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Original Research Article

To Compare Neuromuscular Blockers and Ventilation among Airway Pressure Release Ventilation (APRV) Mode and Synchronized Intermittent Mandatory Ventilation (Simv) Mode among Acute Respiratory Distress Syndrome (ARDS) Patients

Charu Sharma[1], Nilesh Kumar Patira[2], Nishigandha Mahajan[3], Manoj U Mahajan[4], Suresh Chandra Dulara[5], Vipin Narayan Sharma[6], Nishkamni[7]

[1]Assistant Professor, Department of Anaesthesia, Geetanjali Medical College and Hospital, Udaipur

[2]Associate Professor, Department of Medicine, Pacific Medical College and Hospital, Udaipur

[3]Assistant Professor, Department of Anaesthesia, Pacific Medical College and Hospital, Udaipur

[4]Assistant Professor, Department of Medicine, Pacific Medical College and Hospital, Udaipur

[5]Professor, Department of Anaesthesia, GMC, Kota

[6]Intern, Ananta Institute of Medical Sciences and Research Centre, Rajsamand

7Medical Officer, SNM Hospital, Leh

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Corresponding author: Manoj U Mahajan
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Abstract

Introduction: ARDS was defined as: the acute onset of respiratory failure, bilateral infiltrates on chest radiograph, hypoxemia as defined by a PaO2/FiO2 ratio ≤200 mmHg, and no evidence of left atrial hypertension or a pulmonary capillary pressure <18 mmHg (if measured) to rule out cardiogenic edema. Aim: to compare use of SIMV and APRV mode of ventilation in patients suffering from ARDS in terms of ventilatory function, sedative and neuromuscular blocking agent requirement and final outcome in terms of mortality and ICU stay. Methodology: Present study was carried out for one year duration from 1 November 2015 to 31 October 2016 on patients who were pre-diagnosed as ARDS, who were on mechanical ventilation in the Intensive Care Unit of MBS hospital attached to Govt. Medical College, Kota. Results: Mortality rate in Group I was 55% whereas the same in Group II was 60%. Despite having higher mortality rate in Group II, the difference was not significant statistically (p=0.749). Conclusion: primary use of APRV with maintained unsupported spontaneous ventilation as compared to SIMV with PS lowers sedation and NMBD requirement.

Keywords: Airway Pressure Release Ventilation (APRV), Synchronized Intermittent Mandatory Ventilation (SIMV), Acute Respiratory Distress Syndrome (ARDS)

Introduction

The most accepted definition of ARDS for use at the bedside or to conduct clinical trials was the American-European Consensus Conference (AECC) definition, published in 1994. ARDS was defined as: the acute onset of respiratory failure, bilateral infiltrates on chest radiograph, hypoxemia as defined by a PaO2/FiO2 ratio ≤200 mmHg, and no evidence of left atrial hypertension or a pulmonary capillary pressure <18 mmHg (if measured) to rule out cardiogenic edema. In addition, Acute Lung Injury (ALI), the less severe form of acute respiratory failure, was different from ARDS only for the degree of hypoxemia, in fact it was defined by a PaO2/FiO2> 200 anda PaO2/FiO2 ≤300 mmHg [1, 2].

Treatment modalities of ALI remain mainly supportive. In ALI, the mainstay of supportive therapy is ventilatory treatment[3].

A mechanical change of substantial importance in the late 1960's and early 1970's that shaped the present era was the introduction of Positive End Expiratory Pressure (PEEP). Two modes of ventilation viz. Assisted Ventilation (AV) and Controlled Mechanical Ventilation (CMV) came together in a single piece of equipment and modern era of multiple choice respiratory support was born. Introduction of IMV, permitted spontaneous respiration in the midst of substantial respiratory failure which paved the way for a superb means of weaning i.e SIMV. [3-5]

The evolution of APRV mostly revolves around modifying the CPAP and release time durations (time at expiration—TLow). However, the most significant evolution in APRV has been the development of the ability to personalize the expiratory duration to precisely meet the needs of the patient's changing lung physiology. The advantage of this method is that expiratory duration is set to maintain and open and stable the lung, regardless the level of lung pathology [6].

There has been ever-growing concern that mechanical ventilation aggravates existing lung injury, or even by in and of itself induces lung injury (ventilator-associated lung injury – VALI [7].

