Original Article

The Comparison Effects of Two Methods of (Adaptive Support Ventilation Minute Ventilation: 110% and Adaptive Support Ventilation Minute Ventilation: 120%) on Mechanical Ventilation and Hemodynamic Changes and Length of Being in Recovery in Intensive Care Units

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Abstract

Background: The conventional method for ventilation is supported by accommodative or adaptive support ventilation (ASV) that the latter method is done with two methods: ASV minute ventilation (mv): 110% and ASV mv: 120%. Regarding these methods this study compared the differences in duration of mechanical ventilation and hemodynamic changes during recovery and length of stay in Intensive Care Units (ICU). **Materials and Methods:** In a clinical trial study, forty patients candidate for ventilation were selected and randomly divided into two groups of A and B. All patients were ventilated by Rafael ventilator. Ventilator parameters were set on ASV mv: 110% or ASV mv: 120% and patients were monitored on pulse oximetry, electrocardiography monitoring, central vein pressure and arterial pressure. Finally, the data entered to computer and analyzed by SPSS software. **Results:** The time average of connection to ventilator in two groups in modes of ASV mv: 110% and 120% was 12.3 ± 3.66 and 10.8 ± 2.07 days respectively, and according to *t*-test, there was no significant difference between two groups ($P = 0.11$). The average of length of stay in ICU in two groups of 110% and 120% was 16.35 ± 3.51 and 15.5 ± 2.62 days respectively, and according to *t*-test, there found to be no significant difference between two groups ($P = 0.41$). **Conclusion:** Using ASV mv: 120% can decrease extubation time compared with ASV mv: 110%. Furthermore, there is not a considerable side effect on hemodynamic of patients.

Keywords: *Mechanical ventilation, separation time, ventilation time*

Introduction

Mechanical ventilation is a complicated process involving relationships between pressure, flow, volume, and time. In a simple classification, ventilation modes are divided into volume control, pressure control or both.

Recently, many changes have been occurred in treating patients under intensive care, such as providing new methods of anesthesia as well as special techniques of ventilation (respiration modes suited for rapid weaning); these methods have, in a way, affected intubation time, reduced the length of stay in Intensive Care Unit (ICU) and also reduced complications as well as costs.[1-2]

In the last decade, ventilation time has been the subject of discussion in papers and scientific communities, so that early extubation is an already ordinary phenomenon in various surgeries such as coronary artery bypass graft (CABG).[3] It is natural that negative impacts can be effectively decreased by reducing the time needed for mechanical ventilation. In a study on the effects of early extubation on cardiopulmonary function have found that increase in the left ventricular filling, improvement of ventricular function and consequently increase in cardiac output are the positive results of early extubation.[4] On the other hand, this procedure has some positive effects on the respiratory system, including reducing the risk of nosocomial pneumonia and damage to lung tissue. The advances in patients' comfort, reduction of complications, ease of control and treating patients and saving costs, patients' discharge from hospital and ease of doing activities, which prevents many complications of

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physical inactivity, are among those advantages which Peterson *et al*. have accounted.[3] In addition to clinical benefits, one should not ignore economical benefits of early extubation.[4] Yet, extubation techniques, the type and mode of equipment and variables related to personnel and physician are probably involved in this issue.

Despite the benefits of early extubation, in many surgical centers of Iran, while patients have access to clinical criteria for extubation, they remain under mechanical ventilation for a many hours without the need for ventilator. Thus, it seems that determining some variables related to extubation time as well as choosing a useful method of ventilation, effectively help patients in ICU with open heart surgery.[5]

Now, there are two different methods of extubation including synchronized intermittent mandatory ventilation and adaptive support ventilation (ASV). ASV is a new method which is recommended due to its simplicity. This method has been examined in several studies; however, the number of its use in CABG is limited, in which the time of extubation has been reported to be in different ranges, however, it has been mostly noted that this method expedites the extubation time. ASV is a control mode ventilation that is a closed loop, and it is regulated by ASV of respiratory rate (RR), tidal volume (TV), minute ventilation (mv) as well as respiratory activities of the patient.[6-8]

Changes in respiratory conditions increases or decreases the level of pressure support without interference. Previous studies were conducted on the effects of ASV during anesthesia in thoracic and abdominal surgeries, in such a way that in a study on 27 medical patients with ventilation, ASV considerably reduced the time of ventilation with equipment, and led the patient toward weaning.[2]

