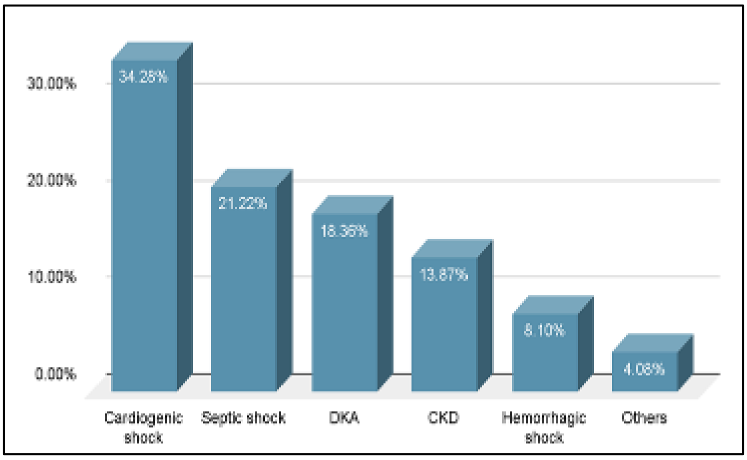

Figure 6 Distribution of diagnosis in the study participants (n=245)

Figure 6 shows the distribution of diagnosis in patients presenting to ED who have been included in this study. Among the 245 patients, the proportion of cardiogenic shock was 34.28%, septic shock was 21.22%, DKA was 18.36%, CKD was 13.87%, hemorrhagic shock was 8.1% and others were 4.08%.

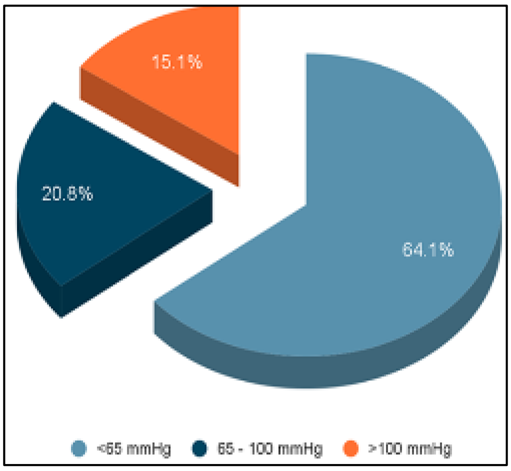

Figure 7 MAP distribution of the study participants (n=245)

Figure 7 depicts the distribution of mean arterial pressure (MAP) in the study participants. The mean MAP (in mmHg) of the patients included in this study was 72.04 ±31.09. Patients with MAP <65mmHg constituted around 64.08% followed by the group 65 - 100 mmHg which constituted around 20.81%.

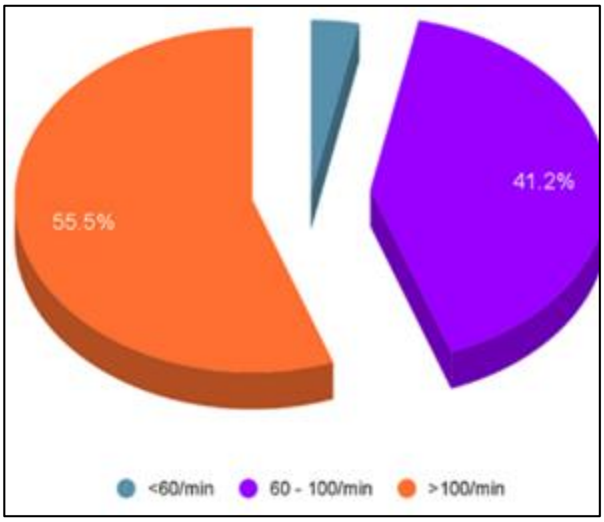

Figure 8 Distribution of pulse rate in the study participants (n=245)

Figure 8 depicts the distribution of pulse rate in the study participants. The mean pulse rate (beats per minute) of the patients included in this study was 103 ±21. Patients with pulse rate >100/min constituted around 55.51% followed by 60 - 100/min which constituted around 41.22%.

