Original Research

DIAGNOSTIC ACCURACY OF THE RAPID SHALLOW BREATHING INDEX (RSBI), THE RATE OF CHANGE OF RSBI OVER TIME, AND THE PARASTERNAL INTERCOSTAL MUSCLE THICKNESS FRACTION (PICTF%) IN PREDICTING SUCCESSFUL WEANING FROM MECHANICAL VENTILATION

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ABSTRACT

Background: Mechanical ventilation is a common intervention used in ICUs. Around 37% of patients getting admitted into Indian ICUs end up needing mechanical ventilation. Early spontaneous breathing trial (SBT) and extubation when tolerated will help avoid complications.

Objectives: To study the diagnostic accuracy of RSBI, Rate of change of RSBI & Parasternal Intercostal Muscle Thickness Fraction (PICTF%) as predictors of weaning success.

Materials and Methods: This prospective, observational, single-centre cohort study was conducted in the Intensive Care Units (medical, surgical, and emergency ICUs) of MRMC, Kalaburgi. Duration of study was from August 2025 to April 2026. All adult patients admitted to the ICU who required invasive mechanical ventilation for ≥48 hours and subsequently fulfilled criteria to undergo a Spontaneous Breathing Trial (SBT) were screened for enrolment into the study. Clinical, biochemical, and hemodynamic parameters were recorded at admission and after 24 and 48 hours.

Results: Both ΔRSBI% and PICTF% emerged as independent predictors of weaning success, whereas RSBI, although still useful, showed comparatively lower discriminative performance.

Conclusion: The combination of ΔRSBI% and PICTF% captures both sides of the equation: changing ventilatory pattern and the muscle dynamics that underpin it. This dual perspective is consistent with contemporary pathophysiological models and may explain why the combined index achieved the highest predictive accuracy in our cohort.

Keywords: Mechanical Ventilation, Weaning, RSBI, Rate of change of RSBI, PICTF%, SBT.

INTRODUCTION

Mechanical ventilation remains one of the most frequently employed and life-saving interventions for critically ill patients in emergency departments and intensive care units. Although initiating ventilatory support is often a clear and timely decision, determining when and how to safely discontinue it is far more complex. Prolonged dependence on mechanical ventilation is associated with well-recognized complications, including ventilator-associated pneumonia, respiratory muscle atrophy, diaphragmatic dysfunction, and increased mortality [1,2].

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On the other hand, premature extubation carries its own risks, frequently resulting in respiratory failure, reintubation, and poorer clinical outcomes [3]. Consequently, accurately identifying the optimal timing for ventilator liberation is a pivotal aspect of critical care practice.

Weaning constitutes a substantial proportion—nearly 40%—of the total duration of mechanical ventilation in many ICU patients [4]. Successful weaning requires a careful balance between recovery from the underlying disease process and the patient's ability to sustain spontaneous breathing.

The Rapid Shallow Breathing Index (RSBI), defined as the ratio of respiratory rate to tidal volume (breaths/min/L), has long been one of the most widely used predictors of weaning success. Since its introduction by Yang and Tobin in 1991, an RSBI value below 105 breaths/min/L has been associated with a greater likelihood of successful extubation [5]. Subsequent studies have validated its usefulness across diverse patient populations and clinical settings [6,7].

Alongside these developments, bedside ultrasonography has gained increasing attention as a non-invasive and real-time method for evaluating respiratory muscle function during weaning.

While diaphragmatic thickening fraction has been extensively investigated and shown to correlate with weaning outcomes [8,9], diaphragmatic performance alone does not fully represent overall inspiratory effort. In this context, the parasternal intercostal muscles—particularly active in patients with diaphragmatic dysfunction—have emerged as important contributors to inspiratory mechanics. Ultrasound assessment of parasternal intercostal muscle thickness fraction offers an indirect yet objective measure of respiratory muscle recruitment during spontaneous breathing [10,11]. This parameter may be especially valuable in emergency and critical care settings, where diaphragmatic measurements alone may not adequately predict weaning success.

