Original research article

A Prospective Study to Compare Airway Pressure Release Ventilation (APRV) mode with Synchronized Intermittent Mandatory Ventilation (SIMV) mode in acute respiratory distress syndrome (ARDS) Patients at a Government Tertiary Level Hospital in Kota, Rajasthan.

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

[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 Medicine, Pacific Medical College and Hospital, Udaipur

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

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

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

[7]Medical Officer, SNM Hospital, Leh

Corresponding Author: Nishigandha Mahajan
E-mail: drnishi.mahajan@gmail.com

Abstract

Introduction: Acute lung injury and its more severe form, acute respiratory distress syndrome (ARDS), cause respiratory failure, the most common organ failure leading to intensive care. 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. Specifically, conventional pressure-targeted SIMV uses a "physiological" inspiratory time with I:E ratio less than 1:1.

Aim: To compare Airway Pressure Release Ventilation (APRV) mode with Synchronized Intermittent Mandatory Ventilation (SIMV) mode in Acute Respiratory Distress Syndrome (ARDS) patients.

Method: 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%.

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

Introduction

Acute lung injury (ALI) is an inflammatory reaction of the lung to various insults. Acute lung injury and its more severe form, acute respiratory distress syndrome (ARDS), cause respiratory failure, the most common organ failure leading to intensive care. ARDS causes alveolar edema and collapse primarily in dependent lung regions adjacent to the diaphragm, resulting in intrapulmonary venous admixture of blood and severe arterial hypoxemia[1].

Treatment modalities of ALI remain mainly supportive. In ALI, the mainstay of supportive therapy is ventilatory treatment[2]. 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. PSV proved to be an addition to IMV that facilitated spontaneously breathing patients. Pressure support does for the respiratory muscles what vasodilators do to ventricular muscles unloading. Another rather important justification for newer modes of ventilation was the persistently high mortality rate of ARDS despite application of PEEP which lead to the redefining of PCV and description of IRV[3].

Traditionally patients were being ventilated with SIMV mode. The new APRV mode was introduced for the first time in 1987 for patients with acute respiratory distress syndrome. It is a relatively new mode of ventilation that produces tidal ventilation using an inverse ratio ventilation method that differs from any other mode[4].

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. Specifically, conventional pressure-targeted SIMV uses a "physiological" inspiratory time with I:E ratio less than 1:1. Spontaneous breaths thus occur during the expiratory phase. In contrast, APRV uses a prolonged inspiratory time producing socalled inverse ratio ventilation (IRV with I:E ratios of up to 4 or 5:1)[5]. Spontaneous breaths thus now occur during this prolonged inflation period.

This study was designed to compare use of SIMV and APRV mode of ventilation in patients suffering from ARDS in terms of haemodynamic parameters.

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

Table 2: Comparison of two groups for age

		Group I (n=20)		Group II (n=20)	
Age Group(yrs)	Total	No.	%	No.	%
21-30	14	5	25.0	9	45.0
31-40	6	5	25.0	1	5.0
41-50	8	3	15.0	5	25.0
51-60	12	7	35.0	5	25.0
(Range) in years	(21-60)	(25-60)		(21-58)	

χ^2=64.643 (df=3); p=0.200 (NS)

Statistically, the two groups were matched for age and did not show a significant intergroup difference (p=0.200).

In Group I, APACHE scores ranged from 15 to 31 with a mean value of 23.90±5.16 and in Group II, APACHE scores ranged from 7 to 32 with a mean value of 20.25±7.74. Statistically, the difference between two groups was not significant (p=0.087).

