

Comparison of IVC Diameter and Pro-BNP for Judicious use of IV Fluids in Critical ill Patients on IPPV

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ABSTRACT

Aim: To compare the diameter of IVC and levels of Pro-BNP for use of IV fluids in critical ill patients on IPPV

Study Design: Descriptive cross sectional study

Place and duration of study: At the department of Critical Care Medicine the Services hospital, Lahore from April 2021 to March 2022

Methodology: The study was conducted after the approval of hospital ethical committee and from each patient written consent form was also obtained we enrolled 77 patients in our study after fulfilling of inclusion criteria. The base line and echocardiographic characteristics were analyzed including NT-proBNP and inferior vena cava diameter. IVC diameter was determined with the help of echocardiography. NT-proBNP was determined with the help of ELISA kit. For statistical analysis we used SPSS 23 version. Pearson correlation test was also used to check the relation between NT-proBNP and inferior vena cava diameter. Correlation was significant at $p < 0.05$.

Results: The mean age of patients was 62.06 ± 7.54 . 37 (48.1 %) were male and 40 (51.9 %) were female. The results of brain natriuretic peptide (pg/mL) was 280.58 ± 40.82 and NT-proBNP (pg/mL) was 1981.25 ± 278.88 . The Inferior Vena Cava size was 1.86 ± 0.77 cm. The results of correlation was significant ($p < 0.01$) in between the inferior vena cava size and NT-proBNP. The value of correlation was 0.753.

Conclusion: Natriuretic peptides are linked to IVC size in patients with congestive heart failure. These findings imply that left-sided echocardiography and the biomarker assessment have a complimentary purpose. IVC diameter can be beneficial in assessing volume status and discriminating between congestion and non-congestion heart failure.

Keywords: IVC diameter, levels of Pro-BNP, IV fluids, IPPV

INTRODUCTION

Globally, congestive cardiac failure (CCF) is the major cause of morbidity and death. Over 1,000,000 individuals are admitted with this diagnosis each year in the United States, and 5,000,000 people live with the condition, at a cost of \$27.9 billion dollars, making it the most expensive Medicare expense.^(1,2)

ProBNP is crucial in heart failure diagnosis, also in admitted patients of CCF on IPPV. Obtaining a sequence of pro-BNP measures in patients with CCF is beneficial during follow-up.⁽³⁾

The diameter of the IVC is a symptom of venous congestion. The diameter of the IVC may also be a sign of volume overload. Pellicori et al.⁽⁴⁾ find that IVC diameter is a predictor of the disease prognosis in patients with heart failure and gives information similar to the NT-ProBNP "N-terminal pro-B natriuretic peptide".

The IVC is a major blood vessel that transports deoxygenated blood back to right atrium of heart from lower extremities and belly. It is a thin-walled vessel with the greatest diameter in the venous system.^(5,6)

The diameter of IVC is measured with the help of echocardiography and diameter may be affected by the right atrial pressure, respiration and tumour masses.⁽⁷⁾

With the help of ASE guidelines that formed in connection with EAE "European Association of Echocardiography" the diameter of IVC is small "diameter was < 1.2 cm", normal "diameter was $1.2 - 1.7$ cm", dilated "diameter was $> 1.7 - 2.5$ cm" and markedly dilated "diameter was > 2.6 cm".⁽⁸⁾

IVC diameter has previously been used to assess volume status in patients on haemodialysis, in patients on mechanical ventilation in critical care units, and in patients with heart failure, subarachnoid haemorrhage, acute circulatory failure, severe preeclampsia and severe sepsis. The IVC diameter in the general population, however, has not been measured.⁽⁹⁻¹¹⁾

In 1988 pro-BNP was first described and originate from heart also known as cardiac hormone. In the recent years biomarkers played an important role in diseases of cardiovascular regarding risk stratification, diagnosis and therapeutic decision making. Pro-

BNP emerged like a powerful biomarker. It is detected in serum plasma.⁽¹²⁾

In reaction to severe stretching of heart muscle cells, the ventricles of the heart produce NT-proBNP. Although, in comparison to the left ventricle, the right ventricle secretes less NT-proBNP. Stretching of cardiac muscle cells, for example, might be caused by fluid excess. NT-proBNP levels can also be high as a result of renal failure, and they are found in individuals with acute brain injury.⁽¹³⁾

The aim of this study was to compare the diameter of IVC and levels of Pro-BNP for use of IV fluids in critical ill patients on IPPV

METHODOLOGY

The study was conducted after the approval of hospital ethical committee and from each patient written consent form was also obtained. The study was conducted at the department of Critical Care Medicine the Services hospital, Lahore from April 2021 to March 2022.

