Original Article

Weaning from Mechanical Ventilation by Using Pressure Support or T-Tube Ventilation. Comparison Between Patients With and Without Heart Disease

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Objective

To assess cardiorespiratory variables during weaning from mechanical ventilation by using the T-tube and pressure support techniques, and to compare them in groups of patients with and without heart disease.

Methods

To assess the following parameters of 20 patients (57±15 years) undergoing weaning from mechanical ventilation: oxygenation; CO_2 elimination; respiratory and heart rates; tidal and minute volumes; blood pressure; and electrocardiographic alterations. Data were recorded by using both techniques at the following times: zero, 15, and 30 minutes, and after a 30-minute interval. The patients were divided into 2 groups, with heart disease (n=11) and without heart disease (n=9), and then compared.

Results

The pressure support ventilation showed significantly more elevated oxygenation and CO_2 elimination values, and reduced respiratory rate as compared with those of the T-tube ventilation. No difference was found in regard to blood pressure and heart rate. More patients with heart disease had alterations in the ST segment [7 (64%) patients versus 2 (22%)] and arrhythmias [3 (27%) versus 1 (11%)], as compared with patients without heart disease. A lower frequency of tachycardia was observed in those with heart disease.

Conclusion

When comparing pressure support ventilation with T-tube ventilation, a better response was observed in the measurements of the respiratory and oxygenation parameters when using pressure support ventilation. No significant difference was observed in the measurements of cardiovascular parameters. In both weaning techniques, patients with heart disease had tachycardia less frequently, more alterations in the ST segment, and a greater tendency towards the occurrence of arrhythmias.

Key words

mechanical ventilation, myocardial ischemia, weaning

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Most critically ill patients at intensive care units (ICU) require mechanical ventilation. That technique is expensive and has a high rate of morbidity and mortality due to the association of pneumonia and pulmonary lesions[1,2]. Therefore, the professional teams in charge should make sure that liberation of patients from mechanical ventilation occurs properly and safely as soon as possible[3]. Once the patients are treated for the cause that led them to mechanical ventilation, their withdrawal from the ventilator should also be performed as soon as possible[4]. For release or weaning from ventilator, spontaneous breathing and progressive withdrawal trials are performed[5]. In the first modality, the patient is placed in spontaneous breathing without support (T tube), or with a minimum ventilatory support through continuous positive airway pressure (CPAP), or, yet, under a low level of pressure support. On the other hand, the progressive withdrawal technique is more gradual and progressively reduces the patient's ventilatory work[4]. These techniques have been validated in 2 randomized clinical trials[6,7], which reported that approximately 75% of the patients tolerated the spontaneous breathing trial. Most patients recovering from an episode of acute respiratory failure tolerate the spontaneous breathing trial[5], but when progressive withdrawal from mechanical ventilation is required, the time spent with weaning is substantial, and may reach approximately 40% of the total duration of mechanical ventilation[8], or even 60% for patients with chronic obstructive pulmonary disease[9].

Several studies have assessed the indices of oxygenation and breathing mechanics as predictive criteria for success or failure to wean from mechanical ventilation[10,11]. An analysis of such studies has shown a significant variability in the populations evaluated, with use of different parameters and distinct criteria of success and failure to wean. This has led to a considerable confusion about that topic and controversial results in the practical clinical application of those parameters. Therefore, weaning from mechanical ventilation is usually guided by clinical criteria[12].

Despite the existence of several studies about the weaning processes, only a few have compared the pressure support and T-tube ventilation techniques in regard to their oxygenation and breathing mechanics parameters[13], and in regard to their cardiovascular alterations[14]. Studies comparing the behavior of such variables in the groups of patients with and without heart diseases are also scarce. Thus, the present study aimed at comparing the performance of the indices of oxygenation and breathing mechanics, and the cardiovascular parameters, in addition to identifying the behavior of electrocardiographic monitoring in patients undergoing the pressure support and T-tube weaning techniques. The groups with heart disease and without heart disease were also analyzed in regard to the behavior of the cardiovascular variables and electrocardiographic tracings when undergoing those same techniques of weaning from ventilation.