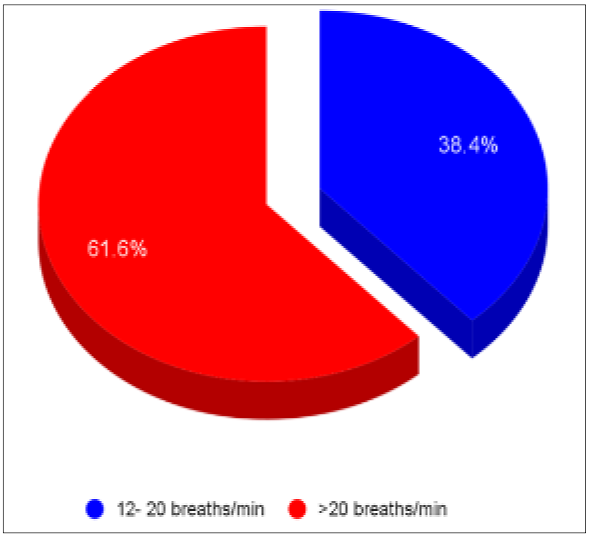

Figure 9 Distribution of respiratory rate in the study participants (n=245)

Figure 9 depicts the distribution of respiratory rate in the study participants. The mean respiratory rate per minute of the study participants was 28 ± 8. 61.63% of patients had respiratory rate > 20/minute and 38.36% had respiratory rate in the range of 12 - 20/minute.

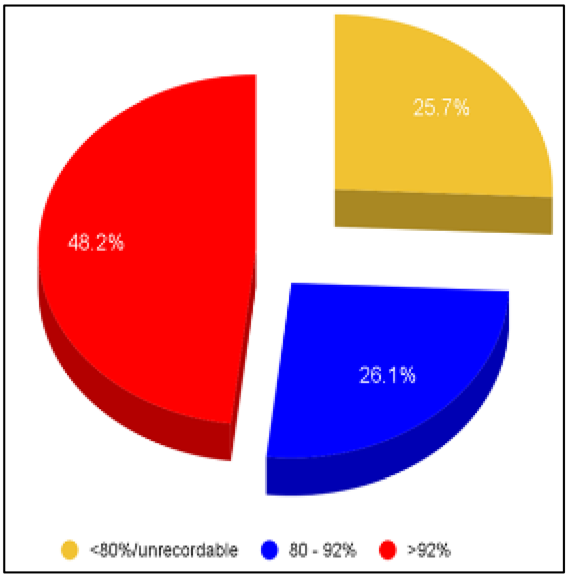

Figure 10 Distribution of SPO2 in the study participants (n=245)

Figure 10 shows the SPO2 of the patients included in this study. The mean SPO2 (%) of the study population was 92.97 ±6.14. In the study population 48.16% had SPO2 >92% and 26.12% had SPO2 between 80 - 92%.

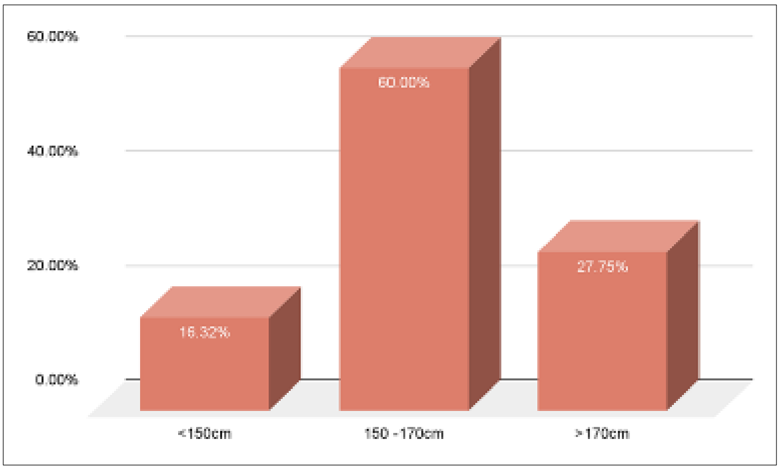

Figure 11 Distribution of height in the study participants (n=245)

Figure 11 depicts the height of the study participants. The mean height (in cm) of the patients included in this study was 163.91 ±7.03. Patients with height in the range of 150 -170 cm constituted around 60% of the study population and patients with height >170cm constituted around 27.75%.