Airway pressure release ventilation (APRV, also known as Bi-Level and Bi-phasic) is a time-cycled, time triggered, pressure-targeted form of ventilatory support. APRV is actually a variation of pressure-targeted SIMV that allows spontaneous breathing (with or without pressure support) to occur during both the inflation and the deflation phases. APRV differs from conventional pressure-targeted SIMV in the inspiratory: expiratory (I:E) timing.

APRV may be a useful rescue mode of ventilation in patients with ARDS due to H1N1 pneumonia. APRV is potentially simpler to institute with little evidence of ventilatory and hemodynamic compromise. Even severe cases of ARDS may respond to APRV and importantly the overall mortality rate with APRV was not greater than that reported with ECMO (21%) [8].

This study was designed to compare use of SIMV and APRV mode of ventilation in patients suffering from ARDS in terms of ventilatory function, sedative and neuromuscular blocking agent requirement and final outcome in terms of mortality and ICU stay.

Methodology:

Present study was carried out for one year duration from 1 November 2015 to 31 October 2016 on patients who were pre-diagnosed as ARDS, who were on mechanical ventilation in the Intensive Care Unit of MBS hospital attached to Govt. Medical College, Kota. Approval from ethical committee of Government medical college Kota, was obtained. Written informed consent from all

patient's attendant was obtained. The study patients were divided into 2 groups with each group consisting of equal number of patients.

Inclusion Criteria

The criteria for inclusion in the study were:

1. Patients between age group of 16 -60 years
2. Mechanically ventilated patients with a preformed diagnosis of ARDS (according to new Berlin criteria)

Exclusion Criteria

The patients who were excluded from the study were:

1. Patient <16 and >60 years
2. Patients who required deeper levels of sedation for management of the underlying disease
   - cerebral edema with increased ICP
   - status epilepticus
3. Neurological cause of respiratory failure
4. Obstructive lung diseases-asthma/COPD

The data was analyzed using Statistical Package for Social Sciences version 24.0.

Results:

Out of a total of 40 patients enrolled in the study, a total of 20 (50%) were managed using SIMV protocol and comprised the Group I of the study while remaining 20 (50%) were managed using APRV protocol and comprised the Group II of study

In Group I, maximum number of patients were aged 51-60 years (n=7; 35%) and minimum were aged 41-50 years. Mean age of patients in Group I was 43.00±11.97 years.

In Group II, maximum number of patients were aged 21-30 years (n=9; 45%) while minimum number was observed in age group 31-40 (n=1; 5%). Mean age of patients in Group II was 39.05±13.19 years.

