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Comparison Of T-Piece Versus Continuous Positive Airway Pressure For Successful Extubation In Critically Ill Patients: An Observational Comparative Study

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Abstract
Aim: *Mechanical ventilation is a life-saving intervention in critically ill patients; however, prolonged ventilation is associated with increased morbidity, mortality, and healthcare costs. Extubation failure requiring re-intubation is associated with a 25–50% increase in mortality. T-piece and Continuous Positive Airway Pressure (CPAP) are commonly used spontaneous breathing trial strategies, but their comparative effectiveness remains debated. The present study aimed to compare the efficacy of T-piece versus CPAP in achieving successful extubation and to evaluate post-extubation outcomes.*
Materials and Methods*: This observational comparative study was conducted over a period of 90 days in the Intensive Care Unit of Sapthagiri Medical College and Hospital, Bengaluru. Fifty mechanically ventilated adult patients meeting standard weaning criteria were randomly allocated into T-piece (n = 25) and CPAP (n = 25) groups. Hemodynamic parameters, arterial blood gas values, respiratory parameters, and Glasgow Coma Scale were recorded at baseline, at extubation, and 48 hours post-extubation.*
Successful extubation was defined as the absence of re-intubation within 48 hours.
Results*: Baseline clinical and physiological parameters were comparable between the two groups. Patients in the T-piece group demonstrated significantly higher respiratory rates and lower PaO_2/FiO_2 ratios at extubation and 48 hours post-extubation. Re-intubation occurred in 7 patients in the T-piece group compared to 4 patients in the CPAP group. Although not statistically significant, CPAP showed better physiological stability and a lower trend toward extubation failure.*
Conclusion*: CPAP-based spontaneous breathing trials provide better physiological stability and demonstrate a lower trend toward extubation failure compared to T-piece trials. CPAP may be a safer and more effective weaning strategy in critically ill patients. Larger multicenter randomized controlled trials are required to validate these findings.*

Keywords: *Mechanical ventilation, Weaning, CPAP, T-piece, Extubation failure, Intensive care unit*

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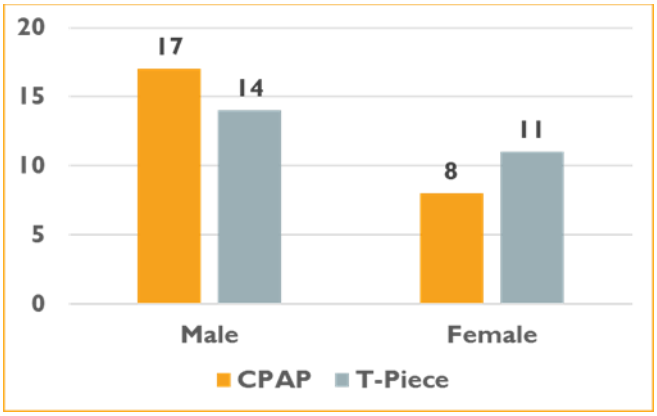
I. Introduction

Mechanical ventilation plays a vital role in the management of critically ill patients. However, prolonged mechanical ventilation is associated with complications such as ventilator-associated pneumonia, diaphragmatic dysfunction, prolonged ICU stay, and increased mortality. Therefore, timely and successful weaning from mechanical ventilation is an essential goal of intensive care management.Extubation failure, defined as the need for re-intubation following planned extubation, significantly worsens patient outcomes and is associated with mortality rates as high as 25–50%. Accurate assessment of readiness for extubation and the selection of an appropriate spontaneous breathing trial strategy are crucial to reduce extubation failure.T-piece trials assess the patient's ability to breathe independently without ventilatory support, whereas CPAP maintains continuous positive airway pressure, thereby preventing alveolar collapse and reducing the work of breathing. Despite widespread use, evidence comparing these two strategies in critically ill patients remains inconsistent, necessitating the present study.