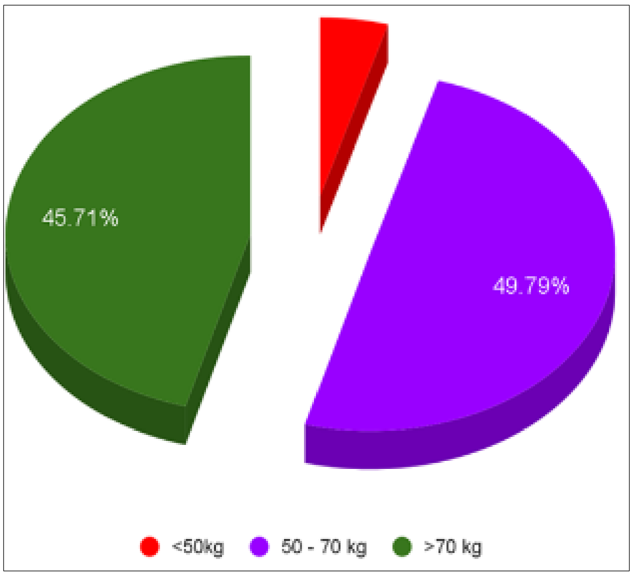

Figure 12 Distribution of weight in the study participants (n=245)

Figure 12 shows the weight of the patients included in this study. The mean weight (in kg) of the study population was 66.66 ±7.57. About 49.79% patients had weight in the range of 50 - 70 Kg followed by 45.71% of patients had weight >70Kg.

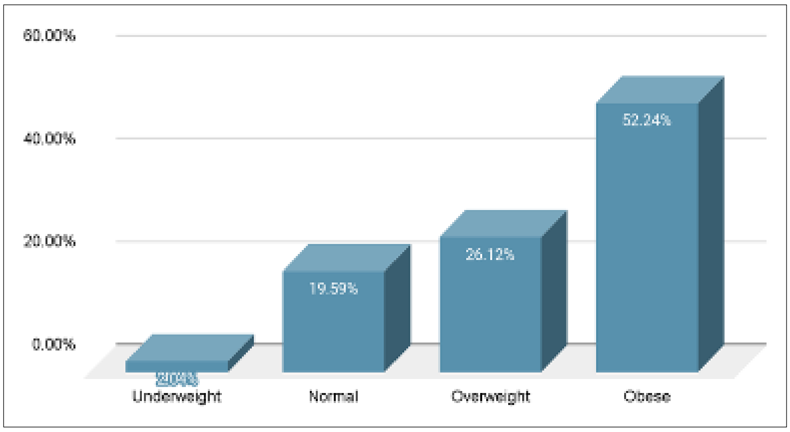

Figure 13 Distribution of BMI in the study participants (n = 245)

Figure 13 shows the BMI of the study participants. About 52.24% study participants were obese and 26.12% of study participants were overweight.