Although several studies have emphasized that whether ASV can be viewed as a preventative chronic state for after surgery patients, or those who are chronically under ventilation; there are concerns for the lack of synchronization of ventilators with patients due to the lack of knowledge about the underlying mechanism of respiratory distress, which can possibly worsen the patient's condition, and ASV should be evaluated in randomized controlled studies, so that its role in clinical operation become clear.[7-10]

ASV mode in ventilation separation in the diseases such as chronic obstructive pulmonary disease, and end-stage renal disease has not been done yet and setting 120% is not a known mode in Iran, so this study can be considered necessary in this field. Thus, the aim of this study was to compare the differences in duration of the time needed for mechanical ventilation and hemodynamic changes and length of stay for recovery in ICUs using two methods of ASV: ASV mv: 110% and ASV mv: 120%.

Materials and Methods

This is a single-blind clinical trial study which was approved by research office of medical school of Isfahan University of Medical Sciences. This study was done in Ayatollah Kashani Medical Center in Isfahan. The statistical population of this study consists of patients suffering from thoracic trauma, lung injury, and acute respiratory syndrome, who are hospitalized in ICU of this hospital in 2013.

Inclusion criteria of this study included the patients hospitalized in ICU, those who were in need of ventilation and not prohibited from using ASV. In addition, the patient was excluded from the study if she/he needed ventilator for more than 24 h, due to nonrespiratory causes and heart failure that requires additional measures, and his or her death before the completion of the study.

The required sample size of this study was determined using sample size estimation formula to compare the averages considering 95% level of confidence, 80% test power, standard deviation (SD) =1 at the time of connecting to ventilator, and minimal difference between the two groups which was equal to 0.1, and the variance of extubation time which had been 0.2 in other studies was estimated 20 subject for each group [Figure 1].

Forty patients candidate for ventilation were selected and included in this study. Patients on admission to ICU were blocked randomly and allocated into two Groups of A and B. All patients were ventilated by Rafael ventilator (Hamilton Raphael Ventilator feature a compact, biphasic design that helps patients to breathe more freely in all modes and phases. ASV is an easy-to-use and safe mode of ventilation for the respiratory in RAPHAEL ventilators). Ventilator parameters were set on MV% 110 or 120 for two group and peep 8 cmH_2O and FIO_2 60%, trigger: Flow trigger of 2 l/min, expiratory trigger sensitivity: Start with 25%, tube resistance compensation: Set to 100%, high pressure alarm limit: 35 cmH_2O and ideal body weight for all by another person, and patients' monitoring which included pulse oximetry, electrocardiography monitoring, central vein pressure and arterial pressure, was done on both groups.

The %Min Vol needed to reduce work of breathing (WOB) in patients with respiratory failure is greater than the 100% Min Ventilation setting in patients.[11] If the patient has poor compliance such as with acute respiratory distress syndrome (ARDS), the minute ventilation percent setting should be increased greater than the 100% MV by the clinician to eliminate $PaCO_2$ or reduce WOB.[12] Hamilton Medical, Inc., guideline for adult patients commence %MV for ARDS/acute lung injury (ALI) 120%[12] and add 20% if T body >38.5°C (101.3°F) or add 5% for every 500 m (1640 feet) above sea level.[10,12] Sulemanji *et al*. was compared ASV mode for ARDS with setting Positive