Methods

Patients undergoing weaning from mechanical ventilation at the intensive care unit (ICU) of a university-affiliated hospital were analyzed. This study comprised those who were on mechanical ventilation for over 48 hours and met the following criteria traditionally used in the ICU routine for improvement or resolution of the cause of respiratory failure: adequate gas exchange indicated by $PaO_2/FiO_2 \geq 200$ or $PaO_2 > 60$ mmHg, $SaO_2 \geq 90\%$ at a $FiO_2 \leq 0.40$, with a PEEP ≤ 5 cmH_2O; Glasgow Coma Scale ≥ 11; body temperature $\leq 38^o$ C; hemoglobin level >10 g/dL; physiological measures of respiratory rate ≤ 35 bpm, tidal volume in spontaneous breathing >5 mL/kg, negative inspiratory force ≤ -20 to -25 cmH_2O; hemodynamic stability with no vasoactive drugs (dopamine, dobutamine or noradrenaline) and no sedative agents[6,7].

Patients with the following characteristics were excluded from the study: hypotension (SBP <100 mmHg or MBP <70 mmHg); severe intracranial disease; barotraumas; thoracic drain or tracheostomy, or both; and use of vasoactive or sedative drugs.

All patients' guardians signed an informed written consent. The study was approved by the committee on ethics of the research and postgraduation group of the hospital.

For mechanical ventilation monitoring, the Ventrak 1500 (Novametrix Medical Systems, Wallingford, CT, USA) was used. The following parameters recorded in the Ventrak were the object of this study: respiratory rate (f=bpm); tidal volume (V_T=mL); and respiratory minute volume (V_E=L/min). For noninvasive measurement of the cardiorespiratory parameters related to gas exchange, a HP modular multiparametric monitor, 66S model, (Hewlett-Packard USA) was used. The parameters recorded in the monitor were as follows: heart rate (HR=bpm); systolic blood pressure (SBP=mmHg); diastolic blood pressure (DBP=mmHg); mean blood pressure (MBP=mmHg); electrocardiographic tracing; ST segment recording (elevation or depression); peripheral oxygen saturation (SaO_2=%); and extrapolated end-tidal carbon dioxide tension ($PetCO_2$=mmHg).

All electrocardiographic tracings were later revised by 2 cardiologists, both blind to the factor studied. If discordance occurred in any case, a third cardiologist was called for the final interpretation. The electrocardiographic tracings were analyzed, compared with those performed at the end of the resting period, and classified by the cardiologists as follows: elevation or depression in the ST segment ≥ 1 mm; elevation or depression in the ST segment <1 mm; T-wave inversion; presence of sinus tachycardia or bradycardia; presence of arrhythmias (defining the type); and no alterations.

Because this was a randomized crossed clinical trial, each patient should undergo both weaning methods, the reduction in the pressure support and T tube. The sequence of the implementation of the method was randomly drawn with sealed envelopes containing the name of each method, which was performed by the intensive care physician in charge.

All patients in the study were being ventilated with the Servo 900C or Servo 300 devices (Siemens-Elema, Solna, Sweden) with support pressure before undergoing the protocol. All the following patients' data regarding their clinical status were registered in a standard form: age; sex; APACHE II scale (Acute Physiology and Chronic Health Evaluation II)[15]; mechanical ventilation duration; cause of admission to the ICU; cause of mechanical ventilation installation; existing diseases; and Glasgow Coma Scale[16].

The parameters of mechanical ventilation recorded before the beginning of the protocol were as follows: ventilatory mode; SBP value; positive end-expiratory pressure (PEEP); FiO_2; V_T; f; and peak inspiratory pressure (PIP). The last arterial gas analysis performed before the beginning of the protocol was recorded.

