Automatic tube compensation versus pressure support ventilation as a weaning mode: does it make a difference?

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Background Automatic tube compensation (ATC) is one of the newer weaning modes that seem promising to improve the weaning process.

Objective To evaluate the benefit of ATC in hastening and improving the weaning process.

Patients and methods In a prospective randomized-controlled trial, all eligible patients of Assiut Chest Department who were mechanically ventilated were included during the period from April 2010 to March 2012. They were divided into two groups, 88 patients weaned by pressure support ventilation (PSV) and 78 patients weaned by ATC. The primary outcomes measure was the ability to maintain spontaneous breathing for more than 48 h after extubation and weaning duration.

Results A total of 166 patients were included; the mean age was 58.6 ± 12.3 years; males represented 70%. The weaning duration was shorter in ATC than in PSV (19.7 vs. 29.9 h, respectively). Also, ATC had a higher trend toward successful extubation than PSV (88.5 vs. 78.4%). Patients who underwent weaning by ATC had a nonsignificant trend toward simple weaning. Moreover, hospital mortality was less in ATC (ATC 15.4% vs. PSV 22.7%). However, the difference did not reach significance in all primary and secondary outcomes.

Conclusion In respiratory ICU patients, the weaning process can be usefully performed by ATC (at least as effective as PSV) but without significant hastening of the weaning process. All primary and secondary outcomes were potentially improved (weaning duration, extubation outcome, predictive value of ATC-assisted ratio of respiratory rate and tidal volume, number of spontaneous breathing trials, weaning category, reintubation rate, complications, and hospital mortality). *Egypt J Broncho* 2015 9:253–260

Egyptian Journal of Bronchology 2015 9:253–260

Keywords: automatic tube compensation, pressure support ventilation, respiratory ICU, weaning

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Received 07 March 2015 **Accepted** 19 June 2015

Introduction

Weaning covers the entire process of liberating the patient from mechanical support and from the endotracheal tube (ETT) [1]. Weaning from mechanical ventilation (MV) is a challenge. Its prolongation is related to increased mortality [2]. Spontaneous breathing trial (SBT) is the major diagnostic test to determine whether patients can be successfully extubated. SBT tolerance is an evidence-based method to predict successful weaning [1]. The question of the most adequate way to perform SBTs is still unanswered [3].

With recent advances in technology, new features on ventilators like automatic tube compensation (ATC) have been developed. Several trials have been performed to evaluate the prediction of weaning outcome using this new feature [4–7].

The working principle of ATC is based on continuous calculations of tracheal pressure, whereby calculation is based on continuously measured flow and airway pressure (at the proximal end of the ETT) and tube-specific coefficients [8]. ATC compensates for the pressure drop across the endotracheal or tracheostomy tube by delivering exactly the amount of pressure necessary to overcome the resistive load imposed by the tube [9]. However, partial tube obstruction as a result of secretions and kinking might result in undercompensated ETT resistance with the ATC mode [8,10].

ATC has been shown to decrease the work of breathing (WOB) necessary to overcome ETT resistance more effectively than pressure support ventilation (PSV) or continuous positive airway pressure (CPAP). So, it can simulate spontaneous breathing without ETT, so it has been designated as 'electronic extubation'. Therefore, ATC is ideally suitable for use during the weaning period [11]. It is possible, however, that ATC could allow more marginal patients to tolerate a breathing trial, who then would develop ventilatory failure after extubation. This mode therefore theoretically can decrease the weaning duration and increase the

 DOI: 10.4103/1687-8426.165905

probability of successful extubation by decreasing the WOB [12].

The aim of the study was to assess the value of ATC in predicting successful weaning and hastening the weaning process. To do this, we assessed extubation outcome after an SBT with ATC and compared it with PSV.

Patients and methods

Study design and ethics

The present prospective randomized-clinical trial study was conducted in Respiratory Intensive Care Unit (RICU), Chest Department, Faculty of Medicine, Assiut University Hospital, during the period from April 2010 to March 2012. The study design was approved by the Scientific Ethics Committee of Faculty of Medicine of Assiut University. After meeting the inclusion criteria, informed consent was obtained from the patient or the surrogate decision-maker.