We enrolled 77 patients in our study after fulfilling of inclusion criteria. The inclusion criteria were as: patients who had congestive heart failure and on IPPV "Intermittent positive-pressure ventilation". Patients who had not congestive heart failure were excluded.

The base line and echocardiographic characteristics were analyzed including NT-proBNP and inferior vena cava diameter. IVC diameter was determined with the help of echocardiography. NT-proBNP was determined with the help of ELISA kit.

For statistical analysis we used SPSS 23 version. Qualitative "frequency and percentages" and quantitative "mean and standard deviation" analysis were performed for the collected data

Pearson correlation test was also used to check the relation between NT-proBNP and inferior vena cava diameter. Correlation was significant at $p < 0.05$.

RESULTS

We enrolled in our study 77 patients after fulfilling of inclusion criteria. The mean age of patients was 62.06 ± 7.54 . Out of 77 patients 37 (48.1 %) were male and 40 (51.9 %) were female.

The results of medical history showed that 29 (37.7 %) patients had diabetes, 51 (66.2 %) had arterial hypertension, 30 (39.0 %) had hyperlipidemia, 33 (42.9 %) had coronary artery disease and 27 (35.1 %) had prior heart failure.

In patients the baseline clinical and laboratory data results showed that Systolic blood pressure (mmHg) was 140.74 ± 10.84 , diastolic blood pressure (mmHg) was 82.19 ± 7.43 , Heart rate (bpm) 87.57 ± 8.44 , serum sodium (mEq/L) was 135.60 ± 3.82 , serum potassium (mEq/L) was 5.04 ± 1.37 , hemoglobin (mg/dL) was 12.38 ± 1.11 , creatinine (mg/dl) was 1.2 ± 0.4 , brain natriuretic peptide (pg/mL) was 280.58 ± 40.82 and NT-proBNP (pg/mL) was 1981.25 ± 278.88 .

Table-1: Baseline characteristics of patients

Demographic variables	Results
Age (years)	62.06 ± 7.54
Gender	
Female	40 (51.9 %)
Male	37 (48.1 %)
Medical History	
Diabetes	29 (37.7 %)
Arterial hypertension	51 (66.2 %)
Hyperlipidemia	30 (39.0 %)
Coronary artery disease	33 (42.9 %)
Prior heart failure	27 (35.1 %)
Baseline clinical and laboratory data	
SBP (mmHg)	140.74 ± 10.84
DBP (mmHg)	82.19 ± 7.43
Heart rate (bpm)	87.57 ± 8.44
Serum sodium (mEq/L)	135.60 ± 3.82
Serum potassium (mEq/L)	5.04 ± 1.37
Hemoglobin (mg/dL)	12.38 ± 1.11
Creatinine (mg/dl)	1.2 ± 0.4
Brain natriuretic peptide (pg/mL)	280.58 ± 40.82
NT-proBNP (pg/mL)	1981.25 ± 278.88

The echocardiographic characteristics of patients was given in table-2 as the left ventricular ejection fraction was 27.1 ± 6.8 %, LVDD was 61.8 ± 7.9 mm, LVSD was 50.9 ± 9.7 mm and IVC size was 1.86 ± 0.77 cm.

The results of respiratory collapse of the IVC was out of 77 patients 29 (37.7 %) had < 50 %, 25 (32.5 %) had > 50% and absent in 23 (29.9 %) patients.

Table-2: Echocardiographic characteristics of patients

Left ventricular EF (%)	27.1 ± 6.8
LVDD (mm)	61.8 ± 7.9
LVSD (mm)	50.9 ± 9.7
Inferior vena cava size (cm)	1.86 ± 0.77
Respiratory collapse of the IVC	
< 50 %	29 (37.7 %)
> 50%	25 (32.5 %)
Absent	23 (29.9 %)

The results of correlation was significant ($p < 0.01$) in between the inferior vena cava size and NT-proBNP. The value of correlation was 0.753.