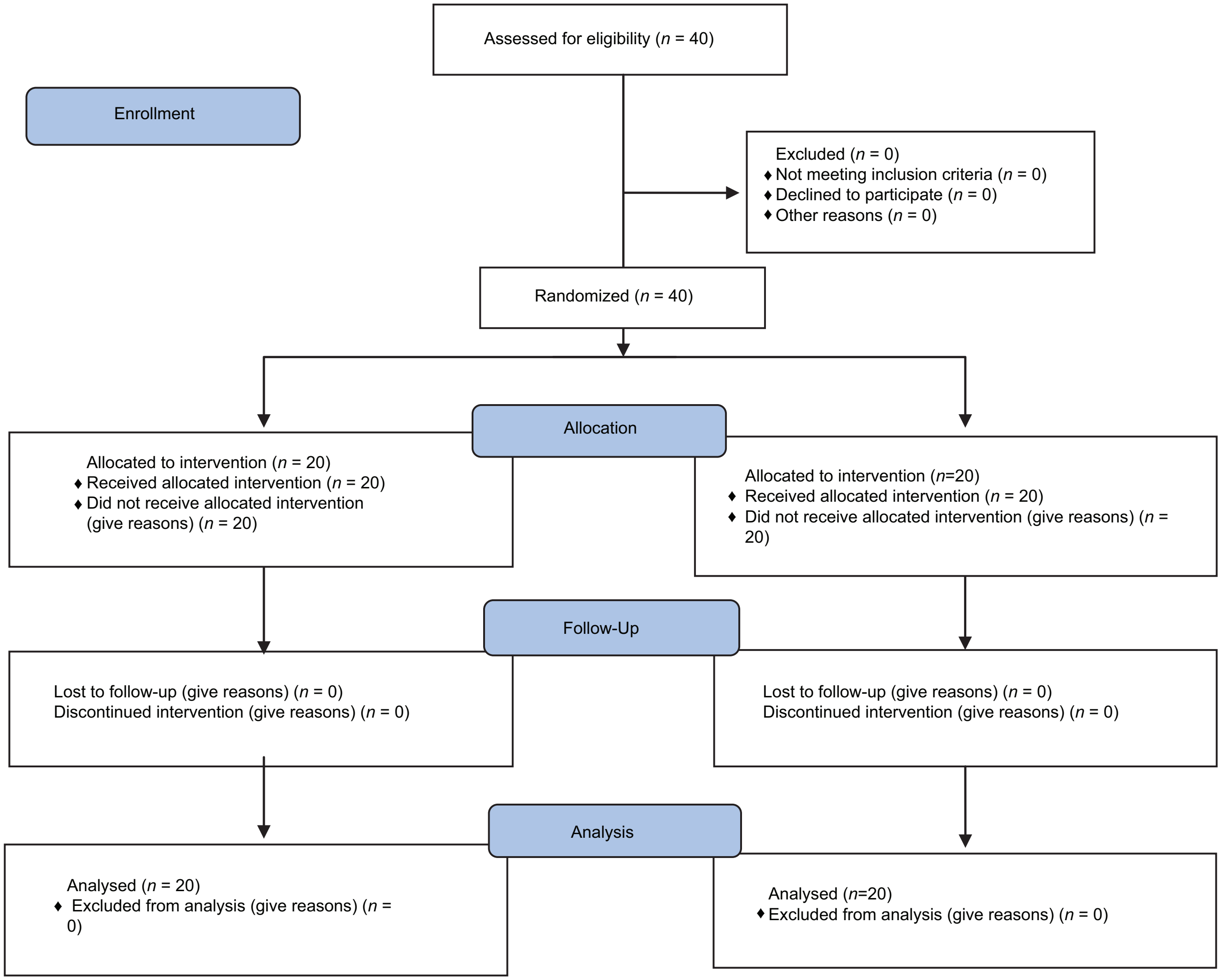

Figure 1: Study CONSORT flowchart

end-expiratory pressure 8, 12, and 16 cm H_2O, and target minute volume 120%, 150%, and 200% of predicted minute volume.[13] In our study, MV% 120% was compared with %MV 110%, and patients' extubation and weaning was done by guideline adjustments of Hamilton Company.[12]

In this study, the anesthesiologist of the responsible study was blind about the method of ASV mode and ventilation mode was applied by other anesthesiologist who not have role in the study.

Sedation of patients in ICU was done by 2 mg/IV bullous morphine and 2 mg/IV bullous midazolam, and then it was done through 2 mg/IV/PRN morphine and 2 mg/IV/PRN midazolam. During ventilation, arterial blood gas was checked and recorded at the time of admission and then on a daily basis. In addition, respiratory parameters including lung compliance, $PaCO_2$, artero-alveolar difference, TV, RR, P peak, P inspiratory, P mean, PAO_2/PiO_2, rapid shallow breathing index, extubation duration, and mechanical time of ventilation, were examined and recorded. In addition, patients' extubation and weaning were done by score of Hamilton Company.[12]

The collected data were recorded in a specific checklist and were analyzed by SPSS software version 22 (SPSS Inc. 233 South Wacker Drive, 11th Floor Chicago, IL 6066412) using statistical tests of " T-student test and Chi-square" and "analysis of variance with repeated measures".