Patients

Patients were eligible for enrollment (166 patients) if they admitted to respiratory ICU with respiratory disorders and required MV for more than 1 day. Exclusion criteria include patients who received noninvasive ventilation without subsequent intubation; patients who died before they were ready to wean; patients who experienced unplanned extubation before or during the weaning process; age less than 18 years and patients with postarrest encephalopathy.

Baseline patient data

Full history was taken from the patient or their relatives. Full clinical examination also was observed on the day of ICU admission. Chest radiography, daily arterial blood gases, and full laboratory assessment were carried out. Illness severity and expected mortality were measured on the day of ICU admission by Acute Physiology and Chronic Health Evaluation (APACHE) II score [13] and the Simplified Acute Physiology Score (SAPS) II [14]. Moreover, the prospectively collected data included reasons for ICU admission according to a predefined list of medical diagnoses, amount of sputum, ETT diameter, duration of hospitalization, and use of sedative and its duration.

Procedures

Initiation of mechanical ventilation

All included patients (166 patients) were intubated using ETTs of size 7.0–8.0 mm. Ventilation was performed with the Puritan–Bennett 840 ventilator. Patients were adjusted on synchronized intermittent mandatory ventilation (Nellcor Puritan-Bennett 840 ventilator, Florida, USA), volume controlled mode except for patients with severe asthma and acute respiratory distress syndrome (ARDS), who were adjusted on pressure controlled mode (synchronized intermittent mandatory ventilation, pressure control) as a lung protective strategy.

Weaning from mechanical ventilation procedure

The procedure of weaning from MV was considered as early as possible. Patients who were receiving MV more than 24 h underwent a daily screen of subjective and objective indices for assessment of readiness to wean. Weaning was conducted in 166 patients, according to the current statement of ERS, ATS, ESICM, SCCM, and SRLF [1].

The process of SBT

Usually SBT was conducted early in the morning, when the patient was fully rested and fully conscious. The duration of the trials ranges between 30 and 120 min. Shorter time duration can be recommended for patients on the ventilator for less than 1 week and weaning success is expected, while longer duration trial is for patients who have previously failed weaning [15].

Modes of SBT: The SBT was performed with either PSV or ATC. In both groups, the patients breathed through the ventilator circuit with flow-triggering set at 3 l/min, the peak end expiratory pressure at 0–5 cmH_2O and FiO_2 less than or equal to 0.4. For patients who were weaned by PSV (88 patients), initial positive pressure support (PS) was 15 cmH_2O. Patients were extubated at PS of 8 cmH_2O, which is necessary to overcome increased airway resistance. The first trial was usually conducted by rapid decline of PS, while subsequent trials were conducted by rapid or gradual reduction of support [1]. PS was lowered by 2–4 cmH_2O based on respiratory parameter, circulation, and patient response. In the ATC group (78 patients), the size of the ETT is entered into the ventilator software and the patients breathe through the ventilatory circuit with inspiratory ATC set at 100%. Patients who failed the first SBT underwent all subsequent SBTs with the same SBT method.

Monitoring during SBT

Patients should be subjectively observed for dyspnea, fatigue, anxiety, and distress. The criteria for passing an SBT include good respiratory pattern, adequate gas exchange, hemodynamic stability, and subject comfort [1]. Arterial blood gases were done at the

end of the SBT. Tolerance to SBT was continuously evaluated. Ventilatory data were recorded at the end of the SBT, including tidal volume, respiratory rate, RR/TV (breaths/min/l), and the integrative weaning index (IWI). IWI equals to static compliance of the respiratory system (Cst, rs)×arterial oxygen saturation (SaO_2)/RR/TV ratio [16]. Values were displayed on the ventilator and we used the average of three breaths.

Signs of a low trial tolerance (SBT failure) included spontaneous respiratory rate more than 35/min, heart rate more than 140/min (or ≥20% change), systolic blood pressure more than 180 mmHg or less than 90 mmHg, PaO_2 less than or equal to 60 mmHg or SaO_2 less than 90% on FiO_2 less than or equal to 0.4, pH less than or equal to 7.32 or a decrease in pH more than or equal to 0.07, $PaCO_2$ more than 50 mmHg or an increase in $PaCO_2$ more than 8 mmHg, RR/TV more than 105 breaths/l, worsening of respiratory distress, deterioration of the neurological status, including psychomotor agitation requiring sedation and life-threatening cardiovascular alterations [1].