II. Materials And Methods

This was an observational comparative study conducted in the Intensive Care Unit of Sapthagiri Medical College and Hospital, Bengaluru, over a period of 90 days, after obtaining approval from the Institutional Ethics Committee. The study aimed to compare the effectiveness of T-piece and Continuous Positive Airway Pressure (CPAP) as spontaneous breathing trial strategies for successful extubation in critically ill patients.A total of fifty adult patients receiving mechanical ventilation in the ICU were included in the study. All patients were ventilated using synchronized intermittent mandatory ventilation (SIMV) mode prior to initiation of the weaning process. Patients were screened daily for readiness to wean based on standard clinical and physiological criteria.Patients aged 18 years and above who met standard weaning criteria were eligible for inclusion. These criteria included a PaO_2/FiO_2 ratio greater than 150, tidal volume greater than 5 mL/kg, positive end-expiratory pressure less than 8 cmH_2O, arterial pH greater than 7.35, Glasgow Coma Scale score of 11 or more, hemodynamic stability without vasopressor support, hemoglobin level of at least 8 g/dL, absence of sedative administration in the preceding 48 hours, and the presence of adequate cough reflex and airway clearance.After meeting eligibility criteria, patients were randomly allocated into two groups using computer-generated random numbers. Twenty-five patients were assigned to the T-piece group and twenty-five patients to the CPAP group. Allocation was performed after ensuring clinical readiness for spontaneous breathing trials.



In the T-piece group, patients were disconnected from the ventilator and administered a spontaneous breathing trial using a T-piece with supplemental oxygen at a flow rate of 4 L/min. The trial was continued for a minimum duration of 30 minutes, during which patients were closely monitored for signs of respiratory distress, including tachypnea, use of accessory muscles, desaturation, hemodynamic instability, or altered sensorium. Patients who tolerated the spontaneous breathing trial for 30 minutes or more without evidence of intolerance were considered fit for extubation.In the CPAP group, patients were placed on Continuous Positive Airway Pressure with pressure support of 8 cmH_2O, positive end-expiratory pressure less than 5 cmH_2O, and fraction of inspired oxygen less than 0.4. The CPAP trial was continued for 60 minutes. Patients who tolerated CPAP without signs of respiratory distress or hemodynamic instability were considered suitable for extubation.Hemodynamic parameters including heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded. Respiratory parameters such as respiratory rate, oxygen saturation, and arterial blood gas values including PaO_2, $PaCO_2$, and pH were documented. Neurological status was assessed using the Glasgow Coma Scale. These parameters were recorded at three time points: at baseline prior to spontaneous breathing trial, at the time of extubation, and at 48 hours following extubation.Successful extubation was defined as the ability of the patient to maintain spontaneous breathing without the need for re-intubation for at least 48 hours following planned extubation. Extubation failure was defined as the requirement for re-intubation within 48 hours of extubation. Post-extubation outcomes including the need for non-invasive ventilation and requirement for tracheostomy were also documented.Statistical analysis was performed using appropriate statistical methods. Continuous variables were expressed as mean and standard deviation, and categorical variables were expressed as frequencies and percentages. Comparisons between groups were made using independent t- test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. A p-value of less than 0.05 was considered statistically significant.

III. Results

Fifty mechanically ventilated patients were included in this observational comparative study, with twenty-five patients each in the T-piece and CPAP groups. Baseline demographic characteristics, hemodynamic variables, arterial blood gas values, respiratory parameters, and neurological status were comparable between the two groups. At baseline and at the time of extubation, hemodynamic parameters remained similar in both

groups. However, the T-piece group consistently demonstrated higher respiratory rates and significantly lower PaO_2/FiO_2 ratios compared to the CPAP group, indicating increased respiratory workload and inferior oxygenation.

At 48 hours post-extubation, these differences became more evident.

The T-piece group exhibited persistently higher respiratory rates along with mildly elevated heart rate and mean arterial pressure, whereas the CPAP group maintained greater physiological stability. Oxygenation, as reflected by the PaO_2/FiO_2 ratio, remained superior in the CPAP group.

Figure 1

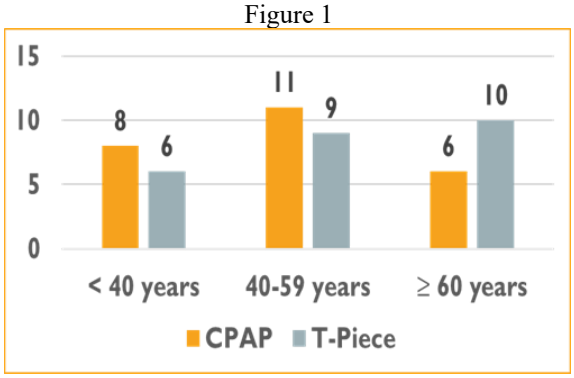


Figure 1: The age distribution table/graph shows that patients in the <40, 40–59, and ≥60 years categories were similarly distributed between the CPAP and T- piece groups, indicating no age-related bias. The gender distribution table/graph demonstrates a comparable number of male and female patients in both groups.