Integrating dynamic RSBI assessment with ultrasonographic evaluation of respiratory muscle activity may provide a more comprehensive understanding of the physiological readiness for weaning. Such a multimodal approach has the potential to improve predictive accuracy, reduce weaning failure rates, and support individualized weaning strategies [12,13]. Importantly, both RSBI monitoring and bedside ultrasound are non-invasive, repeatable, and feasible in routine clinical practice, making them particularly suitable for time-sensitive decision-making in ICUs and emergency departments.

In light of these considerations, the present study aims to evaluate the predictive value of RSBI, the rate of change of RSBI, and ultrasound-derived parasternal intercostal muscle thickness fraction in determining weaning outcomes among mechanically ventilated patients. By combining traditional respiratory indices with emerging ultrasonographic markers, this study seeks to improve the accuracy and safety of weaning decisions and ultimately enhance patient outcomes in critical care settings.

MATERIAL AND METHODS

This prospective, observational, single-centre cohort study was conducted in the Intensive Care Units (medical, surgical, and emergency ICUs) of MRMC, Kalaburgi. Duration of study was from August 2025 to April 2026.

Study Population

All adult patients admitted to the ICU who required invasive mechanical ventilation for ≥48 hours and subsequently fulfilled criteria to undergo a Spontaneous Breathing Trial (SBT) were screened for enrolment into the study.

Inclusion Criteria

Patients were included if they:

- Were aged ≥18 years
- Had received mechanical ventilation for ≥48 hours
- Met established readiness criteria for SBT

Exclusion Criteria

Patients were excluded if they had:

- Pregnancy or lactation
- Known neuromuscular disorders affecting respiratory muscles
- Structural chest wall abnormalities (e.g., flail chest, post-thoracotomy)
- Significant pleural effusion or pneumothorax
- Marked ascites
- Diaphragmatic paralysis or injury
- Poor ultrasound window preventing adequate assessment

Sample Size

A total of 90 patients were enrolled in the study. The sample size had been estimated based on a reported mechanical ventilation prevalence of 37% in Indian ICUs (INDICAPS study).

Study Protocol

Baseline Evaluation

Following confirmation of eligibility and consent, demographic and clinical data were recorded, including:

- Age and sex
- Primary diagnosis at ICU admission
- Reason for ICU admission
- SOFA score on admission
- Duration of mechanical ventilation
- ICU length of stay

Spontaneous Breathing Trial (SBT) Protocol

An SBT was performed using Pressure Support Ventilation (PSV) mode for 120 minutes. SBT readiness had been assessed as per ICU protocol. Patients were considered eligible if they fulfilled all of the following:

- Respiratory rate (RR) ≤ 35/min
- $SpO_2 \geq 90\%$ with $FiO_2 \leq 40\%$ and PEEP ≤ 8 cmH_2O
- Presence of adequate cough and gag reflex
- RASS score between −2 and +1
- Absence of continuous sedation or vasopressor support

Measurement Techniques

1. Rapid Shallow Breathing Index (RSBI)

- Values were obtained from the ventilator display
- RSBI was recorded at 5 minutes and 120 minutes of the SBT
- The change in RSBI (ΔRSBI) was computed as:

ΔRSBI:

$$\Delta RSBI = \frac{RSBI_{120} - RSBI_5}{RSBI_5} \times 100$$

2. Parasternal Intercostal Muscle Thickness Fraction (PICTF%)

Parasternal muscle ultrasound was performed using a high-frequency linear probe (10–15 MHz) at the 2nd intercostal space, approximately 3–5 cm lateral to the sternum.