The techniques of weaning from mechanical ventilation were the T-tube ventilation and the pressure support ventilation. In the T-tube technique, the patient is released from the mechanical ventilation with maintenance of the orotracheal tube, through which oxygenation is performed with a T tube. The patient inspires and expires alone. The oxygen flow to be added to the T tube is that necessary for maintaining the FiO_2 balance usually initiated at a 5 L/min flow. In the pressure support ventilation technique, the patient breaths spontaneously, and at each respiratory cycle, the ventilator causes a prefixed positive pressure synchronized with the inspiratory effort of the patient. The pressure level is maintained until the ventilator detects a drop at the end of the patient's inspiratory flow. When established, the pressure support was reduced to 10 cmH_2O, a value used in all patients of the protocol. The PEEP level was reduced to 0 cmH_2O, so that only the effects of support pressure could be observed.

When the first weaning technique was established, the cardiopulmonary and respiratory mechanics parameters were recorded at the following times: 1) time zero - the patient passes from the previous parameters of ventilation to the weaning mode chosen at random, and the parameters are recorded in the first 2 minutes after installation of the randomly chosen weaning mode; 2) time 15 – 15 minutes after finishing the time zero measurements, the time 15 measurements were recorded; 3) time 30 – 15 minutes after finishing the time 15 measurements, the time 30 measurements were recorded; 4) time of respiratory rest – after 30 minutes in the first weaning mode, the patient should return to the mechanical ventilator for at least 30 minutes, in the same ventilatory mode and with the same patterns used before beginning the protocol. This period was aimed at providing a respiratory rest for the patient, and the return to the previous parameters was recorded before the second weaning mode was initiated for continuing the recording of the parameters.

The respiratory rest should not necessarily occur only in the end of the weaning mode instituted, but at any sign of respiratory discomfort, drop in SaO_2 ($<88\%$), an increase in the f (>35 bpm) and HR (>140 bpm), SBP >180 mmHg or <90 mmHg, agitation, diaphoresis, or reduction in the consciousness level[6,7].

The patients were compared as a whole in regard to pressure support and T tube in the times zero, 15, and 30, considering the following parameters: f, HR, V_E, V_T, SaO_2, $PetCO_2$, SBP, DBP, MBP, numerical recording of the ST segment, and electrocardiographic tracing.

In a second phase, the patients were subdivided into 2 groups as follows: patients with heart disease, when they had a history of coronary artery disease or heart failure; and patients without heart disease. The groups were compared with each other regarding pressure support and T tube in the 3 times of the study, considering the cardiovascular parameters (HR, SBP, DBP, MBP) and electrocardiographic tracing.

The results are shown as mean ± standard deviation (SD) for the continuous variables with a normal distribution, and as proportions for the categorical variables. The comparisons between the pressure support and T-tube weaning modes were performed by use of the Student *t* test for paired samples. The chi-square (χ^2) test was used to compare the categorical variables. For comparing the measures obtained in different points in time (0, 15, and 30 minutes) in each technique, analysis of variance (ANOVA) was used for repeated measures. The significance level adopted was $P<0.05$.

Results

The clinical characteristics of the 20 patients studied are shown in table I. These patients were in the ICU, intubated and on pressure support ventilation, and, before undergoing the study protocol, had been on mechanical ventilation for 2 to 54 days.

The arterial gas analyses performed in the hour preceding the protocol was as follows: pH, 7.41±0.1; $PaCO_2$, 39±12 mmHg; HCO_3, 23±6; PaO_2, 98±29 mmHg; and SaO_2, 97±2%.

The patients' parameters of mechanical ventilation before initiating the protocol were as follows: SBP, 12±3 cmH_2O; PEEP, 5±1 cmH_2O; FiO_2, 36±3; V_T, 545±193 mL; *f*, 21±6 bpm; and PIP, 19±4 cmH_2O.

The total SaO_2 values were significantly more elevated during pressure support in all times. No difference in the intragroup values was observed between the techniques when recorded in the 3 different times. The $PetCO_2$ values were greater in the pressure support as compared with those in the T tube in the 3 times. No difference in the intragroup values was observed in the 3 different times (tab. II).

When comparing the 2 weaning modes, the *f* values were significantly lower in the pressure support in time zero and time 15. In the other situations, no statistically significant difference was observed (tab. III).

