Proportional assist ventilation versus pressure support ventilation in weaning ventilation: a pilot randomised controlled trial

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Pressure support ventilation (PSV) has been the most commonly used mode of spontaneous mechanical ventilation during weaning.[1] Some patients experience ventilator asynchrony with the institution of spontaneous mechanical ventilation.[2] Despite widespread use of PSV, there is evidence that patient–ventilator asynchrony may occur with this mode under circumstances of fluctuating tidal volume requirements.[2-4] Ventilator asynchrony is associated with the increased need for sedatives and paralytic agents, prolonged mechanical ventilation, increased length of stay in the intensive care unit (ICU), and increased ICU and hospital mortality.[5,6] Newer modes of ventilation, such as the neurally adjusted ventilatory assist mode and the proportional assist ventilation with load-adjustable gain factors (PAV+) mode, have been introduced to reduce ventilator asynchrony.[7,8]

PAV+ is a mode of spontaneous ventilation in which the ventilator generates a supportive positive inspiratory pressure that is proportional to the instantaneous flow.[9-12] Previous studies have shown that PAV+ is a safe and effective mode of ventilation in critically ill patients, and there is evidence to suggest that PAV+ may be associated with better ventilator synchrony.[13,14] The potential benefits of ventilator synchrony are less need for sedation, analgesia and paralytic agents, and reduced duration of mechanical ventilation, ICU length of stay (LOS) and mortality.

Despite the potential advantages of PAV+ ventilation, there are very few studies comparing PAV+ and PSV in patients being weaned off mechanical ventilation.[7,13,15] A randomised controlled trial showed that when comparing PAV+ with PSV in critically ill ventilated patients, PAV+ increased the probability of remaining on spontaneous breathing with a reduced incidence of ventilator asynchronies as compared with PSV.[13] A recently published pilot randomised controlled trial, comparing PSV versus PAV+ as weaning modes, showed the utility, safety and feasibility of the weaning protocols used in the study.[16] Despite literature confirming the physiological benefits of PAV+ ventilation,[15,17] there are no conclusive data confirming the clinical benefit of this novel mode of ventilation. This pilot randomised controlled study aimed to compare PSV with PAV+ in patients being weaned from mechanical ventilation.

ABSTRACT

Objective: Proportional assist ventilation with load-adjustable gain factors (PAV+) is a mode of ventilation that provides assistance in proportion to patient effort. This may have physiological and clinical advantages when compared with pressure support ventilation (PSV). Our objective was to compare these two modes in patients being weaned from mechanical ventilation.

Design: Prospective randomised controlled trial comparing PSV with PAV+.

Setting: University-affiliated, tertiary referral intensive care unit (ICU).

Participants: Mechanically ventilated patients on a controlled mode of ventilation for at least 24 hours, who were anticipated to be spontaneously ventilated for at least 48 hours after randomisation.

Interventions: Nil.

Main outcome measures: The primary outcome was time to successful liberation from the ventilator after the commencement of a spontaneous mode of ventilation. Secondary outcomes were requirement of rescue (mandatory) ventilation, requirement of sedative drugs, requirement for tracheostomy, re-intubation within 48 hours of extubation, ICU length of stay (LOS), hospital LOS, and ICU and hospital mortality.

Results: 50 patients were randomised to either PSV (n = 25) or PAV+ (n = 25). There was no significant difference between the PAV+ and PSV groups in time to successful weaning (84.3 *v* 135.9 hours, respectively; P = 0.536). Four patients randomised to PAV+ were crossed over to PSV during weaning. There was no significant difference between groups for rescue ventilation, re-intubation within 48 hours, tracheostomy, sedatives and analgesics prescribed, and ICU and hospital LOS. ICU mortality was higher in the PSV group (25% *v* 4 %; P = 0.002).

Conclusions: Both modes of ventilation were comparable in time to liberation from the ventilator.

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Materials and methods

Study setting

Patients were recruited from the ICU of Frankston Hospital, Victoria, Australia. The ICU is a 15-bed, tertiary referral, university-affiliated, medical-surgical ICU, with about 1100 admissions per year. Before initiating the study, there was an educational program on the clinical use of PAV+, and this ventilation mode had been deployed in the ICU for 3 months before study enrolment. The enrolment period was from November 2012 until February 2016. This trial was registered with the Australian and New Zealand Clinical Trials Registry (ref. no. ACTRN12612001097831).