Results

In this study, forty patients who met the inclusion criteria were selected and randomly divided into two groups of 20. Age average of all patients of the study was 35.9 ± 13.2 with the age range of 16–62. 23 (57.5%) were male and 17 (42.5%) were female. The reason for hospitalization in ICU for 16 patients (40%) was ARDS, in case of ten patients (25%) it was pulmonary contusion, and for 14 patients (35%) it was ALI. The age average of patients under mode = 110% was 34.3 ± 12.4, and for patients, under mode = 120%, it was 37.45 ± 14.1 years of age.

There was no significant difference between two groups according to age, sex and the reason for hospitalization. In Table 1, distribution of demographic variables is shown based on group segregation.

Based on the results, the average of maximum inspiratory pressure in patients under mode = 110% and 120% was 23.48 ± 3.06 and 24.59 ± 3.12, respectively, and according to *t*-test, there was no significant difference between two groups ($P = 0.26$). Also, the average of plate index in two groups under mode = 110% and 120% was 18.19 ± 2.64 and 18.81 ± 2.87, respectively, and there found to be no significant difference between two groups ($P = 0.49$). In Figures 2 and 3, the distribution of peak inspiratory pressure and P-plate in both groups is illustrated.

The time average of connecting to ventilator in two groups in modes of 110% and 120% was 12.3 ± 3.66 and 10.8 ± 2.07 days respectively, and according to *t*-test, there was no significant difference between two groups ($P = 0.11$).

The average of length of stay in ICU in two groups of 110% and 120% was 16.35 ± 3.51 and 15.5 ± 2.62 days, respectively, and according to *t*-test, there found to be no significant difference between two groups ($P = 0.41$) [Figures 4 and 5].

In Table 2, the average and SD of hemodynamic parameters in two groups are shown. According to this table, the mean systolic blood pressure on admission time to ICU, the time of connecting to the equipment and the time of detachment was not significantly different between two groups. The diastolic blood pressure in the so-called three times was not significantly different between both groups. However, the mean arterial pressure at the time of detachment in both groups was significantly different ($P = 0.023$) and patients under mode = 120% had lower blood pressure.

Heart rate of patients at the time of admission to ICU was not significantly different between both groups, however, the difference was significant between both groups at the time of connecting to the equipment ($P = 0.03$) as well as at the time of detachment from it ($P = 0.015$). In addition, according to repeated measures of analysis of variance, the mean change in systolic and diastolic blood pressure, and mean arterial in both groups was not significantly different, but the average of heart rate changes was significantly different between both groups ($P = 0.017$). In Figures 6-9, the changes in hemodynamic parameters in two groups are illustrated.

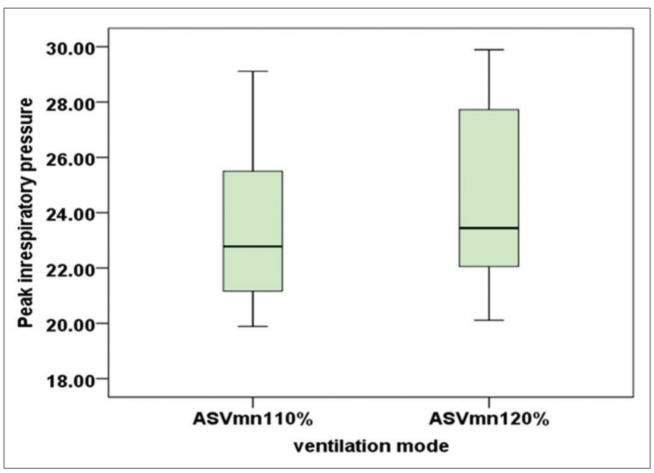

Figure 2: Mean, range and 25% and 75% percentile of maximum inspiratory pressure in both groups (ventilated by adaptive support ventilation minute ventilation: 110% and ventilated by adaptive support ventilation minute ventilation: 120%)

