ORIGINAL RESEARCH PAPER

Volume - 10 | Issue - 06 | June - 2021 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

COMPARISON OF PRESSURE SUPPORT VENTILATION (PSV) AND SYNCHRONIZED INTERMITTENT MANDATORY VENTILATION (SIMV) AS A WEANING MODE.

Anaesthesiology

Dr. Tinson Varghese Thomas*	PG student , Jhalawar Medical College Jhalawar ,326001. * Corresponding Author
Dr. S P Chittora	Senior professor and HOD , Jhalawar Medical College Jhalawar, 326001.
Dr. R K Aseri	Senior professor , Jhalawar Medical College, Jhalawar, 326001.

ABSTRACT

OBJECTIVE: We planned to compare two different mechanical ventilation modes-pressure support ventilation (PSV) and synchronized intermittent mandatory ventilation (SIMV) as the means of weaning.

METHODS : Sixty patients were included in our study. Patients were randomized into two groups. In the PSV group, FiO2 and pressure support values were adjusted in order to maintain PaCO2: 35-45 mm Hg, pH>7.32, 6-8 mL/kg TV (tidal volume), and saturation >92%. For the SIMV group, FiO2, TV, respiratory rate (f) and pressure support values were adjusted to obtain PaCO2: 35-45 mm Hg, pH>7.32, 6-8 mL/kg TV, saturation >92%, and PO2>60 mm Hg. Every morning, spontaneous breathing was tried in all patients. The patients were extubated after 2 hours of successful T-piece trial. The patients who failed spontaneous respiration with the T-piece were returned to mechanical ventilation. Assist controlled ventilation time (AVT), total T-piece time (TTT), total weaning time (TWT), and sedation need (SN) values were recorded. "T-test" and "Chi-square" methods were used for statistical analysis.

RESULTS : In our study, the mean AVT was 83.40 hours for the PSV group and 74.03 hours for the SIMV group (p value=0.151). TWT was 63.30 hours for the PSV group and 91.03 hours for the SIMV group (p=0.037). The mean TTT was 4.67 hours for the PSV group and 7.83 hours for the SIMV group (p value= 0.008). Eight patients in the PSV group and fifteen patients in the SIMV group required sedation during the weaning process (pvalue=0.01).

CONCLUSION: In the weaning period PSV is more superior than SIMV.

KEYWORDS

weaning, pressure support ventilation, synchronized intermittent mandatory ventilation.

INTRODUCTION

Mechanical ventilation is a useful modality for patients who are unable to sustain the level of ventilation necessary to maintain the gas exchange functions (oxygenation and carbon dioxide elimination). Indications for mechanical ventilation vary greatly among patients. Mechanical ventilation may be indicated in conditions due to physiologic changes (e.g., deterioration of lung parenchyma), disease states (e.g., respiratory distress syndrome), medical/surgical procedures (e.g., postanesthesia recovery), and many other causes (e.g., head trauma, drug overdose) leading to ventilatory failure or oxygenation failure[1]. It is known that ventilation treatment could be accompanied by unintended and unexpected adverse events. The pathophysiological event that causes these adverse events is reversal of normal physiology of intrathoracic pressure during positive-pressure ventilation. In addition to the risk of developing barotrauma and volutrauma, mechanical ventilation has also unfavourable impacts on cardiovascular system. Moreover, prolonged mechanical ventilation enhances the risk of ventilator associated pneumonia[2]. This emphasizes the need of minimizing the duration of mechanical ventilation and performing extubation as soon as possible. In recent years, development of numerous modes of mechanical ventilation , which could support spontaneous breathing, has made it possible to gradually decrease the mechanical ventilatory support. Demonstrating that 'weaning' phase accounts for 40% of duration of mechanical ventilation in patients undergoing different mechanical ventilation modes, highlights the importance of this study[3].

The aim of the present study was to determine superiority of two different ventilation models, pressure support ventilation (PSV) and synchronized intermittent mandatory ventilation (SIMV), to each other as two different means of weaning.

METHODS

Study design

Hospital ICU based, randomized, interventional study.

Informed consents of the first degree relatives of the patients were obtained.

INCLUSION CRITERIA

1.Patients aged between 20 and 80 years
2. Admitted in the ICU for any medical or surgical indications.
3. Underwent Assist volume controlled ventilation for atleast 48 hours.
4. Body temperature < 38ºC.
5. Haemoglobin >8.5 g/dL
6. PaO2 >60 mmHg (FiO2 <40%)
7. PEEP <6 cm H2O.
8. Respiratory rate < 35 cycles/min.
9. Spontaneous tidal volume >5 ml/kg
10 .Haemodynamically stable (no need of vasopressor and inotropic medication)
11. Discontinuation of sedation 24 hours ago.
12. No electrolyte or acid-base imbalance.