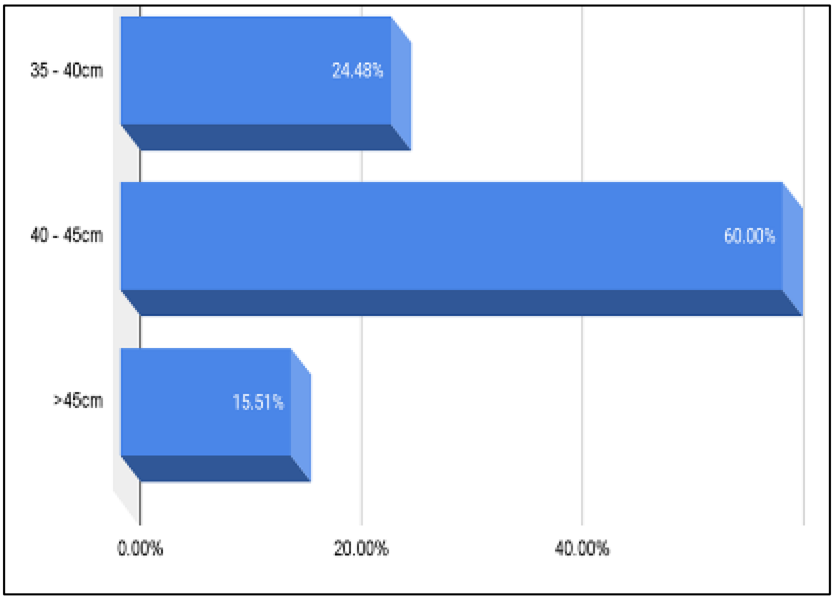

Figure 14 Distribution of neck girth in the study participants (n = 245)

Figure 14 shows the neck girth of patients included in this study. The mean neck girth (in cm) of the study population was 42.77 ±3.01 cm. About 60% of patients had neck girth in the range of 40 - 45cm followed by 24.48% of patients had neck girth in the range of 35 - 40cm.

3.2. Outcome variables of the study

The CVP (saline) measured was below normal (less than 8cmH2O) in 23.67 % of the study population, normal (8 to 12 cm H2O) in 18.78% of the study population and above normal (more than 12cm H2O) in 57.55% of study population (Table 1).

Table 1 CVP (saline) distribution of the study participants (n=245)

CVP (saline)	Frequency	Percent (%)
Below normal	58	23.67
Normal	46	18.78
Above normal	141	57.55
Total	245	100

The CVP (USG) measured was below normal in 24.49 % of the study population, normal in 17.96% of the study population and above normal in 57.55% of the study population (Table 2).

Table 2 CVP (USG) distribution of the study participants (n=245)

CVP (USG)	Frequency	Percent (%)
Below normal	60	24.49
Normal	44	17.96
Above normal	141	57.55
Total	245	100

Using CVP (saline) as the gold standard, for CVP (USG) and CVP (saline) a 3 x 3 contingency table had been made (Table 3). To compare the diagnostic accuracy between CVP(Saline) and CVP(USG) where the measurements were categorized (as normal, above normal and below normal), Kappa statistics has been used to measure the agreement between the two {CVP (saline) and CVP (USG)}. The Kappa value was found to be around 96.33% and after weightage was 97.96% which was almost perfect agreement.

Table 3 Cross tabulation of CVP measured using conventional and non- invasive method (n=245)

CVP (SALINE)		**CVP (USG)**		
	Below normal	**Normal**	**Above normal**	**Total**
Below normal	56	1	1	58
Normal	4	41	1	46
Above normal	0	2	139	141
Total	60	44	141	245

4. Discussion

Evaluation of volume status is an important part in the treatment of critically ill patients. Estimating fluid volume status by clinical examination is essential, but it is inaccurate at times[12,13,14]. Measurement of CVP directly via a central venous catheter (CVC) which is invasive is still being followed in many clinical scenarios for an accurate evaluation. But invasive means of measuring CVP by placing a central venous catheter is potentially dangerous because of the risks of infection and bleeding[15,16]. The ultrasonographic assessment of the height of IJV has been described in literature but has not been well validated[4]. So, we did this study to assess whether the accuracy of ultrasonographic assessment of central venous pressure is as good as conventional assessment of central venous pressure using saline column.

In the literature, the studies on central venous pressure measurement has been done in the intensive care unit and none of the studies has been done in the emergency department. Most of the studies have been carried out in other countries and not much studies have been conducted in our India. Hence, we conducted a study to compare the measurement of central venous pressure using the standard water column method and ultrasound method in the Department of Emergency Medicine in a tertiary care hospital in India.

The mean age (in yrs) of the patients included in our study was 51 ±14.35,which was similar to the previous studies. A prospective observational study done in 2019 in Qatar to study IVC and IJV collapsibility index had mean age of 54.34±16.61 years[17]. Another prospective observational trial in 2014, in USA to study the femoral or internal jugular vein collapsibility had mean age (in years) of 54.1±16.9[18]. Another prospective observational study done in 2014 in China to study the IVC diameter and CVP measurement had mean age (in years) group of 50.8 ± 11.2[19]. This was because increasing age increases the risk of developing acute MI resulting in cardiogenic shock, CKD, diabetes mellitus and sepsis[20].