The total V_E and V_T values showed a significant increase in the presence of pressure support in the 3 times, and no differences were observed in the intragroup comparisons in the times zero, 15, and 30 minutes.

When comparing the T-tube and pressure support techniques, the total HR values showed no significant differences between the groups (tab. IV). Comparing the groups with and without heart disease (tab. V), the HR values were significantly smaller in pressure support ventilation in the time 30 in patients with heart disease. Both in the T-tube and pressure support ventilation, HR was greater in the patients without heart disease than that in patients with heart disease. The total values of MBP, DBP, and SBP, and the numerical value of the ST segment in the comparison between the pressure support and T-tube techniques showed no significant differences between the groups (tab. IV). When comparing separately the groups with and without heart disease in pressure support and T tube, no significant differences were observed in SBP, MBP, DBP, and in the numerical value of the ST segment (tab. V). When comparing patients with and without heart disease (tab. V), both in the T tube and pressure support, HR was greater in patients without heart disease, with statistical significance.

No significant alterations in the ST segment were observed when comparing the pressure support and T-tube techniques. However, when comparing the groups with and without heart disease, alterations in the ST segment were more frequent in patients with heart disease (64%) than in those without heart disease (22%) ($P<0.05$) (tab. VI).

The occurrence of arrhythmias did not significantly differ when comparing the pressure support and T-tube weaning techniques. When comparing the groups with and without heart disease, arrhythmias were more frequent in patients with heart disease (27%) than in those without it (11%), but the values were not significant.

Table I – Clinical characteristics of the 20 patients studied

	Age	Sex	Apache	Glasgow	MV time	Heart diseases	Causes
1	58	M	9	15	4	-	COPD
2	63	M	12	15	2	1	APE
3	58	F	22	15	8	1	APE
4	75	M	19	7	4	1	BCP
5	73	M	10	15	7	1	APE
6	68	F	13	15	4	1	BCP
7	74	M	26	15	3	-	Sepsis
8	52	M	14	15	53	-	Guillian-Barré
9	79	F	29	15	22	-	COPD
10	40	M	2	15	6	1	BCP
11	38	M	17	15	51	-	BCP
12	61	F	23	14	13	1	BCP
13	53	F	18	9	2	1	APE
14	20	M	19	8	2	-	Sepsis
15	44	F	10	15	12	1	BCP
16	68	M	28	12	6	-	Sepsis
17	65	M	35	15	3	-	CPA
18	39	M	16	15	23	1	Sepsis-ARDS
19	71	F	21	15	54	1	HF
20	47	M	11	15	29	-	Sepsis
mean (n)	57	65% M	18	14	15	(11)	
SD	15	35% F	8	1	18		

MV - mechanical ventilation; CPA – cardiopulmonary arrest; BCP - bronchopneumonia; APE - acute pulmonary edema; COPD - chronic obstructive pulmonary disease; HF – heart failure; ARDS - acute respiratory distress syndrome; SD – standard deviation; M - male; F - female.

No significant alterations were observed in the occurrence of sinus tachycardia when comparing the 2 techniques. However, when comparing the groups with and without heart disease, sinus tachycardia occurred only in those without heart disease, equally in both weaning techniques. Of the 9 patients without heart disease, 5 (56%) had sinus tachycardia, and, of those with heart disease, none had that arrhythmia.

Discussion

This study, which aimed at assessing the parameters of gas exchange, respiratory mechanics and cardiovascular monitoring during weaning from mechanical ventilation, by use of the pressure support and T-tube techniques, showed that, in regard to gas exchange, an increase in PaO_2 and $PetCO_2$ occurred during pressure support. In regard to the respiratory functional parameters, a decrease in *f* and an increase in V_E and V_T occurred during pressure support. And, finally, in regard to the cardiovascular parameters analyzed, no significant alterations occurred when comparing the pressure support and T-tube techniques.