Randomization:

It is a statistical procedure by which the patients were allocated into two different groups.

In this study randomization was done by sealed envelope. A total of 60 sealed envelopes (30 per group) were made, each sealed envelope mentioning a particular study group. One of my colleagues asked the patient's relative to pick up a sealed envelope from the box. Patients were allocated to group mentioned on the sealed envelope.

Patients were divided into two groups after recording demographic data, APACHE II score, disease leading to intubation (medical, surgical), concomitant disease likely to influence breathing, presence of previous sedation, blood pressure values (systolic/diastolic/mean), heart rate, SpO2, tidal volume, peak airway pressure (PawP), plateau pressure, respiratory rate (f), amount of PEEP applied, PaO2/FiO2 values, f/VT ratio, and static lung compliance.

Study groups

1.PSV group : FiO2 and pressure support were adjusted to maintain PaCO2 at 35-45 mmHg, pH >7.32, TV at 6-8 mL/kg ,SpO2 >92%, and PaO2 >60 mmHg.
2.SIMV group: TV of 6-8 Ml/kg , FiO2 and pressure support level were adjusted to maintain PaCO2 at 35-45 mmHg, pH >7.32, SpO2>92%, and PaO2>60 mmHg.

Following parameters were recorded:

1.Need for sedation in the PSV and SIMV groups (if sedation was performed, whether the dose increased or not),
2.Requirement of intervention for mechanical ventilation parameters due to impaired gas exchange,
3.Static lung compliance,
4.VT, respiratory rate (presence or absence of tachypnea).
5.f/VT ratio
6.Airway pressures.

7.PaO2/FiO2 ratios,
8.SpO2 , heart rate, blood pressure values.
9.Presence or absence of atelectasis (chest X-ray repeated every morning was evaluated by a radiologist),
10. .Need for non-invasive ventilation after extubation,
11. Need for reintubation.
12. Total 'weaning' time (TWT), Assist controlled ventilation time (AVT), and Total T-piece time(TTT).

Spontaneous breathing trial was performed every morning using a T-piece in the patients fulfilling the following criteria[4]:
1.Improvement of underlying disease causing acute respiratory failure,
2.Discontinuation of vasoactive and sedative agents
3.PaO2 > 60 mmHg
4.FiO2 < 0.5
5.PEEP < 6 cmH2O
6.VT > 6 mL/kg
7.Rapid shallow breathing index (RSBI) -f/VT <105.

Patients satisfying the extubation criteria while breathing through a T-piece were extubated following 2 hr SBT. T-piece was discontinued and mechanical ventilation restarted in the patients who were considered unsuccessful based on the extubation criteria.

SBT failure[4]
1) Respiratory rate >35 cycles/min.
2) SpO2 <90%.
3) Heart rate >140/ min (or higher than 20% of the baseline).
4) Systolic arterial pressure <80 mmHg or >200 mmHg.
5) Agitation.
6) Anxiety.
7) Perspiration.

Extubated patients were monitored for 48 h. Patients who exhibited the criteria of failure either were re-intubated or underwent non-invasive mechanical ventilation depending on clinical symptoms and respiratory parameters. Patients who did not require re-intubation for 48 h were considered successful[4]. Recorded parameters of 30 patients with 'weaning' success with PSV and 30 patients with 'weaning' success with SIMV were compared. All patients were followed-up until death or discharge from the intensive care unit.

Statistical analysis
Statistical Package for the Social Sciences (SPSS, Inc. Chicago, IL, USA) version 16 for Windows was used for statistical analysis. Quantitative data were expressed as mean ± standard deviation. Intergroup comparisons of the normally distributed data were performed by Student's t-test, whereas categorical data were evaluated by chi-square test. A p value smaller than 0.05 was considered statistically significant.

RESULTS
The present study included 60 patients hospitalized in the intensive care unit. No significant difference was found between the groups in terms of demographic data and APACHE II score (p=0.497).The primary diseases and comorbidities of the patients are demonstrated in Tables 1 and 2.