Ethics approval

The study was approved by the Human Research and Ethics Committee of Peninsula Health (ref. no. HREC/12/PH/56). Written informed consent was obtained from all patients or from their surrogate decision maker if they were not able to provide consent.

Study design

The study was a prospective randomised controlled trial comparing PAV+ with PSV in patients who met the eligibility criteria. It was an unblinded study, as concealing the ventilator mode was not feasible and would have compromised patient safety.

Patients were eligible for inclusion if they had been ventilated on a controlled mode of ventilation for at least 24 hours and were anticipated to be spontaneously ventilated for at least 48 hours after randomisation. Patients were excluded if they were unlikely to survive 24 hours from the time of screening, were admitted for palliative care; had brain death, had a confirmed hypoxic brain injury, had an existing or imminent tracheostomy, or had a neuromuscular disease.

Eligible patients were randomised while they were receiving a controlled mode of ventilation, after informed consent, using a computer-generated random number sequence in sealed opaque envelopes, which ensured allocation concealment. Enrolled patients were randomised to either PAV+ or PSV, with both modes of ventilation delivered by the Puritan Bennett 840 (Covidien) ventilator. Once randomised, the attending intensivist managed the weaning process based on a predefined protocol.

Proportional assist ventilation with load-adjustable gain factors protocol

PAV+ was initiated, following the manufacturer's recommendation, where the patient's ideal bodyweight, endotracheal tube size and maximum airway pressure were entered into the ventilator system. Initial positive-end expiratory pressure (PEEP) and fraction of inspired oxygen (Fio_2) requirements were maintained at the level before the initiation of PAV+. Patients were started on 70% support and weaned to 30% support by decrements of 10% as tolerated, according to arterial blood gases, tidal volume, work of breathing, respiratory rate, and accessory muscle use. The support level was increased or the patient returned to mandatory mode if signs of respiratory distress were noted (ie, respiratory rate > 30 breaths per minute, decreased tidal volume or increased accessory muscle use). If patients were noted to be in distress at 70% support, PEEP was increased to a maximum of 12 cmH_2O. In patients who remained distressed, the percentage of support was increased in steps of 5% up to 90%. If the patient required more than 90% support, they were placed back onto a mandatory mode of ventilation. The patient was deemed ready for extubation when tolerating PAV+ with 30% support, PEEP ≤ 5 cmH_2O, Fio_2 ≤ 0.4, and was obeying commands. Hypoxaemia was managed by adjusting the PEEP or Fio_2.

Pressure support ventilation protocol

Patients were started on the PSV level required and weaned to 10 cmH_2O as tolerated, according to arterial blood gasses, tidal volumes, work of breathing, respiratory rate, and accessory muscle use. Pressure support level was increased or the patient returned to a mandatory mode if signs of respiratory distress were noted (ie, respiratory rate > 30 breaths per minute, decreased tidal volume or increased accessory muscle use). The patient was deemed ready for extubation when tolerating ventilation with a PSV of 10 cmH_2O, PEEP ≤ 5 cmH_2O, Fio_2 ≤ 0.4, and was obeying commands. Hypoxaemia was managed by adjusting the PEEP or Fio_2.

If the intensivist determined that a patient was asynchronous or unable to be weaned on their assigned mode of spontaneous ventilation, then change to the alternate spontaneous mode was permissible. This option of crossover was included in the study protocol to ensure patient safety and successful weaning of the patients, given the limited experience with PAV+ in our centre. All decisions relating to the patients' general management were exclusively determined by the attending intensivist.

Clinical parameters

Demographic data on all patients included in the study were obtained at enrolment.

The respiratory, cardiovascular, physiological and ventilator measurements recorded were respiratory rate, tidal volume, peak inspiratory pressure (PIP), fraction of inspired oxygen (Fio_2), PEEP, heart rate, mean arterial blood pressure, and blood gases.

The sedation and analgesic management of patients during the trial period was titrated based on the Richmond Agitation-Sedation Scale (RASS).[18] During the trial period,

patients were generally sedated to maintain a RASS score of –2 to 0. The median hourly dose of sedative and analgesic medications was recorded for the duration of the trial until extubation, irrespective of the mode of ventilation or whether the respiration was unsupported.