In our study, 69.39% of study participants were males. The male proportion was high in our studies which was comparable to other studies. A prospective observational study done in 2013, in the United States to study inferior vena cava collapsibility with central venous pressure had 64.6% male population and 35.4% female population[21]. A prospective observational study done in India, in 2016, to study CVP using near infrared spectroscopy (NIRS) had 70.3% males[22]. A prospective observational study done in 2007, in Switzerland, to study CVP using central venous catheter and USG had 62% males[23]. This was because male gender is a risk factor for developing Acute MI resulting in cardiogenic shock[24,25].

In our study, 34.28% of patients had cardiogenic shock. The proportion of cardiac illness was more in our study population. This was because our country has one of the highest burdens of cardiovascular disease in the world[26]. The higher proportion of cardiac illness in our study was comparable to other studies. A prospective observational study done in 2007, in Switzerland, to study CVP using central venous catheter and USG had 44% patients with cardiac illness[23]. A prospective observational study was done in England in 2004 to measure CVP invasively and non invasively using ultrasonography had 40.62% patients with critical cardiac illness[1]. Another prospective observational study done in 2012, in Switzerland for comparison of noninvasive, bedside ultrasound methods for assessing central venous pressure had 50.6% cases of cardiac illness[27].

The mean MAP in our study participants was 72.04 ± 31.09 mmHg. This was because in our study we included both the patients with low BP(cardiogenic shock, septic shock, hemorrhagic shock) and high BP (CKD). The mean MAP obtained in our study was comparable to other studies. A study done in 2019 in Qatar to analyze the relationship between internal jugular vein, inferior vena cava and central venous pressure in which the mean MAP was 73.13±20.21 mmHg in patients with CVP ≤ 10 mmhg and 68.15±18.17 mmHg in patients with CVP > 10 mmhg[17]. A prospective observational study, done in Iran, in 2016 to assess IJV/CCA cross-sectional area ratio and CVP had mean MAP 70.57± 29.09 mm Hg[7]. A prospective observational study done in 2015, in Germany to study IJV ultrasonography and CVP had mean MAP of 67mm Hg[28].

The mean heart rate per minute in our study was 103.64 ± 21.36. This was similar to other studies. A prospective observational study, done in Iran, in 2016 to study IJV/CCV cross sectional area and CVP had 101.12 ± 21.60 as mean heart rate per minute[7]. This was similar to our study, because they included most of the patients with shock, so there was compensatory tachycardia.

In our study the CVP values were summarized in 3 categories - above normal (>12cmH2O), below normal (<8cmH2O) and normal (8-12 cm H2O). Since we had to compare the diagnostic accuracy of tests which were in categories, here we used Kappa statistics -which measured the agreement between the two. The Kappa value was found to be 97.96% after weightage which was in almost perfect agreement. The final result was as we expected when we started the study.

This was similar to other study results. A prospective observational study was done in Germany in 2015 to determine the use of ultrasonography of the internal jugular vein (IJV) to estimate high or low central venous pressure values in patients who were on mechanical ventilation. In that study it was concluded that the calculation of high or low central venous pressure values by internal jugular vein ultrasonography in various patient positions could be an useful instrument for a quick hemodynamic assessment of the critically ill patients[28].

A prospective observational study was done in China, in 2015, in 76 patients, to measure the degree of correlation between central venous pressure measured invasively by placing a central venous catheter in the right internal jugular vein and non invasively by doing ultrasound in the right internal jugular vein. They finally concluded that the non invasive ultrasound measurement of central venous pressure was as good as conventional measurement of central venous pressure using a central venous catheter[9].

A prospective observational study, done in Malaysia, in 2015, in 25 patients to assess the correlation between IJV height and CVP measured by invasive central venous access had found that the measurement of IJV height using USG correlated well with the invasive central venous pressure measurement[29].