- Muscle thickness was measured at end-expiration and end-inspiration
- Thickness fraction was calculated as:

$$PICTF\% = \frac{Th_{insp} - Th_{exp}}{Th_{exp}} \times 100$$

- The mean of three consecutive respiratory cycles in M-mode was documented

Timing of Measurements

Parameter	Time-point
PICTF%	At initiation of SBT and following successful SBT completion
RSBI	At 5th and 120th minute of SBT
ΔRSBI	Derived from RSBI values

Outcome Measures

Primary Outcome: Weaning Success, defined as sustained spontaneous breathing without the requirement for non-invasive ventilation or re-intubation for 48 hours after extubation

Secondary Outcome: Comparative evaluation of the diagnostic performance of RSBI, ΔRSBI, and PICTF% in predicting successful extubation

Statistical Analysis

Data were analyzed using SPSS software (Version 26). Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range, IQR). Categorical data were summarized as frequencies and percentages

Analytical Tests Used:

- ANOVA or Kruskal–Wallis test for continuous variables
- Chi-square test for categorical variables
- Receiver Operating Characteristic (ROC) curve analysis was used to identify cut-off values and evaluate diagnostic accuracy

Performance metrics such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and overall accuracy were calculated. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 112 ICU patients were screened for eligibility, of whom 90 met the inclusion criteria, provided consent, and were enrolled in the study. All 90 patients successfully completed the 120-minute Spontaneous Breathing Trial (SBT) on Pressure Support Ventilation and were subsequently extubated. Among these, 65 patients (72.2%) achieved successful extubation, maintaining spontaneous breathing without the need for non-invasive ventilation or re-intubation within 48 hours. However, 25 patients (27.8%) experienced extubation failure, requiring either re-intubation or escalation to non-invasive ventilation within the first 48 hours post-extubation.

Table 1: Baseline Characteristics

Variable	Overall	Success	Failure	p-value
Age (years)	56.4 ± 13.8	54.8 ± 13.5	60.6 ± 13.7	0.09
Male sex n (%)	58 (64.4)	40 (61.5)	18 (72.0)	0.35
SOFA (median [IQR])	6 [5–8]	6 [5–7]	7 [6–9]	0.04
Sepsis (%)	39 (43.3)	24 (36.9)	15 (60.0)	0.04
Days on MV	4 [3–7]	4 [3–6]	6 [4–9]	0.02
Hemoglobin (g/dL)	10.9 ± 1.9	11.1 ± 1.9	10.5 ± 1.8	0.16
BMI (kg/m²)	23.8 ± 3.4	23.9 ± 3.3	23.6 ± 3.6	0.70

The baseline characteristics of the 90 patients revealed that the mean age was 56.4± 13.8 years, with patients in the failed extubation group being slightly older (60.6 ± 13.7 years) than those with successful extubation (54.8 ± 13.5 years), though the difference was not statistically significant (p=0.09). Males comprised 64.4% of the cohort, with a slightly higher proportion in the failure group (72%) compared to the success group (61.5%), again without significance (p=0.35). The median SOFA score was significantly higher among patients who failed extubation (7 [IQR 6–9]) than those who succeeded (6 [IQR 5–7], p=0.04), indicating greater illness severity. Sepsis was also more common in the failure group (60.0%) compared to the success group (36.9%), showing a significant association (p=0.04). The median duration of mechanical ventilation before the SBT was longer in those who failed (6 [IQR 4–9] days) than in those who succeeded (4 [IQR 3–6] days, p=0.02). Hemoglobin and BMI values were comparable between groups, with no significant differences (p=0.16 and p=0.70, respectively).

Table 2: RSBI, ΔRSBI% and PICTF% during SBT

Measure	Success	Failure	Mean diff	p-value
RSBI-5	74.2 ± 18.6	103.7 ± 24.9	−29.5	<0.001
RSBI-120	78.3 ± 21.9	131.5 ± 28.7	−53.2	<0.001
ΔRSBI%	5.3 (−4.1–13.8)	26.7 (18.2–41.9)	——	<0.001
PICTF%	9.6 ± 4.2	18.7 ± 6.1	−9.1	<0.001

The comparison of RSBI, ΔRSBI%, and PICTF% between successful and failed weaning groups demonstrates clear and statistically significant differences (all $p < 0.001$). Patients with successful extubation had notably lower RSBI values both at 5 minutes (74.2 ± 18.6 vs. 103.7 ± 24.9) and at 120 minutes (78.3 ± 21.9 vs. 131.5 ± 28.7), indicating more efficient breathing patterns. The change in RSBI (ΔRSBI%) was minimal in the success group (median 5.3%) but markedly higher in failures (26.7%), suggesting greater instability during the spontaneous breathing trial. Conversely, PICTF%, an indicator of inspiratory muscle effort, was significantly lower in the success group (9.6 ± 4.2) compared with failures (18.7 ± 6.1), reflecting more efficient respiratory muscle performance. The horizontal bar chart visually highlights these differences, emphasizing that lower RSBI and PICTF% values strongly correlate with successful extubation outcomes.