When analyzing separately the groups with and without heart disease in regard to their cardiovascular parameters, a decrease in HR was observed during the pressure support technique in the time 30 for the group with heart disease. When comparing patients with and without heart disease, both in pressure support and T-tube ventilation techniques, HR was greater in those without heart disease. Regarding the electrocardiographic parameters, patients with heart disease had more frequent alterations in the ST segment, as well as a trend towards a greater occurrence of arrhythmias. Sinus tachycardia was more frequent in those without heart disease.

Table II – Gas exchange parameters of the 20 patients assessed during the weaning techniques; values in mean ± standard deviation

Parameter	Time	T Tube	PS	p^a
SaO_2	0	95±2	97±1	0.001
	15	95±3	97±2	0.003
	30	95±3	97±1	0.001
p^b		0.517	0.750	
$PetCO_2$	0	31±9	33±9	0.036
	15	32±9	34±9	0.046
	30	32±8	35±10	0.021
p^b		0.333	0.178	

PS - pressure support; SaO_2 - peripheral oxygen saturation; $PetCO_2$ - extrapolated end-tidal carbon dioxide tension; p^a – Student *t* test comparing PS and T tube; p^b - analysis of variance (ANOVA) comparing the 3 times studied.

Table III – Respiratory functional parameters of the 20 patients assessed during the weaning techniques; values in mean ± standard deviation

Parameter	Time	T tube	PS	p^a
	0	28±9	24±9	0.021
f	15	30±10	25±8	0.004
	30	28±8	27±9	0.142
p^b		0.420	0.058	
	0	8±3	11±4	0.001
V_E	15	9±2	11±3	<0.001
	30	9±3	12±4	0.001
p^b		0.333	0.178	
	0	295±75	462±140	<0.001
V_T	15	304±80	455±77	<0.001
	30	290±103	451±83	<0.001
p^b		0.667	0.886	

PS - pressure support; p^a – Student *t* test comparing PS and T tube; *f* – respiratory rate (breaths per minute); p^b - analysis of variance (ANOVA) comparing the 3 times studied; V_E - minute volume (L/min); V_T – tidal volume (mL).

Table IV - Cardiovascular parameters of the 20 patients assessed during the weaning techniques; values in mean ± standard deviation

Parameter	Time	T tube	PS	p^a
HR	0	94±17	93±2	0.638
	15	95±18	96±23	0.825
	30	97±18	97±24	0.926
p^b		0.894	0.878	
	0	133±18	131±24	0.596
SBP	15	137±25	134±23	0.262
	30	136±25	135±24	0.883
p^b		0.831	0.816	
	0	72±16	69±13	0.285
DBP	15	71±14	69±13	0.106
	30	73±13	72±14	0.650
p^b		0.704	0.202	
	0	92±14	91±14	0.672
MBP	15	93±14	91±15	0.565
	30	94±15	92±15	0.233
p^b		0.786	0.920	
	0	0.50±0.76	0.60±0.67	0.378
ST	15	0.55±0.85	0.60±0.71	0.738
	30	0.53±0.90	0.61±0.63	0.576
p^b		0.700	0.958	

p^a – Student *t* test comparing PS and T tube; HR – heart rate (bpm); p^b - analysis of variance (ANOVA) comparing the 3 times studied; SBP– systolic blood pressure (mmHg); DBP – diastolic blood pressure (mmHg); MBP– mean blood pressure (mmHg); ST - numerical value of the ST segment in mm.

Our results agreed with those of some previous studies that reported an increase in SaO_2 in patients undergoing pressure support ventilation as compared with those undergoing T-tube ventilation[12]. Tobin et al[12] reported that PaO_2 was lower in the group of patients undergoing spontaneous breathing than that in patients undergoing mechanical ventilation. Chatila et al[18] reported that patients, who failed to wean from mechanical ventilation (using a T tube), had a drop in oxygen saturation, showing that oxygen desaturation may be rather due to failure to wean than be its cause.