An observational study was done in 2016, in Iran, in 20 shock patients to assess central venous pressure using central venous catheterisation and by ultrasound measurement of central venous pressure using internal jugular vein and inferior vena cava. In that study, they concluded that the non invasive measurement of central venous pressure with ultrasound was as good as invasive measurement of central venous pressure by placing central venous catheter in right internal jugular vein[8].

A prospective observational study, done in 2018, in France, in 22 patients to assess CVP measured using the central venous catheter and USG in right IJV had concluded that the noninvasive measurement of CVP using USG in right IJV was as good as invasive measurement of CVP using central venous catheter in right IJV[5].

In our study, we did not include the patients on mechanical ventilation. So, our results may not be applicable on patients with mechanical ventilation.

5. Conclusion

Based on the study, we conclude that the USG guided measurement of CVP is as good as conventional measurement of CVP using saline column.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Scientific and ethical approval for the conduct of the study was reviewed and approved by Institute Ethics Committee (IEC), Human studies, JIPMER.

Statement of informed consent

Verbal and written consent was obtained from all individual participants included in the study.

References

[1] Baumann UA, Marquis C, Stoupis C, et al. Estimation of central venous pressure by ultrasound. Resuscitation 2005, 64:193.

[2] Bigatello LM, George E. Hemodynamic monitoring. Minerva Anestesiol. 2002 Apr, 68(4):219–25.

[3] Siva B, Hunt A, Boudville N. The sensitivity and specificity of ultrasound estimation of central venous pressure using the internal jugular vein. J Crit Care. 2012, 27:315.e7–11

[4] Donahue SP, Wood JP, Patel BM, Quinn JV. Correlation of sonographic measurements of the internal jugular vein with central venous pressure. The American Journal of Emergency Medicine. 2009, 27:851–5.

[5] Kerleroux B, Pasco J, Dupuis M, Eustache M, Lemrabott A, Jouzel C, et al. Ultrasonographic assessment of the internal jugular vein for the estimation of central venous pressure in hemodialysis patients: A preliminary study. J Clin Ultrasound. 2018, 46:253–8.

[6] Mackenzie DC, Noble VE. Assessing volume status and fluid responsiveness in the emergency department. Clin Exp Emerg Med. 2014, 1:67–77.

[7] Hossein-Nejad H, Mohammadinejad P, Ahmadi F. Internal jugular vein/common carotid artery cross-sectional area ratio and central venous pressure: IJV/CCA and CVP. J Clin Ultrasound. 2016, 44:312–8.

[8] Abbasian A, Feiz Disfani H, Afzalimoghaddam M, Talebian MT, Masoumi B, Nasr-Esfahani M. Measurement of Central Venous Pressure Using Ultrasound in Emergency Department. Iran Red Crescent Med J. 2015 Dec, 17(12):e19403

[9] Xing C-Y, Liu Y-L, Zhao M-L, Yang R-J, Duan Y-Y, Zhang L-H, et al. New method for noninvasive quantification of central venous pressure by ultrasound. Circ Cardiovasc Imaging. 2015 May, 8(5):e003085.

[10] Berlin DA, Bakker J. Starling curves and central venous pressure. Crit Care. 2015 Feb 16, 19:55.

[11] Keller AS, Melamed R, Malinchoc M, John R, Tierney DM, Gajic O. Diagnostic accuracy of a simple ultrasound measurement to estimate central venous pressure in spontaneously breathing, critically ill patients. J Hosp Med. 2009 Jul, 4(6):350–5.

[12] Cook DJ. Clinical assessment of central venous pressure in the critically ill. Am J Med Sci. 1990 Mar, 299(3):175–8.

[13] Connors AF, McCaffree DR, Gray BA. Evaluation of right-heart catheterization in the critically ill patient without acute myocardial infarction. N Engl J Med. 1983 Feb 3, 308(5):263–7.

[14] Eisenberg PR, Jaffe AS, Schuster DP. Clinical evaluation compared to pulmonary artery catheterization in the hemodynamic assessment of critically ill patients. Crit Care Med. 1984 Jul, 12(7):549–53.