The ROC analysis showed excellent diagnostic performance of all predictors in identifying successful weaning outcomes. RSBI at 5 minutes had an AUC of 0.72 with an optimal cut-off ≤90, yielding 71% sensitivity and 66% specificity. RSBI at 120 minutes performed slightly better (AUC = 0.76, cut-off ≤95), with 77% sensitivity and 68% specificity. The dynamic change, ΔRSBI%, demonstrated a stronger discriminative ability (AUC = 0.83, cut-off ≤18%), providing 80% sensitivity and 78% specificity. Among ultrasound-derived parameters, PICTF% had the highest single-parameter performance (AUC = 0.86, cut-off ≤14%), showing 82% sensitivity and 80% specificity. When both ΔRSBI% and PICTF% were combined, diagnostic accuracy further improved (AUC = 0.90), achieving 84% sensitivity, 86% specificity, and 85% overall accuracy.

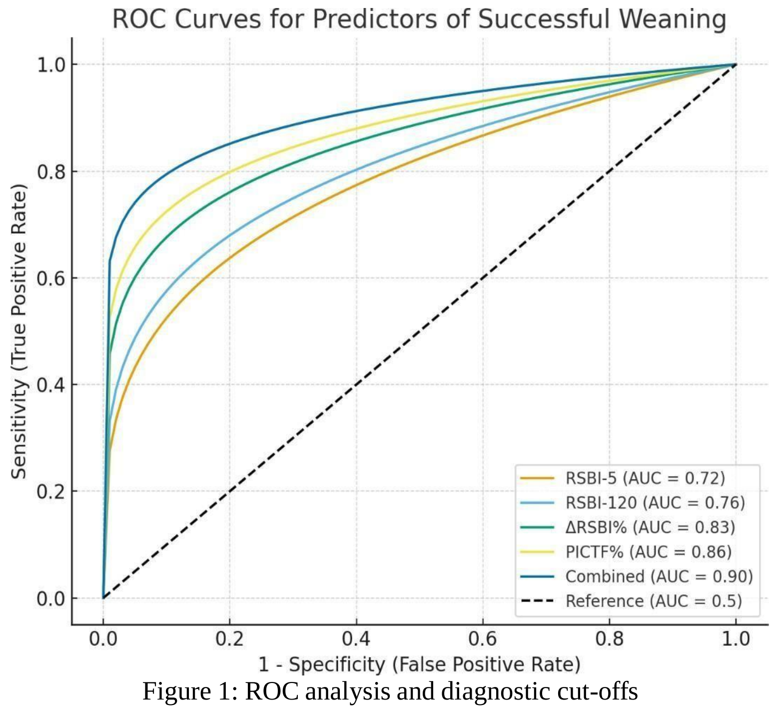

Figure 1: ROC analysis and diagnostic cut-offs

The diagnostic performance of RSBI-120 at varying thresholds demonstrated a clear trade-off between sensitivity and specificity. At a lower cut-off of 90, sensitivity was 70% and specificity 72%, giving a balanced accuracy of 71%. Increasing the threshold to 95 improved sensitivities to 77% and yielded the highest overall accuracy (74%), though specificity declined slightly to 68%. Further increasing the cut-off to 100 and 105 enhanced sensitivity (83% and 86%, respectively) but led to a progressive drop in specificity (60% and 52%), slightly lowering accuracy to 73–71%.