Fate of SBT

Patients in whom the SBT was successful were then extubated. Patients who passed the first SBT and extubated successfully (n = 89) were considered as simple weaning. If one or more signs of poor procedure tolerance were observed during the trial, the patient was considered difficult-to-wean (n = 59) and full ventilatory support was immediately recommended to allow muscle rest. In such patients, the same procedure of weaning was repeated the next day, if permitted by the patient's clinical condition, following the same protocol. Patients who fail at least three weaning attempts, or require more than 7 days of weaning after the first SBT were considered prolonged weaning (n = 18). If the patient could not be disconnected from MV after several attempts without positive evolution of the weaning process, a tracheostomy (n = 11) was considered. The final decision to extubate or to do tracheostomy was made by the physician in charge.

Weaning procedure was considered successful (138 patients) when the unassisted spontaneous breathing is sustained for 48 consecutive hours without respiratory distress, with pH more than 7.35 and PaO_2 more than 60 mmHg in a patient breathing through a mask at FiO_2 less than or equal to 0.6. The total weaning duration was calculated as the days between the time when a patient was first ready to wean and the time when a patient was successfully weaned for the last time [17].

Weaning failure (inability to tolerate spontaneous breathing without ventilatory support) was defined as:

(a) Failed SBT;
(b) Reintubation and/or resumption of ventilatory support following successful extubation for more than 2 days after weaning; and
(c) Death within 48 h following extubation [18].

Outcome variables

The primary outcome measures are weaning duration and successful extubation. The secondary outcome measures are duration of MV, days ventilated before start of weaning, number of SBT, failure of first SBT, weaning categories, length of ICU stay, length of hospital stay, reintubation rate, need of noninvasive ventilation after extubation and its duration, hospital mortality, occurrence of complication arising during the course of the MV, and ICU stay (including pneumonia, ARDS, shock, sepsis, barotrauma, major arrhythmia, renal failure, electrolyte disturbance, deep venous thrombosis, and stress ulcer). In addition the predictive value of ATC-assisted RR/TV was also evaluated.

Statistical analysis

Data were recorded to statistical package for social science, version 21 (IBM Inc., Armonk, New York, USA). Data were described using mean ± SD or frequencies and percentage accordingly if they are quantitative or qualitative, respectively. A P-value was done between both ATC and PSV group and the value of less than 0.05 was considered significant. Nonparametric tests were used in the current study as the Mann–Whitney test (equivalent to independent Student's t-test in parametric tests) and the χ^2-test.

Results

During the study period, 247 patients were intubated and fulfilled the inclusion criteria. Among them, 166 patients met the criteria of weaning, 88 were weaned from MV by PSV mode (PSV group) and 78 were weaned by ATC mode (ATC group). The course and outcome are summarized in Fig. 1.

No statistically significant difference was found between the groups in terms of sex, age, BMI, ever cigarette smoker, previous hospitalization, APACHE II score, SAPS II score, need for sedation more than 24 h, and size of ETT. The only significant variable between both groups was the type of respiratory failure necessitating intubation and MV. The study included 17 patients with acute respiratory failure (12 asthma, three ARDS, two pulmonary embolism) and 149 patients with chronic respiratory failure (120 chronic obstructive pulmonary disease, 13 post-tuberculosis sequelae,

seven obesity hypoventilation syndrome, five ARDS, and four others). Patients with acute respiratory failure were more in the PSV groups, while patients with chronic respiratory failure were more in the ATC groups (Table 1).

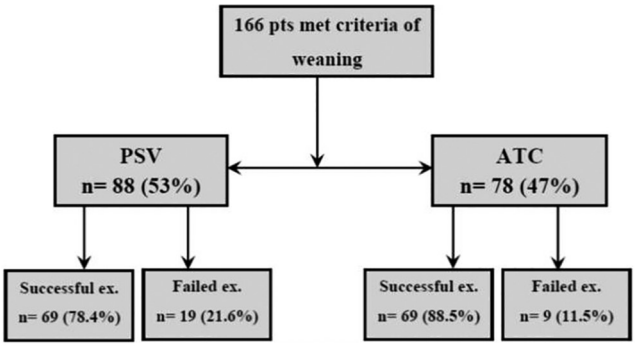
The respiratory and hemodynamic characteristics before the start of weaning according to the method of weaning are shown in Table 2. No statistically significant difference was determined between the groups in terms of vital signs and blood gas parameters.