[15] Karakitsos D, Labropoulos N, De Groot E, Patrianakos AP, Kouraklis G, Poularas J, et al. Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients. Crit Care. 2006, 10(6):R162.

[16] Maecken T, Grau T. Ultrasound imaging in vascular access. Crit Care Med. 2007 May, 35(5 Suppl):S178-185.

[17] Jassim HM, Naushad VA, Khatib MY, Chandra P, Abuhmaira MM, Koya SH, et al. IJV collapsibility index vs IVC collapsibility index by point of care ultrasound for estimation of CVP: a comparative study with direct estimation of CVP. Open Access Emerg Med. 2019, 11:65–75.

[18] Pourmand A, Pyle M, Yamane D, Sumon K, Frasure SE. The utility of point-of-care ultrasound in the assessment of volume status in acute and critically ill patients. World J Emerg Med. 2019, 10(4):232–8.

[19] Zhang X, Luan H, Zhu P, Feng J, Cui J, Zhao Z. Does ultrasonographic measurement of the inferior vena cava diameter correlate with central venous pressure in the assessment of intravascular volume in patients undergoing gastrointestinal surgery? Journal of Surgical Research. 2014 Oct 1, 191(2):339–43.

[20] Long A, Long B, Koyfman A. Non-traditional risk factors for atherosclerotic disease: A review for emergency physicians. Am J Emerg Med. 2018 Mar, 36(3):494–7.

[21] Stawicki SPA, Adkins EJ, Eiferman DS, Evans DC, Ali NA, Njoku C, et al. Prospective evaluation of intravascular volume status in critically ill patients: does inferior vena cava collapsibility correlate with central venous pressure? J Trauma Acute Care Surg. 2014 Apr, 76(4):956–63, discussion 963-964.

[22] Sathish N, Singh NG, Nagaraja PS, Sarala BM, Prabhushankar CG, Dhananjaya M, et al. Comparison between noninvasive measurement of central venous pressure using near infrared spectroscopy with an invasive central venous pressure monitoring in cardiac surgical Intensive Care Unit. Ann Card Anaesth. 2016 Sep, 19(3):405–9.

[23] Thalhammer C, Aschwanden M, Odermatt A, Baumann UA, Imfeld S, Bilecen D, et al. Noninvasive Central Venous Pressure Measurement by Controlled Compression Sonography at the Forearm. Journal of the American College of Cardiology. 2007 Oct 16, 50(16):1584–9.

[24] Albrektsen G, Heuch I, Løchen M-L, Thelle DS, Wilsgaard T, Njølstad I, et al. Lifelong Gender Gap in Risk of Incident Myocardial Infarction: The Tromsø Study. JAMA Internal Medicine. 2016 Nov 1, 176(11):1673–9.

[25] Mayr FB, Yende S, Angus DC. Epidemiology of severe sepsis. Virulence. 2014 Jan 1, 5(1):4–11.

[26] Huffman MD, Prabhakaran D, Osmond C, Fall CHD, Tandon N, Lakshmy R, et al. Incidence of Cardiovascular Risk Factors in an Indian Urban Cohort. J Am Coll Cardiol. 2011 Apr 26, 57(17):1765–74.

[27] Uthoff H, Siegemund M, Aschwanden M, Hunziker L, Fabbro T, Baumann U, et al. Prospective Comparison of Noninvasive, Bedside Ultrasound Methods for Assessing Central Venous Pressure. Ultraschall in Med. 2012, 33:E256–62.

[28] Hilbert T, Ellerkmann RK, Klaschik S, Putensen C, Thudium M. The Use of Internal Jugular Vein Ultrasonography to Anticipate Low or High Central Venous Pressure During Mechanical Ventilation. Journal of Emergency Medicine. 2016, 50:581–7.

[29] Nik Muhamad NA, Safferi RS, Robertson CE. Internal Jugular Vein Height and Inferior Vena Cava Diameter Measurement using Ultrasound to Determine Central Venous Pressure: A Correlation Study. Med J Malaysia. 2015 Apr, 70(2):63–6.

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