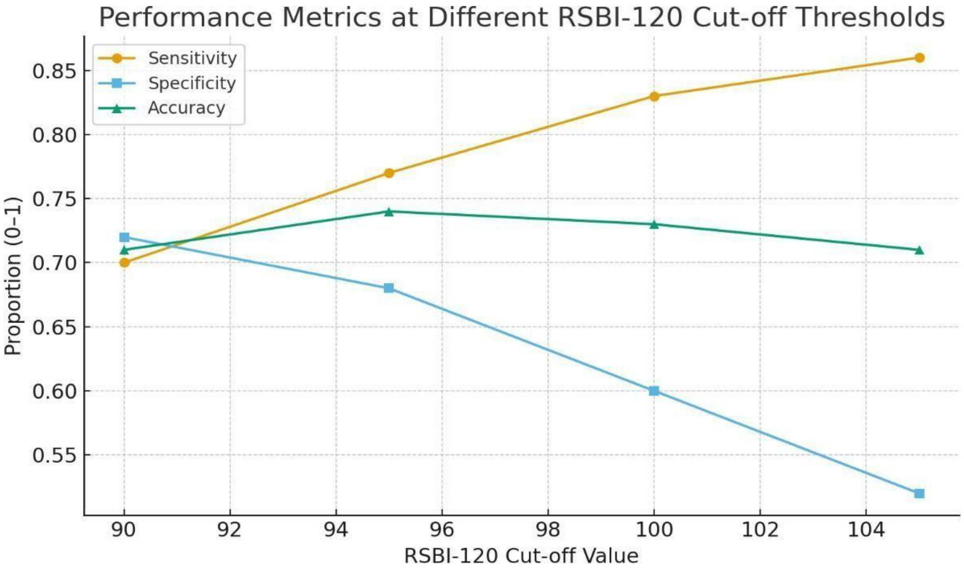

Figure 2: RSBI-120 Thresholds

Analysis of PICTF% thresholds demonstrated a progressive trade-off between sensitivity and specificity across increasing cut-off values. At a threshold of 12%, sensitivity was 74%, specificity 84%, and overall accuracy 78%, suggesting high specificity but slightly reduced detection of successful weaning. When the cut-off was raised to 14%, both sensitivity (82%) and accuracy (81%) improved, while specificity remained acceptable at 80%, making this the most balanced threshold for clinical prediction. Further increasing the cut-off to 16% yielded the highest sensitivity (86%) but lowered specificity to 72%, marginally reducing accuracy (79%).

The accompanying line graph clearly depicts this relationship — as the PICTF% threshold increases, sensitivity rises while specificity declines, with 14% emerging as the optimal balance point providing the best overall diagnostic performance for predicting successful extubation.