Contrary to some studies[19], ours showed that $PetCO_2$ was mildly, but significantly greater in the pressure support ventilation technique, but the increase remained within normal levels. In a group of patients with acute respiratory failure, Pierce et al[19] showed that the elevation in the levels of pressure support caused a decrease in *f*, in $PetCO_2$, and in the asynchronous respiratory pattern. Because capnography is a noninvasive and continuous method, its use to assess the adequacy of ventilation during weaning from mechanical ventilation is attractive; however, until the present time, it has not yet been definitively established. For some authors, $PetCO_2$ was an important predictor of the alterations in $PaCO_2$ that occurred during weaning from mechanical ventilation[20]. On the other hand, in a group of patients in the postoperative period of cardiac surgery, $PetCO_2$ proved to be an incorrect predictive parameter of the alterations in $PaCO_2$ during weaning in 30% of the cases[21]. In addition, in a pilot study, Drew et al[22] reported that the use of $PetCO_2$ did not shorten the time required for extubation, and did not reduce the number of arterial gas analyses performed when the patient underwent weaning from mechanical ventilation.

Table V – Cardiovascular measures in patients with and without heart disease assessed during the weaning techniques; values in mean ± standard deviation

		Without heart disease (n=9)			With heart disease (n=11)		
Parameter	Time	T tube	PS	p^a	T tube	PS	p^a
fc	0	105±18	105±22	1.000	85±11†	84±12‡	0.473
	15	105±18	111±23	0.088	87±13†	83 ± 12‡	0.075
	30	105±21	114±2	0.058	90±13†	83 ± 12‡	0.003
p^b		0.908	0.737		0.657	0.847	
PAS	0	132±20	126±22	0.111	134±17	136 ± 26	0.724
	15	133±21	128±20	0.325	141±27	139 ± 24	0.612
	30	128±21	131±25	0.545	142±27	138 ± 24	0.420
p^b		0.647	0.118		0.247	0.181	
	0	74±17	67±13	0.088	70±15	71 ± 12	0.625
PAD	15	70±16	66±14	0.104	72±14	72±13	0.749
	30	70±13	72±16	0.622	5±12	71±13	0.251
p^b		0.209	0.104		0.172	0.865	
	0	94±18	87±15	0.125	91±12	93±12	0.437
PAM	15	91±16	87±16	0.269	95±14	94±13	0.557
	30	89±16	90±18	0.860	98±14	93±13	0.192
p^b		0.706	0.962		0.501	0.977	
ST	0	0.79±0.58	0.87±0.59	0.594	0.27±0.85	0.39±0.68	0.506
	15	0.81±0.53	0.82±0.69	0.957	0.34±1.02	0.42±0.72	0.720
	30	0.80±0.57	0.72±0.61	0.695	0.31±1.09	0.53±0.67	0.695
p^b		0.953	0.315		0.731	0.057	

PS - pressure support; p^a – Student *t* test comparing PS and T tube; HR – heart rate; p^b - analysis of variance (ANOVA) comparing the 3 times studied; SBP – systolic blood pressure (mmHg); DBP – diastolic blood pressure (mmHg); MBP – mean blood pressure (mmHg); ST - numerical value of the ST segment in mm. † = Student *t* test (P*<0.05)* for the T tube comparing patients with and without heart disease; ‡ = Student *t* test (P*<0.05)* for PS comparing patients with and without heart disease. Note that in both PS and T tube, HR was greater in patients without heart disease than in those with heart disease.

Table VI - Characteristics of the alterations in the ST segment and arrhythmias in 20 patients assessed during weaning; numerical values (% of occurrences)

Characteristics	Total (n=20)		With heart disease (n=11)		Without heart disease (n=9)	
	PS	T tube	PS	T tube	PS	T tube
Alterations in the ST segment	9 (45)	9 (45)	7 (64)	7(64)	2 (22)†	2 (22)†
Elevation in the ST	3 (15)	3 (15)	2 (18)	2 (18)	1 (11)	1 (11)
Depression in the ST	2 (10)	2 (10)	2 (18)	2 (18)	0	0
T-wave inversion	4 (20)	4 (20)	3 (27)	3 (27)	1 (11)	1 (11)
Arrhythmias	4 (20)	4 (20)	3 (27)	3 (27)	1 (11)	1 (11)
AF	2 (10)	2 (10)	1 (9)	1 (9)	1 (11)	1 (11)
VES	1 (5)	1 (5)	1 (9)	1 (9)	0	0
SVES	1 (5)	1 (5)	1 (9)	1 (9)	0	0
Sinus tachycardia	5 (25)	5 (25)	0	0	5 (56)‡	5 (56)‡