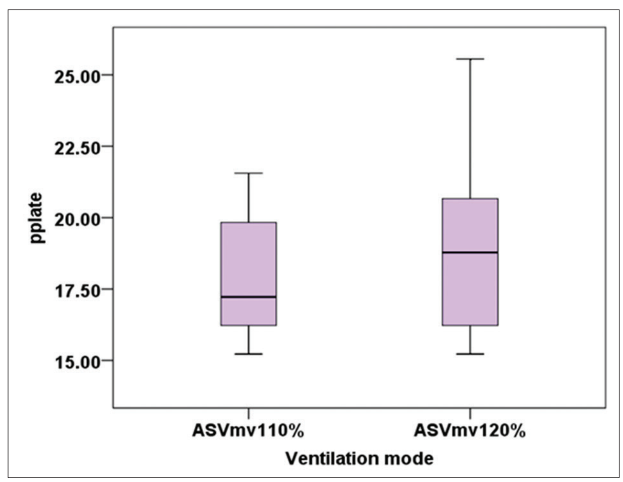

Figure 3: Mean, range and 25% and 75% percentile of P-plate in both groups (ventilated by adaptive support ventilation minute ventilation: 110% and ventilated by adaptive support ventilation minute ventilation: 120%)

Table 1: Distribution of demographic and general variables in both groups

Variable	Mode level	ASV mv: 110%*	ASV mv: 120%**	*P*
Mean±SD of age (year)		34.3±12.4	37.45±14.1	0.46
Sex, *n* (%)	Male	12 (60)	11 (55)	0.75
	Female	8 (40)	9 (45)	
The reason of ICU hospitalization, *n* (%)	ARDS	8 (40)	8 (40)	0.25
	Pulmonary contusion	3 (15)	7 (35)	
	Acute lung injury	9 (45)	5 (25)	
		12 (60)	12 (60)	

*Ventilated by ASV %mv: 110%, **Ventilated by ASV% mv: 120%. SD: Standard deviation, ICU: Intensive Care Unit, ARDS: Acute respiratory distress syndrome, ASV mv: Adaptive support ventilation minute ventilation

Table 2: The average and standard deviation of hemodynamic parameters in two groups

Parameter	Time mode	Entering time to ICU	Time of machine connection	Time of machine disconnection	*P* (between the two groups)
Systolic blood pressure	110%*	148±21.4	146.8±13.4	124.5±6.9	0.52
	120%**	145.5±14.9	141.8±10.4	124.5±14.5	
	P (within any group)	0.67	0.2	0.99	
Diastolic blood pressure	110%*	81.5±9.2	84.3±13.1	80±4.6	0.76
	120%**	82.5±8.7	83±8.8	78±6.2	
	P (within any group)	0.73	0.72	0.25	
Mean arterial pressure	110%*	82.9±14.5	87.8±9.9	74.7±11.8	0.51
	120%**	86.5±11.6	87.3±9.2	66.3±6.8	
	P (within any group)	0.4	0.95	0.023	
Heart bit	110%*	115.3±7.3	116.9±5.6	87.9±4.3	0.017
	120%**	114.7±9.1	112.3±7.2	83.4±6.7	
	P (within any group)	0.82	0.03	0.015	

*Ventilated by ASV mv: 110%, *Ventilated by ASV mv: 120%.** ICU: Intensive Care Unit, ASV mv: Adaptive support v minute ventilation percent

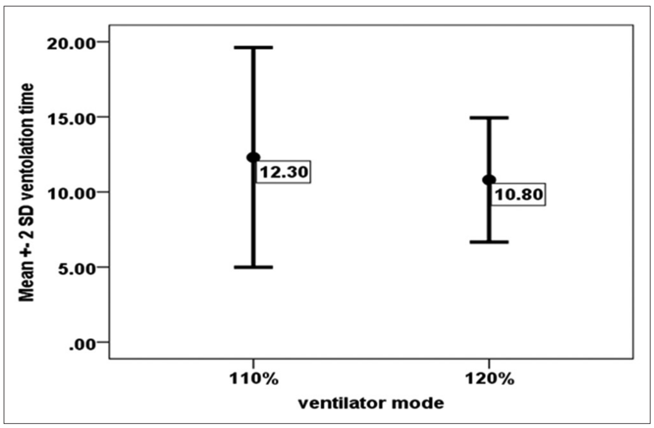

Figure 4: Average and standard deviation of duration of connection to ventilator (days) in two groups (ventilated by adaptive support ventilation minute ventilation: 110% and ventilated by adaptive support ventilation minute ventilation: 120%)