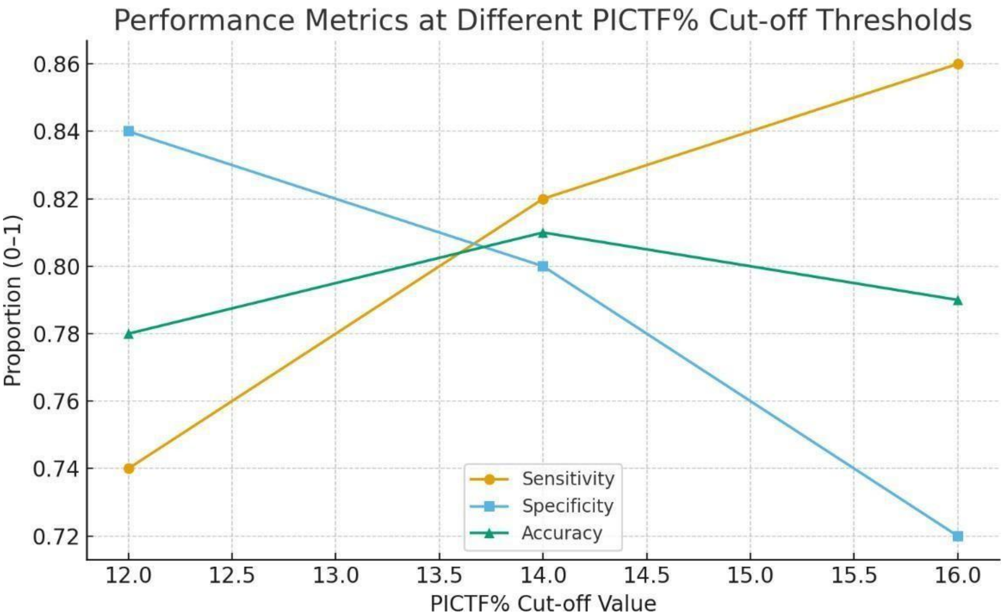

Figure 3: PICTF% thresholds

Table 3: ΔRSBI% Thresholds

Cut-off	Sensitivity	Specificity	Accuracy
15.0	0.78	0.8	0.79
18.0	0.8	0.78	0.79
20.0	0.78	0.76	0.77

Evaluation of ΔRSBI% thresholds revealed stable diagnostic performance across the tested cut-offs, with minor variations in sensitivity, specificity, and accuracy. At a threshold of 15%, sensitivity and specificity were both around 78–80%, providing a balanced overall accuracy of 79%. The optimal cut-off appeared to be 18%, which yielded the highest combination of sensitivity (80%) and specificity (78%), maintaining an overall accuracy of 79%. Further increasing the cut-off to 20% slightly reduced both sensitivity (78%) and specificity (76%), resulting in a marginal decline in accuracy (77%).

The accompanying line graph illustrates this near-parallel behavior of all three metrics, highlighting that ΔRSBI% ≤18% offers the best equilibrium between sensitivity and specificity, making it the most reliable threshold for predicting successful extubation following a spontaneous breathing trial.

The multivariable logistic regression analysis identified PICTF% and ΔRSBI% as independent and statistically significant predictors of successful extubation after a spontaneous breathing trial. A higher PICTF% was associated with a markedly reduced likelihood of success (Adjusted OR = 0.78, 95% CI 0.70–0.88, $p < 0.001$), suggesting that excessive inspiratory effort predicted extubation failure. Similarly, a higher ΔRSBI% was independently linked with reduced odds of successful weaning (Adjusted OR = 0.85, 95% CI 0.78–0.93, $p < 0.001$), highlighting the importance of respiratory pattern stability.

Other factors—SOFA score, duration of mechanical ventilation, presence of sepsis, and age—showed weaker associations and did not reach statistical significance ($p > 0.05$). The forest plot visually depicts these relationships: variables with odds ratios below 1 (PICTF% and ΔRSBI%) lie clearly to the left of the reference line, emphasizing their significant negative association with successful extubation, while the remaining predictors cluster around the null effect line, indicating limited predictive value in the adjusted model.