Outcome measures

Primary outcome

The primary outcome was the time to successful liberation from the ventilator after the commencement of a spontaneous mode of ventilation.

Secondary outcomes

The secondary outcomes included the percentage of patients requiring rescue ventilation (ie, a mandatory mode of ventilation) after commencing a mode of spontaneous ventilation, requirement of sedative drugs after randomisation, requirement of tracheostomy, re-intubation within 48 hours of extubation, ICU LOS, hospital LOS, ICU and in-hospital mortality.

Among the patients who died, only those who survived 48 hours after extubation were considered extubated and ventilation data were only obtained during periods of ventilation. Once a decision had been made to withdraw care, ventilatory support was discontinued and patients were either extubated or decannulated with sedatives and analgesics administered as required.

Definitions

All clinical and physiological parameters were recorded during periods of spontaneous ventilation (ie, on PSV or PAV+ modes), and not during periods of controlled ventilation (ie, if rescue controlled ventilation was required) or during unsupported breathing through a tracheostomy tube.

Rescue ventilation was defined as a patient requiring a mandatory mode of ventilation after having commenced weaning on a spontaneous mode of ventilation.

Weaning duration was defined as the time from commencement of the randomised mode of spontaneous ventilation, until successful liberation from mechanical ventilation. Successful liberation from the ventilator was defined as being alive and not requiring re-intubation for 48 hours after extubation. For patients with a tracheostomy, extubation was defined as the ability to breathe spontaneously for 48 hours without ventilator support. If extubation had been achieved, the last time the patient was ventilated was considered the time of successful weaning.

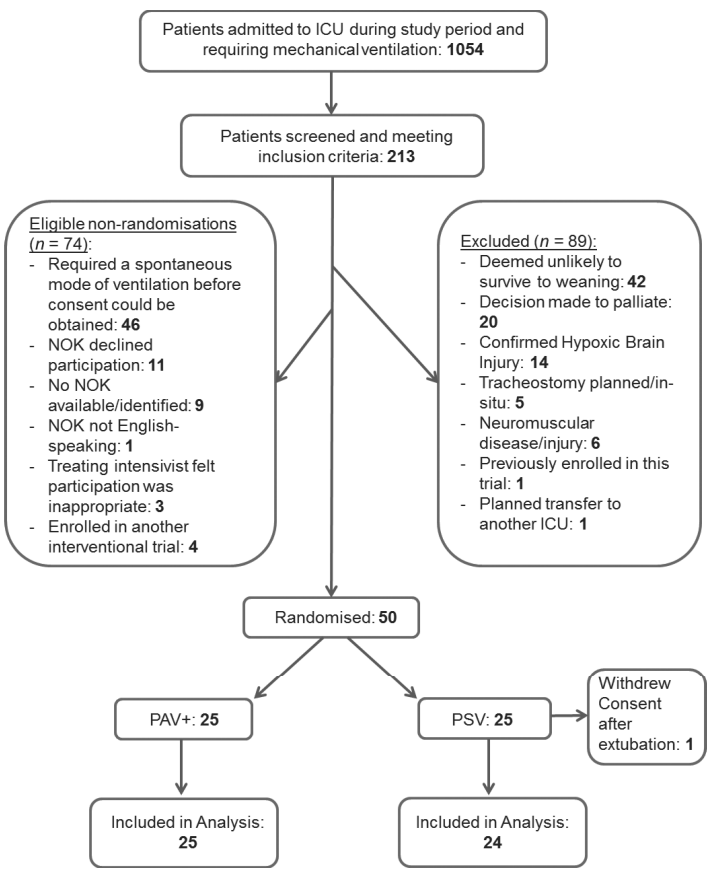
Statistical analysis

A sample size and power analysis was not performed as this was a pilot study. Data were collected on a predefined case report form and analysed using the SPSS (IBM, v.20) statistical package. Categorical variables are presented as percentages, while continuous variables are presented as median and interquartile range. All comparative analyses were by intention to treat. Group comparisons used Mann–Whitney U tests for continuous variables, and Fisher's exact test for proportions. The time from randomisation to liberation from mechanical ventilation (weaning duration) was analysed using log-rank test. In patients who died, the analysis plan for the primary endpoint only included those patients who were extubated or decannulated and survived 48 hours after liberation from the ventilator. Statistical significance was set at $P < 0.05$ (two-tailed).