PS - pressure support; AF– atrial fibrillation; VES - ventricular extrasystoles; SVES - supraventricular extrasystoles; † - P<0.05 chi-square (patients with heart disease *versus* patients without heart disease); ‡ - P < 0.01 chi-square (patients with heart disease *versus* patients without heart disease). Note: the values shown represent the total of electrocardiographic alterations recorded in the times zero, 15, and 30, during the 2 weaning techniques.

Jubran and Tobin[23] have shown that the patients who fail the weaning trials develop rapid and superficial breathing, which, along with the mechanical overload, leads to the deficient elimination of carbon dioxide, resulting in hypoventilation and ineffective gas exchange. According to the same mechanism, one may infer that an increase in the minute volume may improve CO_2 elimination. In our study, an increase in the minute volume occurred, as well as a slight increase in $PetCO_2$ during pressure support.

The results showed a decrease in *f* in the times zero and 15, and an increase in V_T and V_E throughout the entire protocol, when the patients underwent pressure support, and these data are favorable to that weaning method. These findings are in accordance with those reported by Jubran et al[23], who showed a significant decrease in *f* and a significant increase in V_T and V_E, when the pressure support levels increased from 5 to 20 cmH_2O.

The respiratory rate is a frequently used index to predict the outcome of weaning, but it does not adequately discriminate the success of extubation. Tobin et al[12] reported that patients who failed to wean from the mechanical ventilation had a decrease in V_T and an increase in *f*. On the other hand, De Haven et al[24] reported that 105 of 509 extubated patients had a *f* >30 bpm prior to extubation, and 97 were successfully extubated, indicating that tachypnea was a sensitive, although not sufficiently specific, index.

Esteban et al[25] reported that the clinical evolution during the spontaneous breathing trials, assessed by use of *f* and SaO_2 parameters, was completely different for the patients who failed the trial and those who succeeded in the 2-hour trial (T tube or pressure support). Immediately after discontinuation of the ventilatory support, the patients who failed the spontaneous breathing trial had a significantly greater *f* than those who tolerated the complete 2-hour T-tube trial, and SaO_2 was significantly lower. Although these parameters do not predict failure in extubation, a more accurate analysis of the breathing pattern may detect differences that do not reflect on the measurements taken every 15 minutes.

When comparing pressure support and T tube, no significant alterations were found in the cardiovascular parameters analyzed (SBP, MBP, DBP, ST segment, and HR). When comparing patients with and without heart disease, a decrease in HR was observed in those with heart disease when undergoing pressure support in time 30.

Esteban et al [25] reported that in the clinical evolution of patients undergoing the spontaneous breathing trial, a clear difference was observed in the HR and SBP parameters of those who failed the spontaneous breathing trial [HR 100 (85 – 120 bpm); SBP 150 (125 - 180 mmHg)] and those who succeeded in the 2-hour trial (T tube or pressure support) [HR 92 (85 – 105 bpm); SBP 135 (120 - 150 mmHg)]. That study also showed that both techniques, T tube and pressure support, are equally effective in the spontaneous breathing trial before extubation in patients undergoing mechanical ventilation who have difficulty in resuming spontaneous breathing. Our results are in accordance with those of that study, considering that significant alterations in HR and systemic blood pressure were not observed during pressure support or T-tube ventilation. Lemaire et al[26] reported that, in patients with chronic obstructive pulmonary disease and cardiovascular disease, the transition from mechanical ventilation to T tube resulted in an increase in systemic blood pressure, in HR, and in pulmonary artery occlusion pressure, which required the return to mechanical ventilation. Our results showed a mild and nonsignificant tendency towards an increase in HR in the 2 methods, without altering blood pressure.