Table 1

DEMOGRAPHIC DETAILS	CPAP (n=25)	T piece (n=25)
Age (years)	50 ± 18	58 ± 26
Sex (M/F)	17/ 8	14/11
Duration of Ventilation prior to weaning (days)	5 ± 5.0	6 ± 5.0
Size of Endotracheal Tube	7 .5± 1.0	7 ± 1.0

Table 1: Demographic Details The mean age of patients was comparable between the CPAP (50 ± 18 years) and T-piece (58 ± 26 years) groups. Sex distribution (M/F) was similar in both groups. Duration of mechanical ventilation prior to weaning was comparable (CPAP: 5 ± 5 days; T-piece: 6 ± 5 days). Endotracheal tube size was similar in both groups.

Table 2

Variable	CPAP (n=25)	T-Piece (n=25)
COPD with TYPE 1 respiratory failure	4	3
CKD with sepsis	4	4
Acute CVA	2	3
DCLD with PH	2	2
LRTI	4	5
IHD	2	2
SAH	3	2
Unruptured aneurysm	2	2
Multiple trauma with SDH	2	1

Table 2: Common indications for ventilation included COPD with type 1 respiratory failure, CKD with sepsis, acute CVA, DCLD with pulmonary hypertension, LRTI, IHD, SAH, unruptured aneurysm, and multiple trauma with SDH. The number of patients with each condition was similar in both CPAP and T- piece groups.

Figure 3

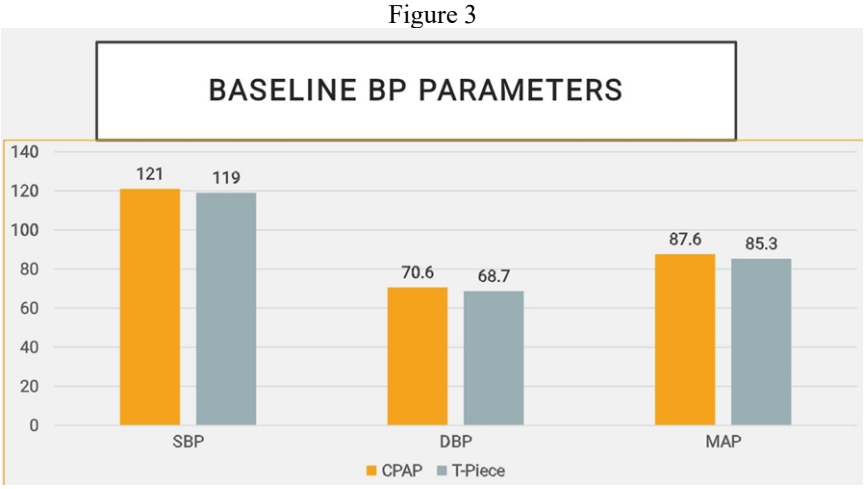


Figure3: Baseline Blood Pressure Parameters. Systolic BP (SBP), Diastolic BP (DBP), and Mean Arterial Pressure (MAP) were comparable between the CPAP and T- piece groups at baseline. No significant hemodynamic differences were observed prior to weaning.

Table 3

Beginning Extubation			
Parameter	**CPAP group (n=25)**	**T-Piece group (n=25)**	**p-value**
Vitals (HR, MAP)	82 ± 10	85 ± 12	0.029
Spo2	97±12	95±14	0.04
RR (breaths/min)	19± 3	22 ± 4	0.035
Mode (SIMV /PS)	22/3	20/5	0.0044
P/F ratio	290 ± 40	260 ± 35	0.0163
GCS	9± 3	8± 4	0.05
At Time Extubation			
Parameter	**CPAP group (n=25)**	**T-Piece group (n=25)**	**p-value**
Vitals (HR, MAP)	85 ± 9	88 ± 11	0.028
spo2	98±8	96±10	0.023
RR (breaths/min)	21 ± 3	24 ± 4	0.018
P/F ratio	280 ± 45	250 ± 40	0.04
GCS	10± 2.0	9± 3	0.023
After 48 hrs Extubation			
Parameter	**CPAP group (n=25)**	**T-Piece group (n=25)**	**p-value**
Spo2	97±10	94±9	0.028
Vitals (HR, MAP)	80 ± 8	86 ± 10	0.02
RR (breaths/min)	18 ± 2	22 ± 3	0.001
GCS	11.3 ± 2.0	10.1 ± 1.1	0.0123

Table 3 : At the beginning of weaning, patients in the CPAP group had better oxygenation, lower respiratory rate, and more stable physiological parameters compared to the T-piece group. At the time of extubation, CPAP continued to provide superior oxygenation with reduced work of breathing, while T-piece patients showed higher respiratory rates. After 48 hours of extubation, CPAP patients maintained better respiratory and neurological stability, whereas the T- piece group showed persistent physiological stress.