Results

Figure 1 shows the number of patients screened and the flow of patients through the study. Fifty patients were

Figure 1. CONSORT diagram for the trial



CONSORT = Consolidated Standards of Reporting Trials. ICU = intensive care unit. NOK = next of kin. PAV+ = proportional assist ventilation with load-adjustable gain factors. PSV = pressure support ventilation.

enrolled, with 25 patients randomised to the PAV+ arm and 25 to the PSV arm. One patient withdrew consent after being randomised to the PSV arm, leaving 24 patients in this arm for analysis. One patient randomised to the PAV+ arm died before spontaneous ventilation and only contributed to demographic and mortality data. Four patients randomised to PAV+ ventilation were crossed over to PSV during weaning, as the treating intensivist deemed the patients were unable to be weaned on PAV+ ventilation (two patients) or not tolerating PAV+ (two patients). No patients crossed over from PSV to PAV+ ventilation.

Table 1 reveals the demographics and clinical characteristics at enrolment of both groups. There was no statistically significant difference in the compared demographics or severity illness between the two groups. The mean arterial pressure was significantly higher in the PAV+ group than in the PSV group. There was no difference between the two groups in the time from hospital admission to the time of randomisation or the modes of ventilation before randomisation, but there was a statistically significant difference between groups regarding the duration of mechanical ventilation before randomisation.

Table 2 shows the comparison of physiological and ventilation parameters during weaning. Patients ventilated on PAV+ had a higher mean arterial pressure. There was a statistical difference in PIP, with a lower PIP recorded in the PAV+ group ($P = 0.015$).

Table 3 shows the physiological and ventilation parameters between study groups at their last ventilatory support. These data reveal no difference in the respiratory rate, tidal volume, PEEP and Fio_2 between groups. The median pressure support before extubation was 10 cmH_20 and the percentage support on PAV+ ventilation was 30%.

Clinical outcomes

The duration of weaning from mechanical ventilation is comparable between both modes (Table 4 and Figure 2). The ICU mortality was higher in the PSV group, and there was no difference in the in-hospital

Table 1. Demographic and clinical characteristics of study patients at enrolment

Variable	PAV+ (n = 25)	PSV (n = 24)	P
Age (years); median (IQR)	65.1 (46.8–77.0)	61.15 (50.5–74.1)	0.766
Gender, male	16 (64.0%)	13 (52.0%)	0.567
Admission source			
Emergency department	11 (44.0%)	13 (54.2%)	
Ward	7 (28.0%)	7 (25.0%)	
Operation theatre	6 (24.0%)	5 (20.8%)	
Other hospital	1 (4.0%)	0 (0%)	
Weight (kg); median (IQR)	80 (70–95)	79.5 (56.3–90.0)	0.207
Diagnoses			
Respiratory	4 (16.0%)	6 (25.0%)	
Cardiac	4 (16.0%)	4 (16.7%)	
Neurological	0 (0%)	1 (4.2%)	
Sepsis	6 (24.0%)	7 (29.2%)	
Gastrointestinal disease	4 (16.0%)	2 (8.3%)	
Other*	2 (8.0%)	0 (0%)	
APACHE-III score; median (IQR)	76.0 (53.5–95.0)	77.5 (61.8–86.3)	0.667
SAPS-II score; median (IQR)	46.0 (33.5–59.5)	45.0 (40.3–53.5)	0.909
Haemodynamic and respiratory parameters; median (IQR)			
Heart rate (bpm)	95.0 (75.8–108.0)	89.0 (78.5–105.0)	0.715
Mean arterial pressure (mmHg)	94.0 (80.0–106.0)	79.0 (73.3–93.0)	0.014
Respiratory rate (breaths/min)	19.0 (15.0–24.0)	18.0 (16.0–20.0)	0.463
Tidal volume (mL)	534.0 (465.8–632.5)	502.5 (470.0–575.8)	0.542
P/F ratio	258.0 (214.3–292.8)	252.0 (193.0–310.0)	0.865
Arterial pH	7.43 (7.38–7.47)	7.41 (7.36–7.44)	0.156
Arterial $Paco_2$ (mmHg)	40.3 (34.1–43.4)	41.4 (33.5–45.4)	0.657
Time from hospital admission to PSV/PAV+ (days)	4.9 (3.7–6.7)	3.6 (2.3–7.0)	0.091
Time from intubation to PSV/PAV+ (days)	4.1 (3.2–4.8)	2.6 (1.4–3.5)	0.006
Ventilation mode before PAV+/PSV			0.977
Bilevel	3 (12.0%)	3 (12.5%)	
SIMV (pressure-controlled)	8 (32.0%)	7 (29.2%)	
SIMV (volume-controlled)	14 (56.0%)	14 (58.3%)	