Primary diseases and comorbidities of patients in both groups.
Table 1. PSV group

Primary disease	comorbidity	No. of patients
pneumonia	diabetes	7
Sepsis-ARDS	hypertension	4
Acute renal insufficiency	hypertension	3
CVA	CAD	5
Myocardial infarction	hypertension	3
Diabetic ketoacidosis	diabetes	5
HELLP syndrome		3

Table 2. SIMV group

Primary disease	comorbidity	No.of patients
Pneumonia	Hypertension	8
Eclampsia		3
Diabetic ketoacidosis	Diabetes	3
ARDS	Hypertension	5
Acute renal insufficiency	Hypertension	4
Myocardial infarction	Diabetes	4
CVA	Hypertension	3

Comparison between study groups in terms of total weaning time and total T piece time before extubation

	Groups	N	Mean ± SD	P value
Total weaning time (TWT) (h)	PSV	30	63.30 ± 37.10	0.037
	SIMV	30	91.03 ± 71.41	
Total T piece time (TTT) (h)	PSV	30	4.67 ± 1.54	0.008
	SIMV	30	7.83 ± 2.15	

The assist controlled ventilation time (AVT) was shorter in the SIMV group than in the PSV group (74.03± 31.24 h vs. 83.40±46.09 h) (p=0.151). Total "weaning" time (TWT) was significantly shorter in the PSV group than in the SIMV group (63.30 ±37.10 h vs. 91.03±71.41 h) (p=0.037). The mean total T piece time (TTT) was 4.67 hours for the PSV group and 7.83 hours for the SIMV group (p value= 0.008).

While 15 patients in the SIMV group required sedation during the 'weaning' process, the number of patients who required sedation was 8 in the PSV group (p=0.01). No significant differences were found between the PSV and SIMV groups in terms of need for non-invasive ventilation and re-intubation. No significant difference was found between the study groups during the 'weaning' process in terms of haemodynamic monitoring parameters. Moreover, no significant differences were found between the study groups in terms of f/VT ratios, PaO2/FiO2 ratios, and static lung compliance.

There were no differences between the groups in terms of readjustment of mechanical ventilation parameters due to impaired gas exchange and need again for an assisted controlled ventilation. Atelectasis development showed no difference between the groups.

DISCUSSION
In the present study, which compared two different modes of mechanical ventilation, we observed that "weaning" process was shorter in the patients undergoing PSV and the need for sedation was also lower in the patients undergoing PSV.

Weaning' time accounts for the substantial proportion (40%) of mechanical ventilation time. Prolongation of this period increases mortality[5]. Penuelas et al. also emphasized an increase in mortality in patients for whom weaning from mechanical ventilation lasted more than seven days[6].

Superiority of ventilation models used for 'weaning' to each other is an important issue. Many different artificial ventilation models are used for 'weaning'. SIMV and PSV are assisted ventilation models used for "weaning". In the present study, we intended to investigate whether these two different models of ventilation were superior to each other during weaning period.

PSV is beneficial to meet the work imposed by respiratory and trigger system and endotracheal tube via a ventilator circuit. Although the range to compensate this work has been determined to be 3-15 cmH2O in various studies, a pressure support of 7 cmH2O may be enough[7,8]. PSV provides complete freedom to the patient in deciding the respiratory rate and I;E ratio, thereby encourages spontaneous breathing and reduces the patient's workload by a pressure support. But constant monitoring of the tidal volume, patients clinical condition and blood gas analysis are required to ensure that patient is not going into hypoxemia as the tidal volume is not assured.

SIMV on the other hand encourages spontaneous breathing with a pressure support and ensures adequate tidal volume and respiratory cycles through intermittent mandatory respirations, if the patient is unable to breathe spontaneously. It was believed to be a superior mode based on this assumption. But our study showed a significant increase in the total weaning time (p value=0.037) and total T piece time(p value = 0.008) for patients who were in SIMV mode compared with patients who were in PSV mode. SIMV mode, although synchronises the respirations, imposes a fixed I;E ratio on patients during mandatory respiration thus creating a dysynchrony in the I;E ratio, already carried out by patient during their spontaneous breaths.

In other words, patients who were breathing on their own I;E ratio during spontaneous breaths are imposed with a completely different I;E ratio which is decided by the ventilator, during manadatory breaths.

Thus during mandatory breath cycle, patient's diaphragm can act and lead to diaphragmatic injury or fatigue. This problem is not seen with PSV and can be attribute to the superiority of PSV over SIMV as a weaning mode.

It was found that the need for sedation was lower in the PSV group than in the SIMV. Lower need for sedation also contributed to the decrease in total weaning time in the PSV group as well as it was an indicator that this mode was more comfortable.