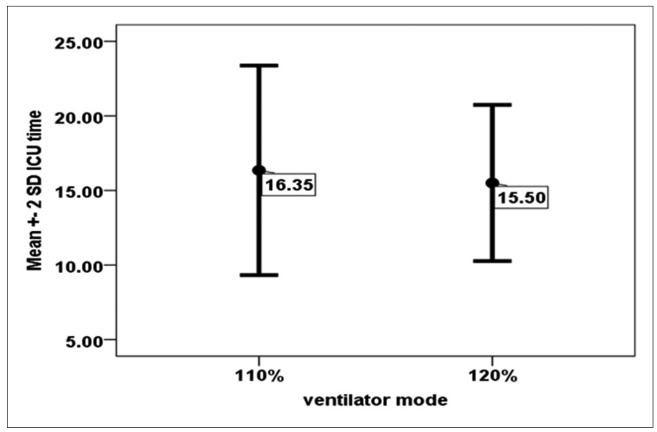

Figure 5: Average and standard deviation during the length of stay in Intensive Care Unit (days) in both groups (ventilated by adaptive support ventilation minute ventilation: 110% and ventilated by adaptive support ventilation minute ventilation: 120%)

Discussion

The overall aim of this study was to compare the differences in duration of mechanical ventilation and hemodynamic changes and length of stay in recovery in ICU through using ASV, ASV mv: 110% and ASV mv: 120%. In this study, two groups, each consisting of 20 patients, one of which undergone ventilation mode = ASV mv: 110%, and the other undergone ventilation mode = ASV mv: 120%, were analyzed and compared. The patients of two groups did not differ significantly with respect to the distribution of age, sex, and the cause of disease, therefore, the confounding effect of the above factors is compensated in this study, and the results of this study are most probably related to the effects of the applied mode on patients.

According to the collected results, the mean inspiratory pressure and P-plate index in two groups with modes 110% and 120% had no significant difference, and the quality of ventilation was similar in two groups, so, there was no significant difference between two modes of the equipment in this respect; thus, this is a natural finding, because both modes were standardized and had a good quality.

According to the results of this study, the length of stay in ICU and duration of connection to ventilator in both groups did not differ significantly, however, duration of the connection to the equipment and length of stay in ICU in patients ventilated with mode = 120% was considerably lower. Two studies conducted by Walthall and Ray and Fernández *et al*. it has been proved that using mode = ASV mv: 120% considerably decreases the time of detaching the equipment.[2,9] However, the lack of significant difference between groups of our study in the length of stay in ICU and duration of connection to ventilator in both groups was most likely due to the small sample size in both groups, which was one of the study's limitation.

The evaluation of hemodynamic parameters in both groups showed that systolic and diastolic blood pressure average at the admission to ICU, the time of connecting

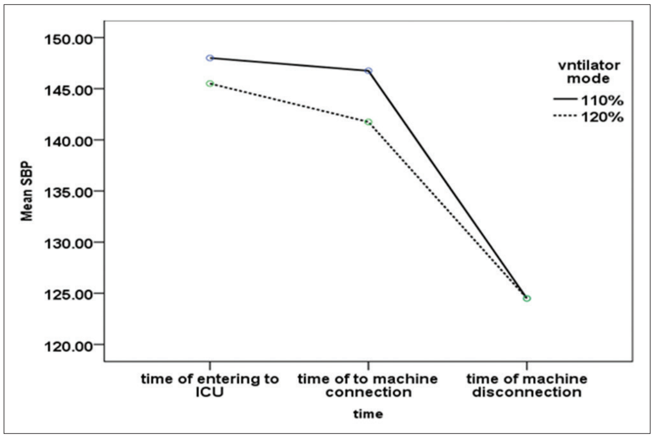

Figure 6: The mean systolic blood pressure in two groups of study (*P* = 0.52) (ventilated by adaptive support ventilation minute ventilation: 110% and ventilated by adaptive support ventilation minute ventilation: 120%)