APACHE = Adult Physiology and Chronic Health Evaluation. bpm = beats per minute. IQR = interquartile range. $Paco_2$ = arterial partial pressure of carbon dioxide. PAV+ = proportional assist ventilation with load-adjustable gain factors. P/F = ratio of arterial partial pressure of oxygen (Pao_2) to fraction of inspired oxygen (Fio_2). PSV = pressure support ventilation. SAPS = Simplified Acute Physiology Score. SIMV = synchronised intermittent mandatory ventilation. * "Other" includes acute poisoning and attempted hanging (without cardiac arrest).

Table 2. Physiological and ventilation parameters* of study patients after randomisation for patients randomised to proportional assist ventilation with load-adjustable gain factors (PAV+) and pressure support ventilation (PSV)

Variable	PAV+: median (IQR)	PSV: median (IQR)	*P*
Respiratory rate (breaths per minute)	23.5 (18.3–28.0)	20.0 (16.0–23.6)	0.058
Maximum respiratory rate (breaths per minute)	30.3 (23.8–34.9)	27.5 (22.6–31.6)	0.285
Tidal volume (mL)	470.0 (386.0–610.7)	555.7 (463.7–627.7)	0.107
Arterial Pao_2 (mmHg)	84.5 (79.9–90.2)	79.9 (74.8–89.6)	0.349
Arterial $Paco_2$ (mmHg)	38.2 (34.9–43.8)	39.7 (35.3–41.9)	0.784
Arterial pH	7.452 (7.424–7.473)	7.433 (7.410–7.463)	0.270
Peak inspiratory pressure (cmH_2O)	17.4 (13.3–18.4)	18.8 (17.3–21.4)	0.015
Mean arterial pressure (mmHg)	94.5 (84.9–97.8)	84.7 (76.4–89.8)	0.005
Heart rate (bpm)	94.4 (84.0–102.0)	84.7 (76.4–89.8)	0.220

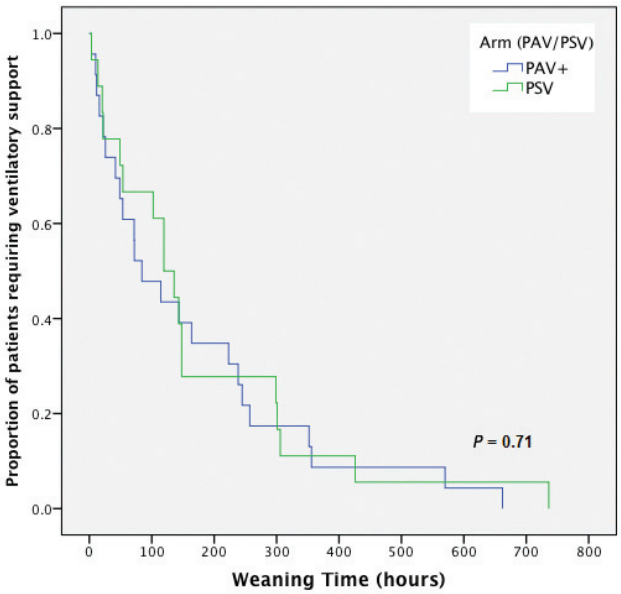
IQR = interquartile range. bpm = beats per minute. $Paco_2$ = arterial partial pressure of carbon dioxide. Pao_2 = arterial partial pressure of oxygen. * Median of daily average data while the patients were weaned on the PAV+ or PSV group.

