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EFFECT OF POSITIVE END EXPIRATORY PRESSURE ON CENTRAL VENOUS PRESSURE IN PATIENTS UNDER MECHANICAL VENTILATION

Anaesthesiology

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KEYWORDS

INTRODUCTION

A majority of patients who are kept under mechanical ventilation may also require central venous (CV) line insertion for different reasons such as inability to access peripheral vein, blood transfusion, or administration of vasoactive agent.(1) Central venous pressure (CVP) is a good indicator of circulatory volume and cardiac function. The normal range of CVP is 8 - 12 cmH2O. It increases to 12 - 16 cmH2O in patients under mechanical ventilation.(1,2)

Positive end-expiratory pressure (PEEP) in patients under mechanical ventilation can affect CVP via increasing intra-thoracic pressure. Various reports exist on the direct relationship between the 2 pressures (3) Few factors such as incorrect adjustment of the ruler's zero point, patient's poor condition, inappropriate placement of the catheter, and using vasopressor may interfere with accurate CVP measurement. The present study was designed with the aim of evaluating the relationship between the mentioned pressures.

MATERIALS AND METHODS

- After ethical committee approval of the university, a quasi-experimental study was carried out in Saraswathi Institute of Medical Sciences, Anwarpur, Hapur (U.P.), on patients undergoing emergency Laparotomy under General Anaesthesia who needed mechanical ventilation in post anaesthesia care unit.
- **Study Duration:** Six months (September 2021 to February 2022)
- **Sample Collection:**
- 50 patients were evaluated in the study
- **Study Design:**
- Quasi - experimental study

Patients were evaluated for effect of change in peep on CVP. All the patients underwent 0, 5, and 10 cmH2O PEEPs and the respective CVPs of the mentioned points were recorded. Since the patients were not able to give written informed consent, it was obtained from their relatives.

Inclusion Criteria

1. Written & informed consent from all patient's relative.
2. Aged 18- 56 years, undergoing emergency laparotomy and needing post op mechanical ventilation with CV line in situ.

Exclusion Criteria:

1. Patients with auto PEEP (more than 2 cmH2O difference between the PEEP reported by the device and the one set for the patient).
2. Patients who were in need of >10 cmH2O PEEP.
3. Patients who needed more than 200 cc/hour intravenous isotonic fluid to maintain hemodynamic stability.
4. Patients who showed hypoxia and hemodynamic instability at any time of the study.

METHODOLOGY

All patients underwent thorough medical evaluation and investigations. Intraoperative monitoring included Five lead ECG with standard lead II , NIBP monitor, pulse oximeter, ETCO2 monitor and temperature monitor. All patients received standard premedication and general anaesthesia . All surgical procedures were performed by an experienced surgeon.

Awake Invasive arterial line was inserted to get rapid ABGs and to access fluid shifts and hemodynamic instabilities. Central venous line was inserted post induction in all patients. All patients were shifted to post anaesthesia care unit in intubated state, with deep sedation and paralysis. The ventilator devices used for the patients were all the same model and from the same manufacturer. (Dragor Savina) All the patients were deeply sedated and under the same ventilator settings including tidal volume = 8 – 10 ml/kg, FiO2 = 40-70%, and PEEP = 0, 5, and 10 cmH2O, frequency = 14/min. Central venous pressure monitor was attached. Intake volume per hour was in a similar range for all the patients.

Data Gathering

After gathering demographic data of the patients using a checklist designed for this study, patients underwent 0, 5, and 10 cmH2O PEEPs and the respective CVPs of the mentioned points were measured and recorded. The time considered for adjustment of CVP with any of the PEEP cut-off points was considered 10 minutes (3). To accurately measure CVP, all measurements were carried out by the same person, in supine position, and by setting the zero point of the CV line ruler at sternal notch level. To minimize errors, measurement for every patient was done twice for each PEEP cut point with 30 minutes intervals and their mean was considered the reference CVP measure. All the calculated measures for CVP in each PEEP cut point was recorded in the prepared checklist and used for analysis.