The characteristics at the end of the first SBT are shown in Table 3. No significant differences were identified between the ATC and PSV groups in any parameter studied at the end of the first SBT. In the ATC group, improvement of exhaled tidal volume (4.96 vs. 4.35 ml/kg), RR/TV (104 vs. 120) and IWI (53 vs. 51) was observed as compared with the PSV group.

We evaluated the role of ATC to improve the predictive value of RR/TV and integrated weaning index in predicting successful outcome as shown in Table 4. Both ATV-assisted RR/TV and IWI were significantly efficient in predicting successful extubation.

Comparison between the groups in terms of weaning outcome is presented in Table 5. Duration of MV, duration of weaning, and the number of SBT were less in ATC than in PSV with no significant difference. In the ATC group, 69 of 78 patients (88.5%) tolerated the breathing trial and underwent successful extubation, compared with 69 of 88 (78.4%) in the PSV group; however, this observed difference was not significant. However,

Fig. 1



The course and outcome of patients in PSV and ATC groups. ATC, automatic tube compensation; PSV, pressure support ventilation.

Table 1 Demographic data and baseline difference between PSV and ATC groups

Parameter	Total (*n* = 166)	PSV group (*n* = 88)	ATC group (*n* = 78)	*P*-value
Sex: male/female	116/50	58/30	58/20	0.24
Age (years)	58.63 ± 12.26	56.86 ± 12.63	60.62 ± 11.58	0.49
BMI (kg/m^2)	26.84 ± 4.53	26.96 ± 4.86	26.71 ± 4.15	0.73
Ever cig. smoker	99 (59.6)	50 (56.8)	49 (62.8)	0.43
Hospitalization last year	0.87 ± 0.88	0.88 ± 0.86	0.86 ± 0.86	0.91
Type for respiratory failure				
ARF	17 (10.2)	13 (14.8)	4 (5.1)	
CRF	149 (89.8)	75 (85.2)	74 (94.9)	0.035*
APACHE II	22.42 ± 4.42	22.14 ± 4.89	22.73 ± 3.84	0.38
SAPS II	38.41 ± 8.84	39.38 ± 9.4	37.33 ± 8.1	0.13
Use of sedative>24 h	67 (40.4)	36 (40.9)	31 (39.7)	0.88
ETT size (mm)	7.49 ± 0.13	7.49 ± 0.14	7.49 ± 0.11	0.72

Continuous data are presented as mean ± SD, whereas categorical variables are presented as frequency and %; APHCHE II, acute physiology and chronic health evaluation; ARF, acute respiratory failure; ATC, automatic tube compensation; CRF, chronic respiratory failure; ETT, endotracheal tube; ever cig. smoker, exsmoker+current smoker; PSV, pressure support ventilation; SAPS II, simplified acute physiology score; *Significant difference.

Table 2 Vital signs and blood gases at the start of weaning trial

Parameter	Total (*n* = 166)	PSV group [*n* = 88 (53%)]	ATC group [*n* = 78 (47%)]	*P*-value
Heart rate (beats/min)	88.46 ± 14.77	90.63 ± 16.43	86.03 ± 12.28	0.075
Mean BP (mmHg)	85.6 ± 19.86	83.19 ± 19.53	88.31 ± 20.01	0.098
Respiratory rate (breaths/min)	25.55 ± 4.39	26.09 ± 4.51	24.94 ± 4.2	0.09
Temperature (°C)	37.15 ± 0.53	37.11 ± 0.52	37.18 ± 0.54	0.12
pH	7.46 ± 0.05	7.46 ± 0.05	7.45 ± 0.06	0.83
$PaCO_2$ (mmHg)	51.8 ± 10.01	51.3 ± 10.73	52.36 ± 9.16	0.49
PaO_2/FiO_2	210.93 ± 49.76	210.85 ± 52.56	211.01 ± 46.75	0.98
SaO_2	95.83 ± 2.27	95.75 ± 2.41	95.91 ± 2.13	0.65

ATC, automatic tube compensation; BP, blood pressure; PSV, pressure support ventilation.