Table 3. Ventilation parameters of study patients at last ventilatory support

	PAV+: median (IQR)	PSV: median (IQR)	*P*
Respiratory rate (breaths per minute)	21.0 (18.3–25.0)	20.5 (15.3–27.0)	0.755
Tidal volume (mL)	491.0 (402.0–634.0)	511.5 (417.8–641.3)	0.540
PSV (cmH_2O)	na	10.0 (10.0–12.0)	na
PAV+ support (%)	30 (20–50)	na	na
PEEP (cmH_2O)	5 (5–5)	5 (5–7)	0.081
Fio_2 (%)	30 (25–35)	30 (25–35)	0.624

Fio_2 = fraction of inspired oxygen. IQR = interquartile range. na = not applicable. PAV+ = proportional assist ventilation with load-adjustable gain factors. PEEP = positive end expiratory pressure. PSV = pressure support ventilation.

Figure 2. Kaplan–Meier curve showing time to successful weaning from the ventilator for patients randomised to the PAV+ (blue) and PSV (green) arms of this trial



PAV+ = proportional assist ventilation with load-adjustable gain factors. PSV = pressure support ventilation.

mortality between groups (Table 4). Of the three patients who died in the PAV+ group, the cause of death was acute myocardial infarction in two patients and ischaemic bowel in one patient. In the PSV group, nine patients died; the cause of death was ischaemic bowel in two patients, advanced malignancy in two patients, spinal abscess in one patient, rupture of abdominal aortic aneurysm in one patient, pancreatitis in one patient, pneumonia in one patient and acute myocardial infarction in one patient. There was no statistically significant difference between the PAV+ and PSV groups in the other secondary outcome measures (Table 4).

Discussion

Our study showed no difference in the primary outcome of time to successful liberation from the ventilator after the commencement of a spontaneous mode of ventilation, and this finding is consistent with a recently published trial comparing these two modes of ventilation during weaning.[16] Moreover, there was no statistically significant difference between groups in the secondary outcomes.

To our knowledge, there are few published randomised controlled trials directly comparing PAV+ and PSV.[13,15,16] Similar to the study by Bosma and colleagues,[16] our study had a weaning protocol, which was followed throughout the weaning period until patients were liberated from mechanical ventilation. The study by Xirouchaki and

Table 4. Comparison of clinical outcomes

Clinical outcomes	*n*	PAV+	*n*	PSV	*P*
Primary outcome					
Time to successful weaning (hours); median (IQR)	23	84.3 (25.7–244.8)	19	135.9 (49.1-301.0)	0.536
Secondary outcomes					
Successfully weaned from the ventilator		23/25 (92.0%)		19/24 (79.2%)	0.25
Rescue ventilation		15/24 (62.5%)		16/24 (66.7%)	1.00
Requirement of tracheostomy		5/24 (20.8%)		7/24 (29.2%)	0.74
Requirement of re-intubation		1/24 (4.2%)		2/24 (8.3%)	1.00
Total weaning time spent on PAV+/PSV		23 (78.6%)		19 (81.6%)	0.272
ICU mortality		1/25 (4.0%)		6/24 (25.0%)	0.002
In-hospital mortality		3/25 (12.0%)		9/24 (37.5%)	0.08
ICU Length of stay (days); median (IQR)	25	9.3 (6.3–17.2)	24	11.8 (6.5–20.1)	0.58
• Patients surviving ICU	24	10.6 (7.5–18.0)	18	11.2 (6.3–20.5)	0.799
• Patients not surviving ICU	1	5.1 na	6	15.6 (6.5–23.8)	0.571
Hospital LOS (days); median (IQR)		23.1 (13.3–29.6)		19.9 (11.7–30.7)	0.47
• Patients surviving hospital	22	26.6 (14.1–31.2)	15	20.1 (11.6–33.9)	0.636
• Patients not surviving hospital	3	13.3 (5.1–13.3)	9	18.9 (10.0–22.8)	0.482
Daily sedative and analgesic dose; median (IQR)					
Midazolam (mg/h)	24	5.2 (4.0–7.4)	24	3.33 (2.5–5.4)	0.107
Morphine (mg/h)	24	1.4 (1.0–4.4)	24	4.1 (2.1–5.1)	0.197
Propofol (mg/h)	24	120.7 (50.8–148.3)	24	91.0 (58.4–132.3)	0.666
Ketamine (mg/h)	24	8.0 (6.6–10.0)	24	10.4 (10.0–12.1)	0.172
Clonidine (μg/h)	24	39.0 (32.6–55.3)	24	30.7 (22.2–45.7)	0.267
Fentanyl (μg/h)	24	26.0 (14.3–36.4)	24	27.8 (25.3–37.8)	0.632
Dexmedetomidine (μg/kg/h)	24	0.48 (0.48–0.81)	24	0.35 (0.17–0.54)	0.400