We were the pioneers to extensively compare between PSV and SIMV in terms of their weaning ability. In their study concerning spontaneous breathing trials via PSV at this level, Brochard et al[9] demonstrated that PSV shortened the 'weaning' time. In another study, three models (VC, SIMV±PS and PRVC) were compared and none of them was associated with mortality[10]. The researchers attributed this to the alveolar pressure's (plateau pressure), which actually reflects hyperinflation of alveoli, remaining at acceptable levels despite high peak inspiration pressure.

Some studies have concluded that spontaneous breathing trial before extubation is the best technique [11,12] The incidence of re-intubation after extubation has found to be 3%-19% in the study conducted by Jones DP etal.[13]

In our study , no significant difference was found between the study groups in terms of the need for non-invasive mechanical ventilation and need for re-intubation. The incidence was 4% and 5% in the PSV group and SIMV group respectively. This was in agreement with Esteban A etal[14] who found out that the incidence of reintubation was between 3% to 15%.

In the present study, development of atelectasis was assessed radiologically by chest X-ray. However, adequacy of this method in definite detection of atelectasis development is limited. This was limitation to our study. Use of CT imaging could provide more illumination into the results.

CONCLUSION

Pressure support ventilation is a superior mode for weaning compared with SIMV, as the total weaning time, total T piece time and sedation requirements were reduced in patients who were on PSV mode. Here, the most important factor that shortened 'weaning' time appeared to be patient friendly aspects of PSV and reduced need for sedation. Moreover, diaphragmatic fatigue and microatelectasis which could not be detected, being higher in SIMV might also have a role. Further studies are needed to clarify all of these points and to decide whether SIMV mode should be encouraged or not for weaning.

REFERENCES

1. David W. Chang. Principles of mechanical ventilation. Clinical Application of Mechanical Ventilation 2014; 4th Ed; 1: 1-25.
2. Epstein S. Complications in ventilator supported patients. In: Tobin M, ed. Principles and Practice of Mechanical Ventilation, 2nd ed. New York: McGraw Hill;2006:877-902.
3. Tobin MJ, Yang K. Weaning from mechanical ventilation. Crit Care Clin 1990; 6: 725-47.
4. David W. Chang, James H.Hiers. Weaning from mechanical ventilation. Clinical Application of Mechanical Ventilation 2014; 4th Ed; 16: 516-43
5. Esteban A, Anzueto A, Frutos F, Alía I, Brochard L, Stewart TE, et al. Characteristics and outcomes in adult patients receiving mechanical ventilation: a 28-day international study. JAMA 2002; 287: 345-55.
6. Peñuelas O, Frutos-Vivar F, Fernández C, Anzueto A, Epstein SK, Apezteguía C, et al. Characteristics and outcomes of ventilated patients according to time to liberation from mechanical ventilation. Am J Respir Crit Care Med 2011; 184: 430-7.
7. Nathan SD, Ishaaya AM, Koerner SK, Belman MJ. Prediction of minimal pressure support during weaning from mechanical ventilation. Chest 1993; 103: 1215-9.
8. Brochard L, Rua F, Lorino H, Lemaire F, Harf A. Inspiratory pressure support compensates for the additional work of breathing caused by the endotracheal tube. Anesthesiology 1991; 75: 739-45.
9. Brochard L, Rauss A, Benito S, Conti G, Mancebo J, Rekik N, et al. Comparison of three methods of gradual withdrawal from ventilatory support during weaning from mechanical ventilation. Am J Respir Crit Care Med 1994; 150: 896-903.
10. Can MF, Yağcı G, Kaymakçıoğlu N, Görgülü S, Harlak A, Peker Y, et al. Factors affecting mortality in mechanically ventilated patients in the surgical intensive care unit. Gulhane Med J 2005; 47: 209-13.
11. Esteban A, Alía I, Gordo F, Fernández R, Solsona JF, Vallverdú I, et al. Extubation outcome after spontaneous breathing trials with T-tube or pressure support ventilation. The Spanish Lung Failure Collaborative Group. Am J Respir Crit Care Med 1997; 156: 459-65.
12. Krieger BP, Ershowsky PF, Becker DA, Gazeroglu HB. Evaluation of conventional criteria for predicting successful weaning from mechanical ventilatory support in elderly patients. Crit Care Med 1989; 17: 858-61.
13. Jones DP, Byrne P, Morgan C, Fraser I, Hyland R. Positive end-expiratory pressure T-piece. Extubation after mechanical ventilation. Chest 1991; 100: 1655-9.
14. Esteban A, Frutos F, Tobin MJ, Alía I, Solsona JF, Valverdú I, et al. A comparison of four methods of weaning patients from mechanical ventilation. Spanish Lung Failure Collaborative Group. N Engl J Med 1995; 332: 345-50.