Table 3 Parameters of weaning at the end of first SBT

Parameter	Total (*n* = 166)	PSV group (*n* = 88)	ATC group (*n* = 78)	*P*-value
Heart rate	94.33 ± 16.56	95.48 ± 17.94	93.02 ± 15.21	0.26
Respiratory rate (breaths/min)	29.84 ± 9.5	30.11 ± 7.16	29.53 ± 11.63	0.69
Tidal volume (ml/kg)	4.63 ± 2.9	4.35 ± 1.56	4.96 ± 3.88	0.17
RR/TV	112.2 ± 59.28	119.56 ± 65.25	103.97 ± 50.9	0.09
IWI	52.23 ± 42.27	51.39 ± 45.34	53.17 ± 38.79	0.79
pH	7.42 ± 0.15	7.43 ± 0.07	7.41 ± 0.22	0.45
$PaCO_2$ (mmHg)	56.37 ± 11.36	56.72 ± 12.58	55.97 ± 9.86	0.67
PaO_2 (mmHg)	72.23 ± 15.25	72.82 ± 18.09	71.58 ± 11.3	0.59
PaO_2/FiO_2	179.81 ± 36.26	179.6 ± 42.6	180.04 ± 27.69	0.94
SaO_2	93.21 ± 42.27	92.86 ± 3.88	93.6 ± 2.59	0.15

ATC, automatic tube compensation; IWI, integrated weaning index; PSV, pressure support ventilation; RR/TV, ratio of respiratory rate and tidal volume; SBT, spontaneous breathing trial.

Table 4 Assisted RR/TV and IWI in predicting successful extubation

Parameter	Successful extubation	Failed extubation	*P*-value
PSV-assisted RR/TV	106.54 ± 59.38	166.87 ± 65.143	0.000*
ATC-assisted RR/TV	96.88 ± 46.89	158.33 ± 49.83	0.000*
PSV-assisted IWI	57.74 ± 46.96	28.33 ± 29.78	0.002*
ATC-assisted IWI	57.08 ± 39.49	23.23 ± 9.17	0.000*

ATC, automatic tube compensation; IWI, integrated weaning index; PSV, pressure support ventilation; RR/TV, ratio of respiratory rate and tidal volume; SBT, spontaneous breathing trial, *Significant difference.

31 patients failed their first SBT in ATC compared with 46 patients in PSV. A total of 30 patients (18.1%) required reintubation: 12 (15.4%) in the ATC group and 18 (20.5%) in the PSV group. There is no significant difference between both groups as regard failure of first SBT, successful weaning, and need of noninvasive ventilation after extubation. No significant difference existed between the ATC and PSV groups regarding weaning categories. However, patients who underwent weaning by PSV had a higher trend toward difficult and prolonged weaning, while patients who underwent weaning by ATC had a higher trend toward simple weaning.

Length of stay, complications, and mortality outcome are demonstrated in Table 6. Hospital-acquired pneumonia was less frequent with ATC versus PSV (12.8 vs. 20.8%, respectively). There was no significant difference in terms of occurrence of hospital-acquired pneumonia or number of complications. Patients weaned by ATC had a nonsignificant trend toward lower ICU and hospital mortality.

Discussion

ATC is a newly developed mechanical ventilatory support method to overcome respiratory work produced by endotracheal resistance.

As regards demographic and baseline data, no significant difference between both ATC and PSV groups was found in term of age, sex, BMI, smoking history, previous hospitalization, APACHE II score, SAPS II score, proportion of patients who required sedation for more than 24 h, and size of ETT. Patients weaned with ATC were compared with patients weaned with PSV in terms of heart rate, mean blood pressure, respiratory rate, and axillary temperature, measured at the start of weaning with no significant difference being found. Also, blood gases variables were not significantly different between both groups. However, patients with acute respiratory rate were more weaned by PSV than ATC ($P = 0.035$). However, the determined statistical significance was of minimal clinical importance, since all other parameters had no significant difference between both groups including APACHE II and SAPS II. So, we can propose that there were no significant differences in baseline characteristics between the two groups. This finding suggests that both modes of weaning (ATC vs. PSV) can be conveniently compared with each other in terms of weaning course and outcome and also regarding the fate of extubation, length of stay, the occurrence of complications, and mortality rate [7].