Statistical Analysis

The data was entered in Microsoft excel data sheet and analysed using SPSS 22 version software. By considering $Z\alpha = 0.5\%$, $p = 95\%$, minimum clinically considerable CVP difference of 1 cmH2O ($d = 1$), and the difference between the standard deviation of CVP in PEEP 10 and 0 of 1.4 (Sdiff = 1.4), the sample size needed was calculated to be 50 cases. Quantitative data were reported as mean and standard deviation and qualitative ones as frequency and percentage. To compare CVP before and after applying various PEEPs, paired t-test or nonparametric Wilcoxon test were used. In all tests, $p < 0.05$ was considered as significance level.

Table 1: Baseline characteristics of the studied population

Studied Variables	Mean±SD (range)
Systolic BP (mmHg)	130.8±15.5 (108 – 165)
Diastolic BP (mmHg)	78.3±12.04 (58 – 101)
Age (years)	Frequency (%)
18-30	24 (48.0)
31-40	13 (26.0)
41-50	10 (20.0)
51-60	3 (6.0)
Mean±SD (range)	31.7±11.0 (18 - 56)
H/o of Hypertension	
Yes	13 (26.0)
No	37 (74.0)

Table 2: Correlation between positive end-expiratory pressures (PEEP) and central venous pressures (CVP) in studied patients

PEEP (cmH2O)	CVP (mean ± SD) (cmH2O)	P value
Paired 1		
0	8.46±2.1	**<0.001**
5	10.90±1.8	
Paired 2		
0	8.46±2.1	**<0.001**
10	12.16±1.6	
Paired 3		
Δ 0-5	2.44±0.5	**<0.001**
Δ 0-10	3.70±0.7	
Paired 4		
Δ 0-5	2.44±0.5	**<0.001**
Δ 5-10	1.26±0.4	

Table 3: Correlation between different positive end-expiratory pressures (PEEP) and sex and history of hypertension

	Sex		Hypertension	
PEEP (cmH2O)	**Mean±SD**	**P value**	**Mean±SD**	**P value**
PEEP 0				
0	8.52±2.3	0.821	8.62±2.4	0.357
1	8.38±1.7		8.0±0.5	
PEEP 5				
0	11.08±1.9	0.400	11.04±2.1	0.362
1	10.64±1.6		10.50±0.5	
PEEP 10				
0	12.27±1.8	0.559	12.27±1.9	0.424
1	12.0±1.4		11.85±0.5	
Δ0-5				
0	2.57±0.5	**0.038**	2.42±0.6	0.634
1	2.26±0.5		2.50±0.0	
Δ 5-10				
0	1.19±0.3	0.126	1.23±0.4	0.349
1	1.36±0.5		1.35±0.4	
Δ 0-10				
0	3.76±0.8	0.513	3.65±0.8	0.410
1	3.62±0.7		3.85±0.4	

Sex* (0= Male, 1= Female), Hypertension**(0=No, 1= Yes)

Table 4 : of correlation between positive end-expiratory pressures (PEEP) and central venous pressure (CVP) in different baseline CVP levels

PEEP (cmH2O)	Δ CVP (cmH2O)	P value
Δ PEEP 5		
CVP<8	2.7±0.5	**<0.001**
CVP= 8-12	2.23±0.4	
CVP>12	0.0±0.0	
Δ PEEP 10		
CVP<8	4.30±0.4	
CVP= 8-12	3.30±0.6	<0.001
CVP>12	0.0±0.0	

RESULTS

50 patients with the mean age of 31.7 ± 11.0 (18 - 56 years) were evaluated (60% male). Table 1 shows the baseline characteristics of the studied patients. Table 2 shows the relationship between various PEEP measures and CVP. 5 cmH2O increase in PEEP led to 2.44 ± 0.5 mean difference in CVP level. If the PEEP baseline is 0 at the time of 5 cmH2O increase, it leads to a higher raise in CVP compared to when the baseline is 5 cmH2O (2.44 ± 0.5 vs 1.26 ± 0.4 ; $p < 0.001$). Adjusting the analyses done in table 2 based on sex, and history of hypertension did not show any significant differences in the mentioned relations (table 3). Evaluation of the relationship between changes in PEEP and CVP measures based on different levels of CVP are summarized in Table 4.

DISCUSSION

The findings of this study showed that an increase in PEEP has a direct relationship with CVP increase. Approximately, a 5 cmH2O increase in PEEP will be associated with about 2.44 cmH2O raise in CVP. When applying a 5 cmH2O PEEP increase, if the baseline PEEP is 0, it leads to a significantly higher raise in CVP compared to when it is 5 cmH2O (2.44 vs. 1.26).