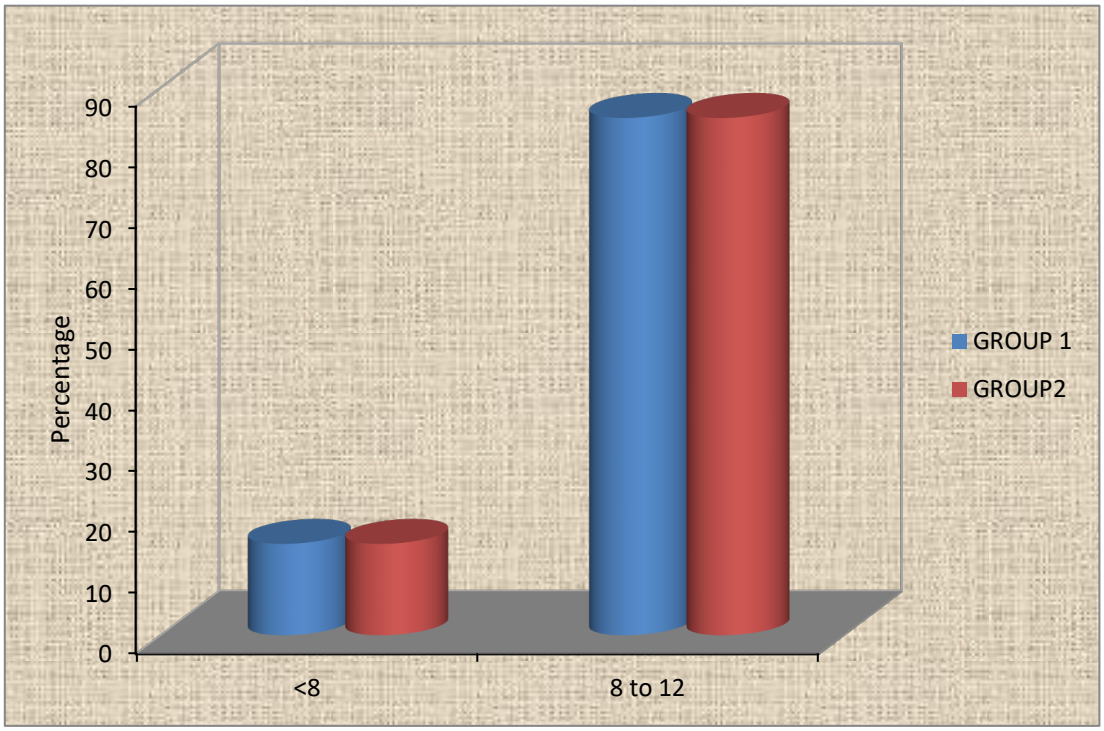

Figure 1: Comparison of two groups for GCS at admission

Table 1: Comparison of APACHE score between two groups

Group	N	Mean	SD	Minimum	Maximum
I	20	23.90	5.16	15	31
II	20	20.25	7.74	7	32
Total	40	22.08	6.75	7	32

t=1.755; p=0.087

The findings shown above depict that the two groups were matched for baseline characteristics.

Table 2: Comparison of two groups for Ramsay Sedation Score

Ramsay Sedation Score	Total	Group I (n=20)		Group II (n=20)	
		No.	%	No.	%
1	2	0	0.0	2	10.0
2	5	0	0.0	5	25.0
3	10	2	10.0	8	40.0
4	11	7	35.0	4	20.0
5	12	11	55.0	1	5.0

z=4.350; p<0.001 (Mann-Whitney U test)

Ramsay Sedation scores were of lower order in Group II as compared to Group I where the sedation scores were of higher order. Statistically, this difference was significant (p<0.001).

Table 3: Comparison of Duration of Ventilator use between two groups

Group	N	Mean	SD	Minimum	Maximum
I	20	8.90	5.87	3	25
II	20	8.85	4.37	3	19
Total	40	8.88	5.11	3	25

t=0.031; p=0.976

Duration of ventilator use ranged from 3 to 25 days. Mean duration was 8.90±5.87 days in Group I and 8.85±4.37 days in Group II. Statistically, this difference was not significant (p=0.976).

Table 4: Lung Injury Score

Variable	Group I (n=20)	Group II (n=20)	Significance of difference (Mann Whitney U test)
Day 1			
Median	2.500	2.000	
Mean	2.375	2.038	
SD	0.401	0.482	
Min	1.75	0.75	z=2.126; p=0.038
Max	3.00	2.75	
Day 2			
Median	1.875	1.00	z=4.409; p<0.001
Mean	2.013	1.013	
SD	0.615	0.503	

Min	0.75	0	
Max	3.25	2	
Significance of change from day 1 to day 2 (Wilcoxon signed rank test)	z=2.534; p=0.011	z=3.732; p<0.001	

Lung injury scores were significantly higher in Group I as compared to Group II on both days 1 and 2 observations (**p<0.05**). In both the groups a significant reduction in Lung Injury scores was observed between day 1 and day 2 (**p<0.05**).

Table 5: Comparison of two groups for Final Outcome

Outcome	Total	Group I (n=20)		Group II (n=20)	
		No.	%	No.	%
Discharged	17	9	45.0	8	40.0
Expired	23	11	55.0	12	60.0