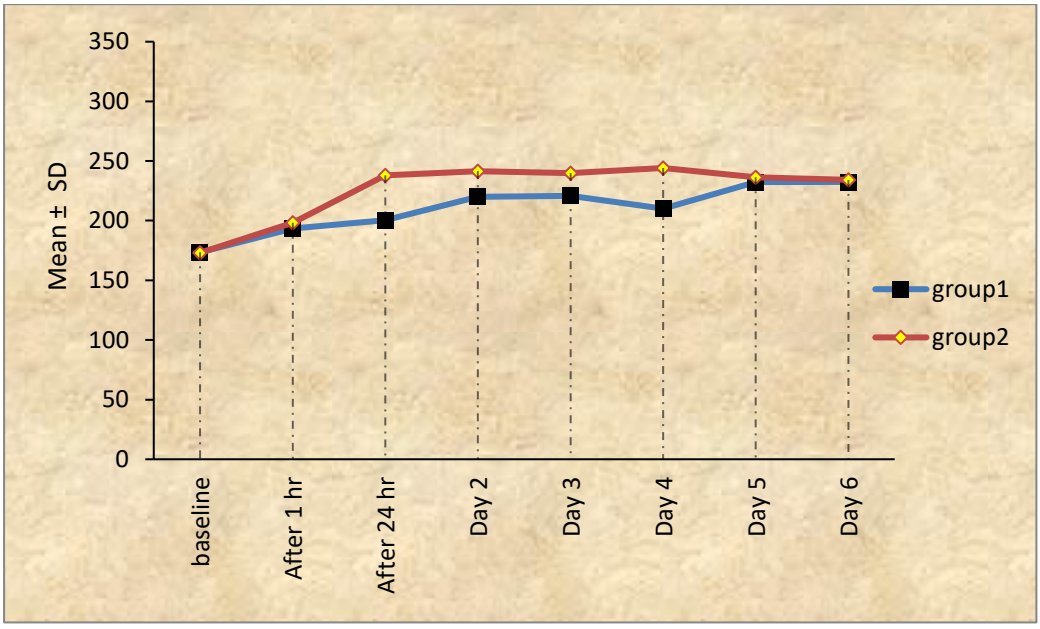
Table 7: Evaluation of Change in P/F ratio throughout the period of study : (a) Group I

Time interval	Corresponding baseline values	Corresponding changed value	Change	Significance of difference (Wilcoxon	Significance

								signed rank test)		
	n	Mean	SD	Mean	SD	Mean	SD	Z	P	
After 1 hr	20	173.45	52.45	193.40	63.28	19.95	37.32	2.916	0.004	S
After 24 hr	20	173.45	52.45	200.30	35.99	26.85	61.17	1.736	0.082	S
Day 2	20	173.45	52.45	219.85	43.99	46.40	49.53	3.063	0.002	S
Day 3	20	173.45	52.45	220.75	50.14	47.30	68.32	2.636	0.008	S
Day 4	16	168.94	49.81	210.06	55.87	41.13	73.81	2.045	0.041	S
Day 5	12	173.25	49.68	232.33	54.14	59.08	71.70	2.223	0.026	S
Day 6	11	171.73	51.81	232.45	46.14	60.73	89.45	2.045	0.041	S

(b) Group II

Time interval	Corresponding baseline values			Corresponding changed value		Change		Significance of difference (Wilcoxon signed rank test)		Significance
	n	Mean	SD	Mean	SD	Mean	SD	Z	P	
After 1 hr	20	173.05	51.84	198.20	57.96	25.15	25.81	3.307	0.001	HS
After 24 hr	20	173.05	51.84	238.00	59.40	64.95	54.75	3.773	<0.001	HS
Day 2	20	173.05	51.84	241.35	59.41	68.30	77.67	3.211	0.001	HS
Day 3	20	173.05	51.84	239.80	62.66	66.75	81.58	3.062	0.002	HS
Day 4	19	172.37	53.17	244.16	79.94	71.79	86.27	2.979	0.003	HS
Day 5	17	171.12	56.23	236.24	78.10	65.12	94.39	2.416	0.016	S
Day 6	16	171.19	58.07	234.19	79.11	63.00	102.39	2.198	0.028	S



Graph 1:

In both the groups, mean value was higher than baseline at all the time intervals and the difference from baseline was also significant statistically at all the time intervals ($p<0.05$) except in Group I at 1 hr interval where though the mean value was higher than baseline yet the difference was not significant ($p=0.082$).

Table 6: Comparison of Average MAP between two groups

Group	N	Mean	SD	Minimum	Maximum
I	20	68.30	9.90	54	89
II	20	67.60	10.78	53	89
Total	40	67.95	10.22	53	89