DISCUSSION

Natriuretic peptides can be used to evaluate fluid status. BNP has a half-life of 20 minutes, whereas NT-BNP has a half-life of 1 to 2 hours. As a result, we prefer the NT-Pro BNP test to the BNP test. NT-pro BNP is a hormonally inactive pro BNP component that is produced by stretched ventricular myocytes and is a precursor to pre-pro BNP. In extremely ill patients of IPPV, NT-pro BNP levels can rise.^(14, 15)

The researchers discovered a link between NT-ProBNP and IVC size in individuals with acute heart failure and maintained or moderately decreased systolic performance.⁽²⁾

BNP has been linked to the size of the IVC in individuals with systolic heart failure. The extent of this link was greater in individuals with systolic heart failure.⁽¹⁶⁾

The mean value of NT-ProBNP in our study was higher in females than in males. Although the mechanism generating higher natriuretic peptides in females is unknown, Redfield et al discovered a 21% increase in BNP levels in women on hormone replacement therapy, suggesting estrogens may be involved.⁽¹⁷⁾

According to the findings of a study⁽¹⁾, the mean diameter of the IVC was greater in patients with heart failure than in control individuals, and it was also greater in patients with the decompensated heart failure. NT-proBNP was shown to have a positive relationship with IVC diameter. These results suggest that in individuals with HF, IVC diameter may be linked to volume load.

Measurements of B-type natriuretic peptide are also important in determining and confirming a correct diagnosis.⁽¹⁾ Pro-BNP is diuretic peptide that is produced in ventricular myocardium and released into bloodstream in response to systolic heart failure, which is marked by increased end-diastolic pressure, left ventricular wall stress and ventricular volume.⁽¹⁸⁾ The level of pro-BNP rises as heart failure progresses.

NT-ProBNP is beneficial in diagnosis of congestive heart failure (CHF) and provides independent prognostic information that allows medicinal treatments to be optimised.⁽³⁾ In the treatment of individuals with CCF, natriuretic peptides and echocardiography are frequently utilized.⁽¹⁹⁾ In terms of the state of right and left sided filling pressures, our findings imply that natriuretic peptides and echocardiography give complimentary information.

In our research, we find that levels of NT-proBNP were greater in critical ill patients on IPPV who had congestive heart failure. These data suggest that patient volume burdens are greater. The levels of NT-proBNP in our research were greater than in prior investigations.^(1, 20) We hypothesized that this finding had anything to do with ethnicity. Furthermore, because our patients' socioeconomic status was low, they were frequently brought to the hospital in late heart failure stages.

IVC diameter is an essential indication of volume burden in patients with symptoms of congestion, and it corresponds with pro-BNP in patients with heart failure.⁽⁴⁾

In our study the echocardiographic characteristics of patients was showed that inferior vena cava size was 1.86 ± 0.77 cm. Similar results were also find in different studies as the mean size of inferior vena cava find by Pellicori et al.⁽⁴⁾ was 1.5 in non-heart failure patients and 1.9 cm in heart failure patients.

In study by Heble et al⁽²⁾ found inferior vena cava diameter was 1.85 cm in heart failure patients and study by Besli et al.⁽¹⁾ found inferior vena cava diameter was 2.17 cm in heart failure patients

In our study the results of correlation was significant ($p < 0.01$) in between the inferior vena cava size and NT-proBNP. The value of correlation was 0.753. similar results were also find by Heble et al⁽²⁾, and Pellicori et al.⁽⁴⁾ that there was strong correlation between NT pro BNP and IVC diameter in congestion heart failure patients on IPPV.

The results of our study showed that determining IVC diameter was beneficial in a variety of situations especially in critical ill patients on IPPV of congestive heart failure. This is the first study in our setting to assess IVC diameter and NT pro BNP. In addition to a clinical examination, we feel that assessing IVC diameter and NT pro BNP may help in distinguish between individuals with congestion heart failure and those with compensated HF.

CONCLUSION

Natriuretic peptides are linked to IVC size in patients with congestive heart failure. These findings imply that left-sided echocardiography and the biomarker assessment have a complimentary purpose. IVC diameter can be beneficial in assessing volume status and discriminating between congestion and non-congestion heart failure.

Ethical Approval: Permission from the Ethical Committee of the hospital was taken.

Conflict of Interest: The authors declared no conflict of interest.

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