χ^2=0.102; p=0.749

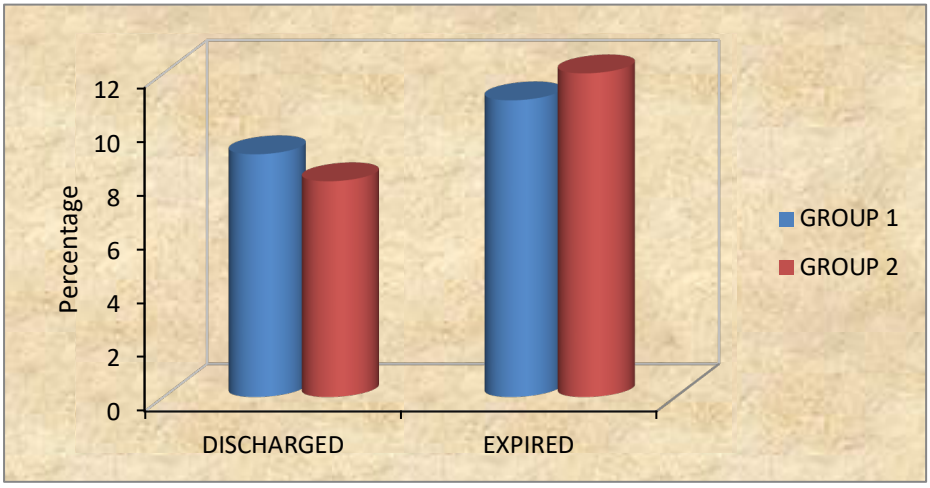

Figure 2: Comparison of two groups for final outcome

Mortality rate in Group I was 55% whereas the same in Group II was 60%. Despite having higher mortality rate in Group II, the difference was not significant statistically (p=0.749).

Discussion:

Demographic data did not reveal statistically significant difference (p>0.05) and was similar among both the Groups I and II: In Group I, both males and females were equal in number (50% each), however, in Group II, there were 8 (40%) females and 12 (60%) males,but this difference was not statistically significant. (p=0.525).

Sedation scores were of lower order in APRV group (RSS = 3) as compared to SIMV group where the sedation scores were of higher order (RSS = 5) with respect to patient comfort and tolerance of mechanical ventilation. Statistically, this difference was significant (p<0.001), probably because of better patient ventilator synchrony in APRV as compared to SIMV. Similar facts regarding sedation requirement were also observed by Sydow M et al [9]. (1994), Kaplan et al [10]. (2001) who found lower sedation requirement in APRV group as compared to the control group. Putensen et al. [11] (2001) reported that patients on APRV group were maintained at Ramsay sedation scale of 3 as compared to PCV group which had to be maintained with neuromuscular blocking drugs at Ramsay sedation scale 5. However, some studies

like T.Varpula et al [12]. (2004)and R.Maxwell et al [13]. (2010) found no difference in sedation requirements in APRV and SIMV group.

Eleven patients in group I and three patients in group II had to be paralyzed during the course of their mechanical ventilation NMBDs use was found to be lower in the APRV group than the SIMV group and the difference was found to be statistically significant (p = 0.008). APRV promotes near elimination of neuromuscular blockade as shown by Sydow M et al [9]. (1994) and Kaplan et al [10]. (2001). If the patients in APRV group did not meet ventilator criteria, they were taken on control mode, because APRV behaves as PC-IRV when NMBDs are administered, thereby abolishing any advantages of APRV mode which are because of unsupported spontaneous breaths.

Duration of ventilator use was 8.90 ± 5.87 days in Group I and 8.85 ± 4.37 days in Group II which was found to be insignificant between the two groups (p>0.05). T.Varpula et al12. (2004) and Lianji LIU et al [14]. (2009) were unable to demonstrate any difference between the two strategies, APRV and SIMV with PS, regarding number of ventilator-free days. In contrast Putensen et al [11]. (2000) found shorter duration of ventilator stay as opposed to the PCV group (p< 0.05).

Lung injury scores (LIS) were found to be 2.375 ± 0.4 and 2.013 ± 0.6 on day 1 and 2.038 ± 0.482 and 1.013 ± 0.503 on day 2 in groups I and II respectively. In both the groups a significant reduction in LIS was observed between day 1 and day 2 (p<0.05). Mean reduction in LIS was higher in Group II as compared to Group I and this difference between two groups was statistically significant too (p=0.004). No study has compared LIS in both the groups . In our present study we found less number of quadrants involved on chest x-ray after ventilating patients with either mode and improvement in compliance and P/F ratios. By incorporating PEEP, we calculated LIS score at day 2 which showed improvement as compared to day 1, improvement being greater in APRV group as compared to SIMV. Most of the studies have assessed improvement in imaging with the help of CT scan and have found that persistent spontaneous breathing improves lung aeration (Wrigge et al [15]., *2003)*. *Yoshida et* al [16]. (2009) with the help of helical CT scan concluded that APRV is a better mode of ventilation than PSV in improving atelectasis in ARDS patients. Putensen et al [11] (2000) also found APRV use to be associated with increase in respiratory system compliance. [17]

Conclusion:

In ARDS, primary use of APRV with maintained unsupported spontaneous ventilation as compared to SIMV with PS.

1. Lowers sedation and NMBD requirement
2. Proved no change in outcome of the patients in terms of number of ventilator days or mortality.

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