It seems that sex, history of hypertension, do not significantly affect CVP increase rate.

In a study by Yang et al. 1 cmH2O increase in PEEP, led to 0.38 cmH2O increase in CVP, which is approximately in line with the present study (4).

A study on the effect of PEEP in patients under mechanical ventilation showed a significant direct relationship between 0, 5, and 10 cmH2O PEEPs with CVP. The CVP increase was related to mean PEEP during mechanical ventilation when PEEP was set 10 or less, in a study by Cao et al., which is in line with this study (6).

In the present study, 5 cmH2O increase in PEEP, led to 1.5 – 2.5 cmH2O increase in CVP. Currently, CVP is used as a guide for fluid therapy efficiency and monitoring the effects of intake volume on cardiovascular system. Many current treatment protocols, especially regarding septic shock patient management, define the aim of the treatment as achieving a CVP of 8 - 12 cmH2O in patients without ventilator and 12 - 16 cmH2O in those under mechanical ventilation. However, the study by Cao et al. showed that in patients under ventilator and PEEP, CVP alone is not a good reference for estimation of circulatory volume and required fluid volume for resuscitation (8).

Considering the existing controversies in this regard, it seems that we should seek more accurate scales for determining the efficacy of fluid therapy in patients under mechanical ventilation. Until then, the best way might be using modified CVP based on PEEP rate.

Limitations

Patients with a variety of underlying illnesses were included, which can affect the results.

The patients have been in different phases of hospitalization, therefore the rates and efficiencies of treatments received (fluid, vasoactive drugs) were different among them. In addition, CVP measurement using a ruler has some limitations in its nature, such as adjusting the zero point. Naturally, there are some limitations for applying long-term PEEPs in these patients, which can affect the conclusion. It is suggested to eliminate the afore-mentioned limitations to accurately evaluate the effect of PEEP on CVP in future studies.

CONCLUSION

- The findings of this study revealed the direct relationship between PEEP and CVP. Approximately, a 5 cmH2O increase in PEEP will be associated with about 2.5 cmH2O raise in CVP.
- When applying a 5 cmH2O PEEP increase, if the baseline PEEP is 0, it leads to a significantly higher raise in CVP compared to when it is 5 cmH2O (2.44 vs. 1.26).
- It seems that sex, and hypertension do not have a significant effect in this regard.

REFERENCES

1. Marino PL, Sutin KM. The ICU book. Williams & Wilkins Baltimore; 1998. [Google Scholar]
2. Wai A. Roberts and Hedges: Clinical Procedures in Emergency Medicine. LWW; 2010. [Google Scholar]
3. Roberts JR, Hedges JR. Clinical procedures in emergency medicine. Elsevier Health Sciences; 2009. [Google Scholar]
4. Yang Z, Zhou J, Sun B, Qian Z, Zhao H, Liu W. [The influence of positive end-expiratory pressure on central venous pressure in patients with severe craniocerebral injury] Zhongguo wei zhong bing ji jiu yi xue= Chinese critical care medicine= Zhongguo weizhongbing jijiuyixue. 2012;24(5):283–5. [PubMed] [Google Scholar]
5. Marx J, Walls R, Hockberger R. Rosen's Emergency Medicine-Concepts and Clinical

Practice. Elsevier Health Sciences; 2013. [Google Scholar]
6. Cao F, Liu X, Chen R, Wang X. [Effect of positive end-expiratory pressure on central venous pressure and common iliac venous pressure in mechanically ventilated patients] Zhongguo wei zhong bing ji jiu yi xue= Chinese critical care medicine= Zhongguo weizhongbing jijiuyixue. 2008;20(6):341–4. [PubMed] [Google Scholar]
7. Geerts B, Aarts L, Groeneveld A, Jansen J. Predicting cardiac output responses to passive leg raising by a PEEP-induced increase in central venous pressure, in cardiac surgery patients. British journal of anaesthesia. 2011;107(2):150–6. [PubMed] [Google Scholar]
8. Cao F, Chen R, Liu X, He R. [Effect of positive end-expiratory pressure on the pressure gradient of venous return in hypovolemic patients under mechanical ventilation] Zhongguo wei zhong bing ji jiu yi xue= Chinese critical care medicine= Zhongguo weizhongbing jijiuyixue. 2009;21(10):583–6. [PubMed] [Google Scholar]