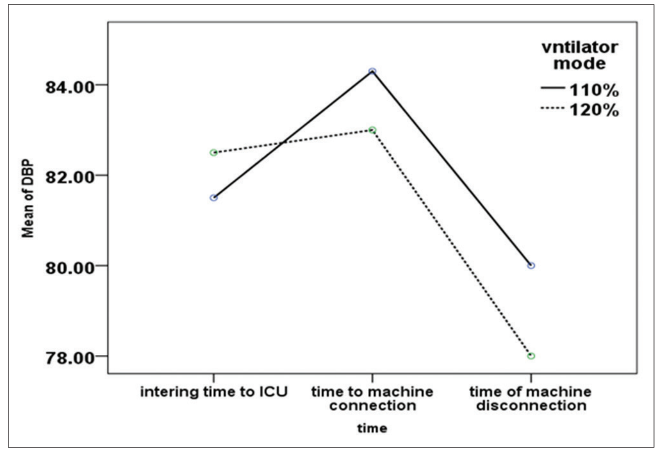

Figure 7: The mean diastolic blood pressure in two groups of study (*P* = 0.76) (ventilated by adaptive support ventilation minute ventilation: 110% and ventilated by adaptive support ventilation minute ventilation: 120%)

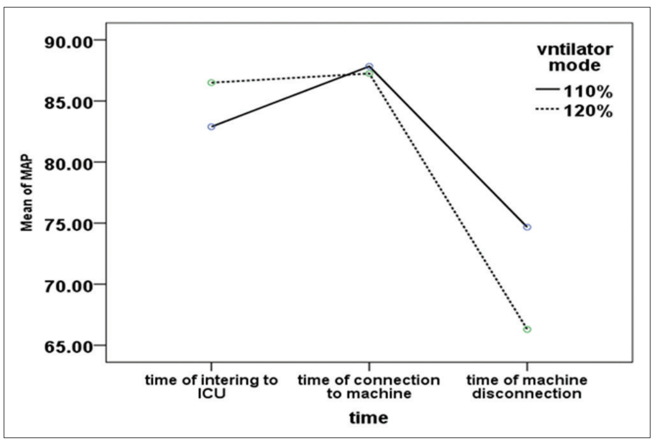

Figure 8: Mean arterial pressure in two groups of study (*P* = 0.51) (ventilated by adaptive support ventilation minute ventilation: 110% and ventilated by adaptive support ventilation minute ventilation: 120%)

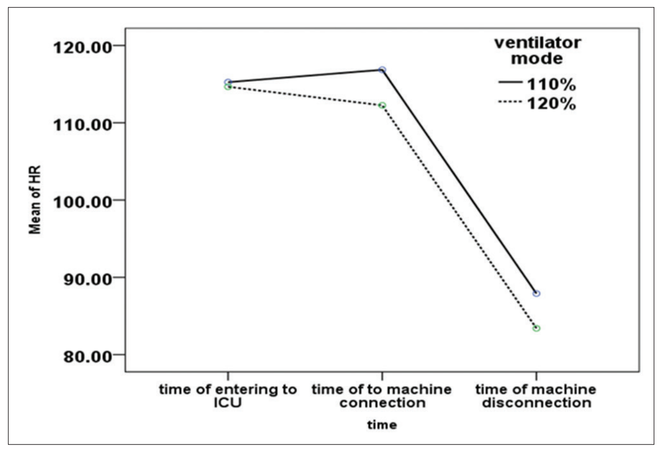

Figure 9: Mean heart rate in two groups of study (*P* = 0.017) (ventilated by adaptive support ventilation minute ventilation: 110% and ventilated by adaptive support ventilation minute ventilation: 120%)

to the equipment and its detachment did not significantly differ between both groups, but the mean arterial pressure at the time of detachment from the equipment was significantly different between both groups, and patients under mode = 120% had lower mean pressure. In addition, heart rate of patients at the admission to ICU was not significantly different between both groups; however, there was a significant difference at the time of connection to and detachment from the device between two groups. While the average of systolic and diastolic blood pressure changes and mean artery was not significantly different between both groups, but the average of heart rate changes was significantly different between two groups and patients under mode = 120% had lower heart rate.

Conclusion

Thus, it can be concluded that patients under both modes had a good hemodynamic stability, however, patients under mode = 120% had better stability. Therefore, regarding the obtained results of this study, and its comparison with other studies, the overall conclusion of this study is that using mode = ASV mv: 120% has a relatively shorter time of detachment than mode = ASV mv: 110%; besides, it causes no complication, such as affecting hemodynamic parameters of patients, however, due to the limitations of this study, it is recommended that wider studies with greater sample size be done in this field.

The limitation of this study was the limited sample size and time to follow-up, thus other studies with more sample size and more time of follow-up is recommended.

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Conflicts of interest

There are no conflicts of interest.

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