Table 4

Timepoint	Parameter	CPAP (Mean ± SD)	T-piece (Mean ± SD)	P-value
Beginning extubation	pH	7.42 ± 0.03	7.44 ± 0.02	0.0054
	PaCO2	42 ± 4.0	45 ± 3.0	0.02
	PaO2	88 ± 7.0	85 ± 6.0	0.035
	SaO2	96.5 ± 2.0	88± 6.0	0.0063
	Lactate	2.1 ± 0.4	2.3 ± 0.3	0.002
At time of extubation	pH	7.457 ± 0.04	7.471 ± 0.03	0.0016
	PaCO2	43 ± 4.0	47 ± 2.0	0.0045
	PaO2	91.8 ± 7.0	90 ± 8.0	0.02
	SaO2	97 ± 1.0	97 ± 4.0	0.04
	Lactate	1.69 ± 0.4	2.01 ± 0.3	0.00137
48 hrs after extubation	pH	7.43 ± 0.03	7.46 ± 0.04	0.00269
	PaCO2	40 ± 4.0	46 ± 4.0	0.001
	PaO2	95 ± 8.0	92 ± 8	0.05
	SaO2	98 ± 1.0	92.5 ± 2.0	0.02
	Lactate	1.2 ± 0.4	1.5 ± 0.3	0.002

Table 4: Arterial blood gas analysis at all time points demonstrated lower $PaCO_2$, higher PaO_2 and SaO_2, and lower lactate levels in the CPAP group, indicating better ventilation and metabolic recovery.

Figure 4 Figure 5

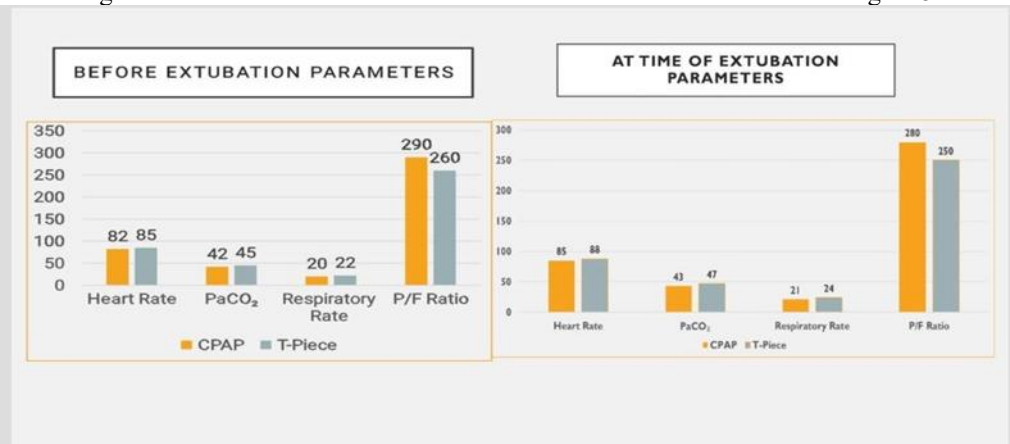


Figure 4: Before extubation parameters. The CPAP group had a slightly lower heart rate and $PaCO_2$ and a lower respiratory rate compared to the T-piece group. The PaO_2/FiO_2 ratio was higher in the CPAP group, indicating better oxygenation before extubation.

Figure 5: At extubation, the CPAP group continued to show lower respiratory rate and $PaCO_2$. The P/F ratio remained higher with CPAP, showing superior gas exchange compared to the T-piece group.