Moreover, no significant difference was observed in terms of characteristics at the end of first SBT between both groups. These results are consistent with Figueroa-Casas and colleagues, who posted that RR/TV ratio and PaO_2/FiO_2 had no significant difference between ATC group and CPAP group. Selek and colleagues reported that there was no significant difference regarding the respiratory rate and SaO_2 over the course of the study period between ATC and T-piece. On the other hand, Haberthur and colleagues stated that there were significant differences between both groups in respiratory rate, tidal volume, and RR/TV ratio. We also found that the predictive value of ATC-assisted RR/TV and IWI was improved in predicting

Table 5 Weaning course and outcome

Parameter	Total (*n* = 166)	PSV group (*n* = 88)	ATC group (*n* = 78)	*P*-value
Duration MV before weaning (days)	3.37 ± 1.92	3.49 ± 2.18	3.23 ± 1.59	0.26
Duration of MV (days)	4.33 ± 2.87	4.6 ± 3.17	4.01 ± 2.48	0.39
Duration of weaning (h)	25.11 ± 38.31	29.93 ± 42.84	19.68 ± 31.85	0.08
Number of SBT	1.76 ± 1.03	1.84 ± 1.08	1.67 ± 0.97	0.28
Failure of first SBT [*n* (%)]	77 (46.4)	46 (52.3)	31 (39.7)	0.07
Successful extubation [*n* (%)]	138 (83.1)	69 (78.4)	69 (88.5)	0.08
Reintubation [*n* (%)]	30 (18.1)	18 (20.5)	12 (15.4)	0.26
Need of NIV after extubation [*n* (%)]	95 (57.2)	46 (52.3)	49 (62.8)	0.17
Duration of NIV (days)	1.28 ± 1.7	1.09 ± 1.55	1.49 ± 1.84	0.13
Weaning category [*n* (%)]				
Simple weaning	89 (53.6)	42 (47.7)	47 (60.2)	0.11
Difficult weaning	59 (35.5)	34 (38.6)	25 (32.1)	0.38
Prolonged weaning	18 (10.8)	12 (13.6)	6 (7.7)	0.16

ATC, automatic tube compensation; MV, mechanical ventilation; NIV, noninvasive ventilation; PSV, pressure support ventilation; SBT, spontaneous breathing trial.

Table 6 Length of stay, complications, and mortality outcome

Parameter	Total (*n* = 166)	PSV group (*n* = 88)	ATC group (*n* = 78)	*P*-value
ICU stay (days)	8.67 ± 7.29	8.94 ± 7.71	8.37 ± 6.82	0.62
Hospital stay (days)	14.23 ± 8.24	13.76 ± 8.56	14.76 ± 7.89	0.44
HAP [*n* (%)]	28 (16.9)	18 (20.5)	10 (12.8)	0.14
Complication number	1.61 ± 1.82	1.8 ± 1.99	1.41 ± 1.58	0.17
ICU mortality [*n* (%)]	26 (15.7)	18 (20.5)	8 (10.3)	0.055
Hospital mortality [*n* (%)]	32 (19.3)	20 (22.7)	12 (15.4)	0.16

ATC, automatic tube compensation; HAP, hospital-acquired pneumonia; PSV, pressure support ventilation.

extubation outcome (P = 0.000 in both). Cohen and colleagues reported similar results.

The duration of MV and duration of MV before weaning were less in ATC than in PSV, but this observed difference did not reach statistical significance (P = 0.26 and 0.39, respectively); these results are consistent with those of Figueroa-Casas and colleagues, who reported similar results. Moreover, weaning duration and weaning trials were less in the ATC than in the PSV group (20 vs. 30 h and 1.7 vs. 1.8 weaning trials). However, this observed difference of about 10 h between the two groups did not also reach statistical significance (P = 0.08). These results are compatible with those of Figueroa-Casas and colleagues, who found similar results. However, Aggarwal and colleagues concluded that the duration of weaning was significantly shorter in the ATC group than in the PSV group in patients with severe neuroparalytic snake envenomation. Also, Selek and colleagues found weaning duration was significantly shorter in ATC versus T-piece (4.96 vs. 7.42 days, respectively); there results could not be evaluated objectively because of limited patient number.