When comparing patients with and without heart disease using the T tube, HR was observed to be significantly greater in those without heart disease, which may be explained by the fact that at least 7 patients with heart disease were being treated with specific drugs, such as propranolol, digoxin, captopril, isosorbide, and amiodarone. Patients without heart disease were not receiving such drugs.

Regarding the electrocardiographic parameters, the alterations in the ST segment were significantly more frequent in patients with heart disease, and the occurrence of sinus tachycardia was greater in patients without heart disease, both in pressure support and T-tube ventilation.

The increase in the cardiac overload, when changing from mechanical ventilation to spontaneous breathing, can cause alterations in myocardial perfusion and ischemia[18,27], leading to a successful weaning. Rasanen et al[27] reported the occurrence of electrocardiographic alterations indicating myocardial ischemia in 6 out of 12 patients with myocardial infarction complicated with respiratory failure, requiring mechanical ventilation. Hurford and Favorito[28] reported that 6 of 17 patients depending on mechanical ventilation who failed to wean from mechanical ventilation had electrocardiographic alterations evidencing ischemia. Abalos et al[29] reported ischemia in monitoring the ST segment in 9% to 14% of patients with coronary artery disease when undergoing weaning from mechanical ventilation after noncardiac surgery. Chatila et al[18] have also reported the presence of ischemia in 6% of those patients. However, ischemia was more frequently detected (10%) in patients with history of coronary artery disease associated with failure to wean in 22% of the cases. The studies cited suggested that the incidence of myocardial ischemia may be overestimated due to electrocardiographic criteria relatively insensitive to detect myocardial ischemia[18,30]. Many patients are suspected to fail to wean from mechanical ventilation, due to occult myocardial ischemia or myocardial ischemia not well-detected on electrocardiographic tracings.

Those studies have not performed a comparative analysis between T-tube and pressure support ventilation. Our findings confirm those cited, with a predominance of alterations in the ST segment in patients with heart disease, and showed that the weaning methods are equivalent, without advantages of one over the other.

The significantly greater occurrence of sinus tachycardia in patients without heart disease may be explained by the fact that patients with heart disease are usually treated with drugs specific for their cardiovascular impairment, which is not the case of patients without heart disease.

Arrhythmias were observed with both methods and more frequently in patients with heart disease, although without a significant difference.

The interpretation of our results should consider certain methodological limitations. The size of the sample (n=20) was statistically accepted for comparing pressure support and T-tube ventilation, without considering the analysis into groups. However, when subdividing the patients into with and without heart disease groups, the number of patients in each group was reduced, which may have interfered with the power to detect differences in the results. This may have been the reason for not detecting the differences when comparing pressure support and T-tube ventilation in patients with (n=11) and without (n=9) heart disease.

Another limitation relates to the analysis of cardiovascular variables, which included only simple clinical parameters and electrocardiographic evaluation, which may not have detected smaller magnitude alterations.

Our conclusions were as follows: 1) when comparing the weaning techniques: a) an improvement in oxygenation and in the respiratory functional parameters occurred in the pressure support ventilation technique, which was shown by the reduction in the respiratory rate at least during the first 15 minutes and by the increase in V_T and V_E; b) no difference was observed in the cardiovascular and electrocardiographic variables; 2) when comparing the groups with and without heart disease, the former had the following: a) significantly smaller HR values in the 30 minutes with pressure support, as compared with those with T tube; b) a greater incidence of ST alterations, smaller occurrence of tachycardia, and a tendency towards a greater occurrence of arrhythmias. On the other hand, patients without heart disease had a tendency towards a greater incidence of tachycardia. Finally, regarding the evaluation of the cardiorespiratory parameters in critically ill patients undergoing the pressure support and T-tube ventilation weaning techniques, new studies are required. Such studies should have larger samples to show the differences that may exist. They also should have a more sophisticated methodology for cardiovascular assessment, such as Holter monitoring, myocardial scintigraphy, and echocardiography, increasing the probability to detect milder cardiovascular alterations.

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