ICU = intensive care unit. IQR = interquartile range. LOS = length of stay. na = not applicable. PAV+ = proportional assist ventilation with load-adjustable gain factors. PSV = pressure support ventilation

colleagues[13] had a study duration that was protocolised for only 48 hours, beyond which the clinicians were allowed to use other modes of ventilation. This study design prevents any conclusions drawn on the effects of PAV+ on duration of weaning. Nevertheless, the study by Xirouchaki and colleagues[13] found that PAV+ was associated with reduced patient–ventilator asynchronies and increased the probability of remaining on spontaneous breathing. The study by Teixeira and colleagues[15] compared PAV+ with T-tube ventilation and PSV in patients who were predominantly ventilated for trauma. This study again found PAV+ to be comparable with T-tube ventilation and PSV in terms of extubation failure, duration of mechanical ventilation, and ICU and hospital stay.

The ICU mortality rate was 4% in patients assigned to PAV+ and 25% in the PSV group, which was statistically significant. These outcomes were unexpected and the complications were not anticipated at randomisation. The mode of ventilation was considered an implausible contributor to their mortality.

In a previous study, PAV+ was noted to be user-friendly as compared with PSV,[17] and was associated with fewer interventions in ventilator settings. This study, however, compared both modes only for 48 hours after randomisation, and contrasted with our study in that we compared these modes until extubation. While we did not compare the number of interventions in ventilator settings in our study, we noted that in four patients randomised to PAV+ ventilation, the attending clinician elected to change to PSV during weaning. Two patients had prolonged ventilation on PAV+ (an average of over 140 hours) before the intensivist changed to PSV due to the difficulty in weaning on PAV+. A further two patients were switched from PAV+ to PSV shortly after enrolment, as the intensivists opined that the patient was not tolerating PAV+. Such incidences of failing on PAV+ were also noted in other studies,[13] and may be

attributed to relative inexperience in delivering PAV+. Despite the introduction of PAV+ to our ICU 3 months before the initiation of this study, this timeline may still have been inadequate to familiarise the staff with this new weaning mode of ventilation.

Ventilator asynchrony is seen in about 25–80%[2,19,20] of patients receiving mechanical ventilation. We did not directly evaluate the incidence of asynchrony with PAV+ and PSV, as the evaluation of asynchrony during weaning is complex.[21,22] However, we have compared the sedative and analgesic usage on both modes during the weaning. The requirement of these drugs were comparable between both modes, implying that there was no difference in patient discomfort or agitation between the two groups — a conclusion that could further be supported by the mean heart rate and respiratory rate in the PAV+ and PSV groups. The study by Bosma and colleagues[16] found a trend towards a reduction of ventilator asynchrony with PAV+ which did not reach statistical significance, but the investigators inferred that they may have underestimated the true prevalence of ventilator asynchrony in their study.[16]

Study limitations

The study was unblinded and lacked external validity as it was a single centre study. Moreover, it was a pilot study underpowered to detect significant clinical differences between the two modes of ventilation. There were no validated measurements of patient–ventilator asynchrony and transpulmonary pressure, and there was no a priori selection of patients who were at risk of prolonged weaning. Familiarisation of staff with PAV+ was of limited duration (3 months) and this may not have been an adequate time for the all the staff to be familiar with the PAV+ mode, which may have contributed to the crossover of patients from the PAV+ group to the PSV group.

Conclusion

The time to successful liberation from mechanical ventilation was comparable between PAV+ and PSV, and PAV+ appears to be a safe alternative to PSV.

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Competing interests

None declared.

Author contributions

Trial conception and design: JB, IC, SG, KH and RT.

Data acquisition: CG.

Data analysis: CG and RT.

Data interpretation: CG, RT and JB.

Manuscript drafting: JB, RT and CG.

Revision of critically important intellectual content: RT, KH, IC and SG.

All authors have reviewed the final manuscript and have given approval for it to be submitted for publication.

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