Figure 6 Figure 7

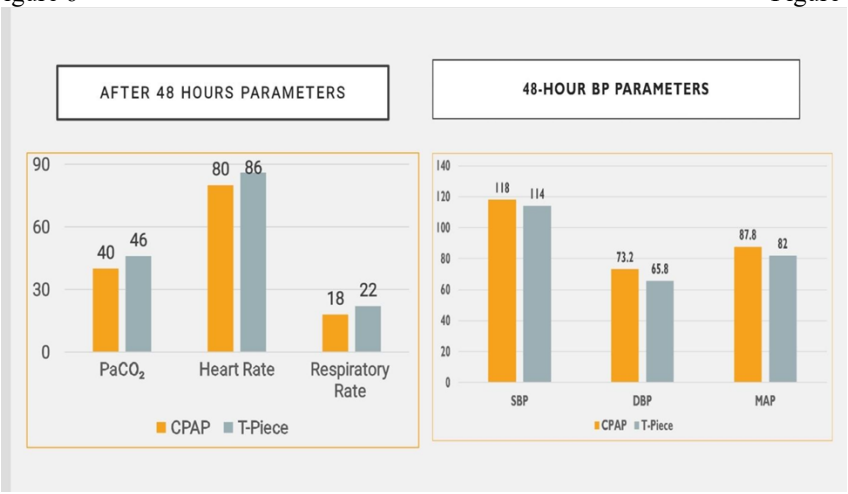


Figure 6: After 48 hours, the CPAP group had lower $PaCO_2$, lower heart rate, and lower respiratory rate, reflecting reduced work of breathing. The T-piece group showed persistently higher values, suggesting ongoing physiological stress**.**

Figure 7: Systolic, diastolic, and mean arterial pressures were comparable in both groups, with the CPAP group showing slightly better stability.

Figure 8

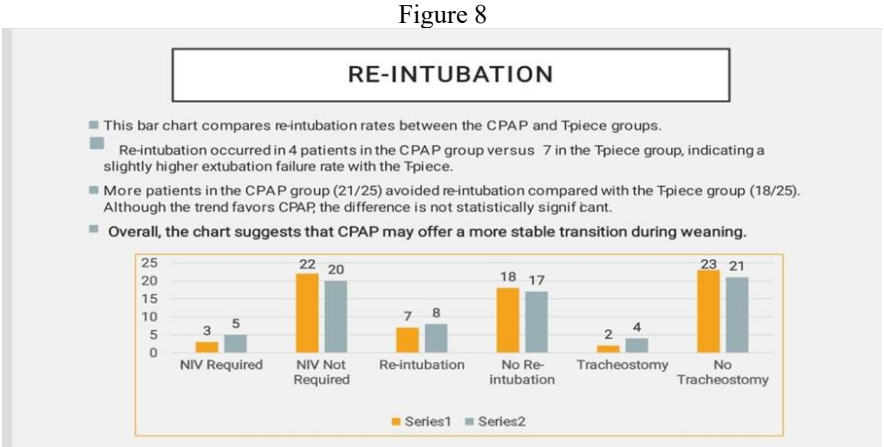
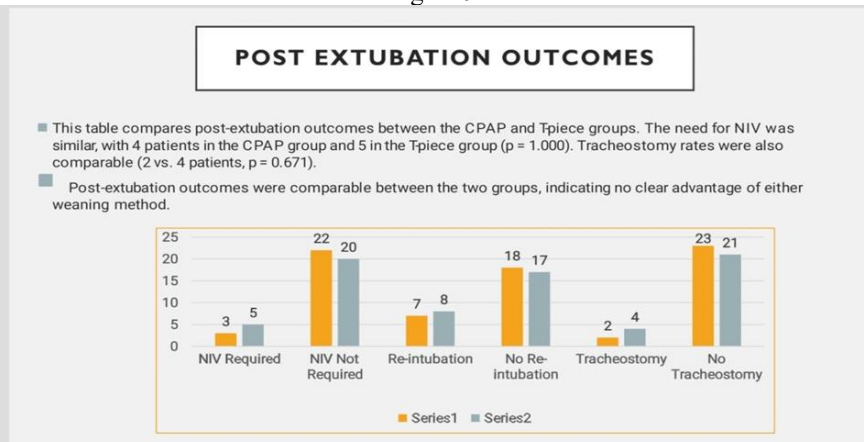


Figure 9



IV. Discussion

This observational study conducted at Sapthagiri Medical College and Hospital, Bengaluru, compared T-piece and CPAP as spontaneous breathing trial (SBT) strategies for successful extubation in critically ill patients.Fifty mechanically ventilated patients were included in this observational comparative study, with twenty-five patients each in the T-piece and CPAP groups. Baseline demographic characteristics, hemodynamic variables, arterial blood gas values, respiratory parameters, and neurological status were comparable between the two groups Successful extubation was achieved in a higher proportion of patients in the CPAP group. Re-intubation within 48 hours was required in seven patients in the T- piece group compared to four patients in the CPAP group. Although this difference did not reach statistical significance, the observed trend favored CPAP. Similar findings have been reported by Kumar et al., Khandelwal et al., and Tiwari et al., who demonstrated lower extubation failure rates and improved post- extubation outcomes with CPAP or pressure-supported SBTs compared to T-piece trials, particularly in patients with borderline respiratory reserve.