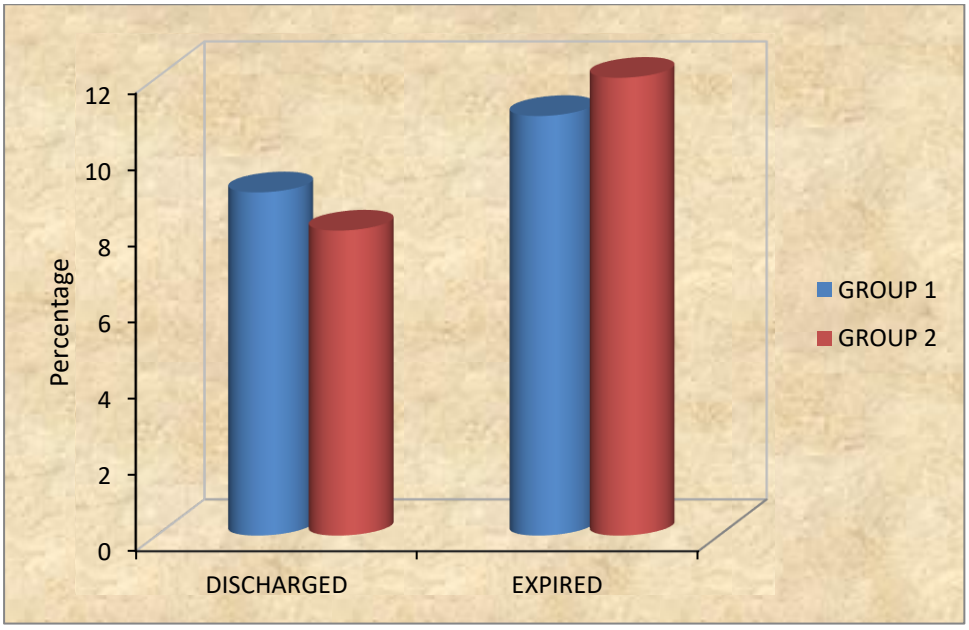
t=0.214; p=0.832

Table 7: Comparison of Mean Heart Rate between two groups

Group	N	Mean	SD	Minimum	Maximum
I	20	119.20	17.33	80	150
II	20	103.75	20.71	56	130
Total	40	111.48	20.41	56	150

t=2.559; p=0.015 (significant)

Mean Average MAP ranged from 53 to 89 mm Hg. It was 68.30±9.90 in Group I as compared to 67.60±10.78 mm Hg in Group II, thus showing the difference between two groups not to be significant (p=0.832) Mean heart rate ranged from 56 to 150 bpm. It was 119.20±17.33 in Group I as compared to 103.75±20.71 bpm in Group II, thus showing the difference between two groups to be significant (p=0.015). 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).



Graph 2: Showing outcome of patients in two groups

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: mean age (± standard deviation) 43.00±11.97 yrs and 39.05±13.19 yrs respectively. 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).

Vasopressor usage was noted in both the groups with 12 patients in group I and 11 patients in group II requiring it. There was no significant difference in the vasopressor usage between the two groups (p>0.05). T.Varpula [6] (2004) also reported similar physiological changes in both the groups. However Putensen et al [7]. (2000), Lianji LIU et al[10] (2009) found increased cardiac performance of APRV group and less vasopressor requirement than the control group. Ventilatory parameters were studied using P/F ratio and Lung injury score (LIS).

In our present study we found P/F ratios to be slightly higher in APRV group as compared to SIMV group at all time intervals but the difference was not found to be statistically significant (p>0.05) except at 24 hours where the P/F ratios in groups II was higher than group I and the difference was statistically significant. (p=0.014) .Valentine DD[8] (1991) concluded that all three modes, SIMV, APRV & PSV provide acceptable oxygenation in patients after cardiac surgry. Yoshida.T etal[9] (2009) in a retrospective study found better P/F ratios in ARDS patients ventilated with APRV as compared to PSV.T. Varpula[6] (2004) found similar results and significant improvement in P/F ratios in the APRV group after 24 hours and concluded that both APRV and SIMV were comparable with respect to P/F ratios during the first seven days. Lianji LIU and coworkers[10] (2009) conducted a retrospective analysis and found that APRV offered better oxygenation and better P/F ratio than SIMV during first 7 days of mechanical ventilation in ARDS patients. Maxwell et al[11] (2010) conducted a study on trauma patients with acute respiratory failure and compared APRV mode with PCV and they found no differences in P/F ratios during the 5 day observation period. APRV mode has been studied, and it potentially benefits ARDS patients because it allows spontaneous breathing with relatively low level of pressure support and this has been proved by many experimental and clinical studies. Downs and Stock[12] (1987), Putensen et al[7] (1994), Lianji LIU et al[10] (2009) have shown in their studies that APRV mode of ventilation results in improved ventilation perfusion matching, and better arterial oxygenation. Improved oxygenation and increased venous return due to spontaneous breathing results in increased cardiac output and hence enhanced oxygen delivery as shown by Putensen et al[7] (1999). Our observation has been consistent with the findings of the previous studies.

Less than half of the total patients (17/40) in our study survived and were discharged. Mortality rate was slightly higher in the APRV group as compared to the SIMV group, but the difference is statistically insignificant (p=0.749). However, Lianji LIU et al[10] (2009) demonstrated lower mortality in the APRV group. There may be several reasons of mortality in a critically ill patient which cannot be explained by difference in ventilator mode alone.

Conclusion:

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

1. Is feasible and potentially beneficial.
2. Shows better clinical improvement in terms of P/F ratio, chest X-ray and lung compliance
3. Shows no improvement in hemodynamic variables.
4. Proved no change in outcome of the patients in terms of number of ventilator days or mortality.
5. References:

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