We found a nonsignificant trend toward more failure of the first SBT in the PSV group than ATC (46 vs. 31% P = 0.07); this same finding was also reported in a study of ATC versus T-piece versus PS [8] and in two studies of ATC versus CPAP [5,19]. Moreover, in a similar study of ATC versus PSV of 7 cmH_2O a trend of better SBT tolerance with ATC was found [6].

We did not find a significant difference in extubation outcome between PSV and ATC (successful extubation rate of about 78 vs. 89%, respectively). This was consistent with Haberthur and colleagues, Cohen and colleagues, and Figueroa-Casas and colleagues, who concluded the same result with different numbers. This apparent discrepancy with a study of ATC versus PSV by Cohen and colleagues, which claimed a superior extubation outcome with ATC, merits further consideration. Moreover, we did not find a significant difference in reintubation rate between both groups (PSV 15% vs. ATC 20%). This was also compatible with Cohen and colleagues and Figueroa-Casas and colleagues. Also Selek and colleagues did not find significant differences between ATC and T-piece.

We also evaluated the need of noninvasive ventilation after extubation, either prophylactic or therapeutic, for treatment of postextubation respiratory failure (PSV 52% vs. ATC 63%). Our result demonstrated a nonsignificant difference in both groups in favor

of PSV in the need and duration of noninvasive ventilation. This was more than what was posted by Tallo and colleagues – that between 25 and 40% of patients have a respiratory distress after extubation. That is probably due to the chronic nature of the majority of our study patients. Moreover, patients who underwent weaning by PSV had a nonsignificant trend toward difficult/prolonged weaning, while patients who underwent weaning by ATC had a nonsignificant trend toward simple weaning. These variables were not evaluated between both groups in previous studies. ICU length of stay, complications including hospital-acquired pneumonia, ICU, and hospital mortality outcome demonstrated a nonsignificant difference in both groups in favor of ATC.

Some considerations should be clarified. First, the rate of passing of the first SBT was 53.6%, which is much lower than the range (58–74%) reported by other investigators with various SBT methods [19]. This can be explained by the nature of patients in our study as all patients had primary pulmonary cause of respiratory failure and the majority of patients had chronic respiratory failure (89.8%). COPD appears as an independent risk factor for increased duration of weaning and weaning failure with failure of first SBT rate reaching up to 61% [1]. Second, unsuccessful extubation rates in our study lie within the range 12–24%, as reported in previous studies [20]. Third, the reintubation rate (18%) in our study was slightly higher than the range (10–15%) reported by Thille *et al.* [21] but within the range (6–23%) reported by Ferrer *et al.* [22].

Despite the strong theoretical advantages of ATC, most of the studies published to date did not prove superiority to other SBT methods. For ATC to be superior to other weaning modes, failure would need to frequently result from the imposed WOB rather than other causes. Only 10–20% of extubated patients fail extubation and require reintubation. Many of those result from upper-airway obstruction, excessive secretions, inadequate cough, or abnormal mental status – a combination of factors that compromise the patient's ability to protect the airway and have little to do with the SBT ventilation mode. Of the remainder, it is likely that only a minority can be attributable to excessive or insufficient support by PSV (which proposed to be avoided by ATC). Although the ideal level of PS varies widely, the typically used pressure range of 5–8 cmH_2O may actually prove adequate in most patients; this range may infrequently lead to either excessive or inadequate support [23]. The pressure delivered by ATC depends on the characteristics of the ETT [24]. ETT configuration changes and tracheal secretions can increase ETT resistance and decrease the ability of ATC to compensate for the increased respiratory workload [10]. Although ATC can be considered as a safe procedure, its use in clinical routine yet remains controversial [3].

We agree with Frutos-Vivar and Esteban, who stated that despite the appropriate results obtained in the studies published to date (including our result), more researches are needed, involving larger patient samples and, especially, patients with weaning difficulties, to be able to recommend ATC as the method of choice in performing weaning trial.

Conclusion

In a respiratory ICU population, ATC was safe, reliable, and can be reasonably used for weaning trials. ATC confers a potential benefit in weaning duration, weaning category, number of Ss, failure of first SBT extubation outcome, ICU length of stay, complication, and mortality rate. In addition, ATC improves the predictive value of RR/TV and IWI in predicting weaning success.

Although each variable of primary and secondary outcome was nonsignificantly improved by ATC, the observed differences were efficient and worthy. When we evaluate all these variables collectively, we can state that ATC might improve the weaning process.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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