Hemodynamic responses during the weaning process also deserve consideration. Unsupported spontaneous breathing during T-piece trials increases respiratory workload and sympathetic activation, potentially leading to tachycardia and elevated mean arterial pressure. In the present study, mildly elevated heart rate and mean arterial pressure were observed in the T-piece group at 48 hours post- extubation, whereas patients in the CPAP group demonstrated greater hemodynamic stability. These findings are consistent with observations by Matić and Majerić-Kogler and Narsale et al., who reported increased cardiovascular stress during T-piece trials compared to pressure-supported weaning strategies**.**

Although re-intubation rates were not statistically different between the two groups, a higher proportion of patients in the T-piece group required re- intubation. This observation is clinically significant, as even modest reductions in re-intubation rates can substantially impact ICU length of stay, morbidity, and resource utilization. Subirà et al., in a large randomized clinical trial, demonstrated superior extubation success with pressure support ventilation compared to T-piece trials, emphasizing the importance of gradual withdrawal of ventilatory assistance rather than abrupt transition to unsupported breathing.

The requirement for non-invasive ventilation (NIV) and tracheostomy was comparable between the two groups in the present study, though numerically higher in the T-piece group. Similar trends were reported by Cekmen and Erdemli and Prasad et al., who noted increased post-extubation respiratory support requirements following T-piece trials, suggesting greater respiratory muscle fatigue and loss of alveolar recruitment.

The findings of this study are further supported by disease-specific and population-based studies. Molina-Saldarriaga et al. and Shende et al. demonstrated improved extubation outcomes with CPAP in patients with chronic obstructive pulmonary disease (COPD), attributing the benefit to maintenance of functional residual capacity and reduction in dynamic airway collapse.

Rangaswamy et al., in a randomized study involving postoperative ventilated patients, reported higher extubation success and improved physiological stability with CPAP-based SBTs, reinforcing the role of CPAP in preventing derecruitment and excessive work of breathing.

Furthermore, Saxena et al. highlighted improved overall weaning outcomes with pressure-supported strategies compared to T-piece trials in the Indian ICU population, emphasizing the relevance of CPAP-based SBTs in resource-limited settings. The landmark study by Esteban et al. also cautioned against prolonged or unsupported spontaneous breathing in critically ill patients, particularly those with limited cardiopulmonary reserve.

From a practical standpoint, the results of the present study are particularly relevant in Indian ICU settings, where patient acuity is often high and post- extubation monitoring resources may be limited. CPAP-

based spontaneous breathing trials may provide a safer, more physiologically stable weaning strategy, especially in patients with prolonged mechanical ventilation, sepsis, postoperative status, or marginal respiratory parameters

The strengths of this study include its real-world ICU population, comprehensive physiological monitoring, and clinically meaningful outcome measures. However, limitations include the single-center observational design and relatively small sample size, which may limit generalizability and statistical power.

In summary, this observational study conducted at Sapthagiri Medical College and Hospital demonstrates that CPAP-based spontaneous breathing trials offer better physiological stability, improved oxygenation, and a lower trend toward extubation failure compared to T-piece trials. While both strategies remain acceptable, CPAP appears to provide a safer and more gradual transition from mechanical ventilation to spontaneous breathing in critically ill patients. Larger multicenter randomized controlled trials are warranted to further validate these findings and establish standardized weaning protocols.

V. Conclusion

In this observational comparative study conducted in a tertiary care intensive care unit, CPAP-based spontaneous breathing trials demonstrated better physiological stability and a lower trend toward extubation failure compared to T-piece trials in critically ill patients. Although both strategies were effective for weaning from mechanical ventilation, patients in the CPAP group showed superior respiratory stability and oxygenation during the peri-extubation period. While the difference in re-intubation rates did not reach statistical significance, the consistent clinical trend favoring CPAP suggests that it may provide a safer and more reliable transition from mechanical ventilation to spontaneous breathing. Larger multicenter randomized studies are warranted to confirm these findings and to establish standardized weaning protocols

Limitations

This study was limited by its single-center observational design and relatively small sample size, which may limit generalizability and statistical power.

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