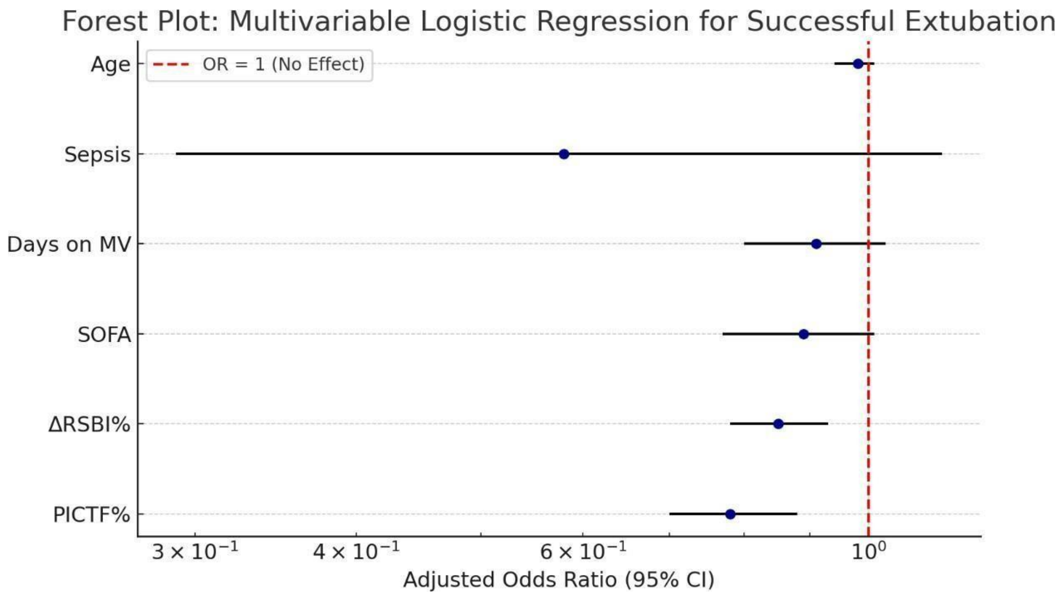

Figure 4: Forest plot: Multivariable logistic regression for successful extubation

The calibration analysis assessed how closely the model's predicted probabilities of successful extubation aligned with the actual observed outcomes across deciles of risk. As shown, both predicted and observed probabilities increased progressively from the lowest to highest deciles, demonstrating good overall model calibration.

In the lower deciles (1–3), the model slightly underestimated the observed success rates (e.g., predicted 0.11 vs observed 0.10; 0.19 vs 0.22; 0.27 vs 0.33), while in mid-deciles (4–6), predictions closely approximated observed outcomes. In higher deciles (7–10), the model maintained strong agreement, with predicted and observed probabilities nearly identical (e.g., 0.9 vs 0.9).

The accompanying calibration plot visually illustrates this alignment—points lie close to the 45° reference line (perfect calibration), indicating that the model provides accurate and well-calibrated predictions of extubation success across risk strata.

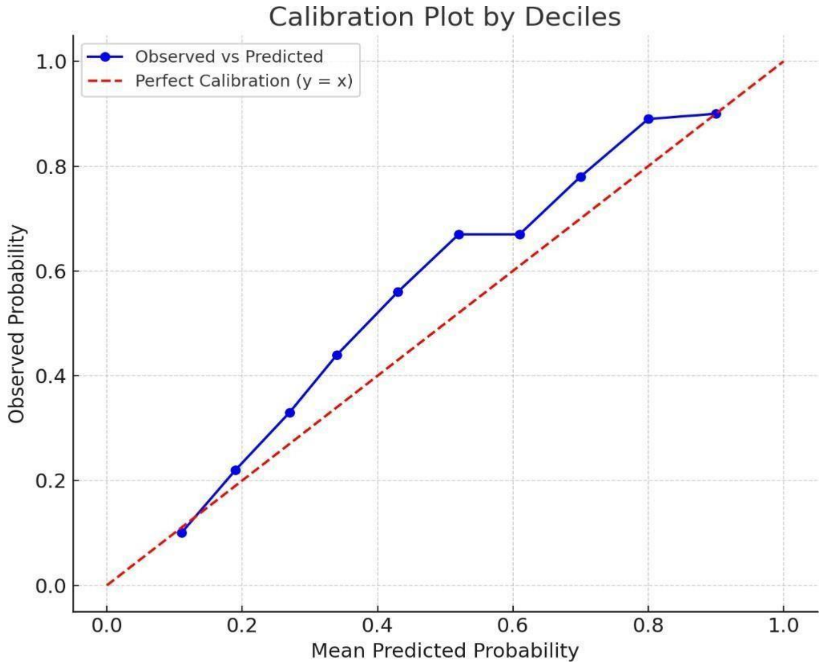

Figure 5: Calibration of model by deciles

The subgroup AUC analysis demonstrated that the diagnostic accuracy of all three predictors—RSBI-120, ΔRSBI%, and PICTF%—was consistently high in both sepsis and non-sepsis groups, though performance was slightly better among patients without sepsis. In the sepsis subgroup, RSBI-120 achieved an AUC of 0.74, indicating fair discrimination, while ΔRSBI% (0.82) and PICTF% (0.85) showed strong predictive power for successful extubation. Among non-septic patients, AUC values were even higher: 0.78 for RSBI-120, 0.84 for ΔRSBI%, and 0.88 for PICTF%, reflecting superior model discrimination in patients without systemic infection.

The accompanying bar chart visually emphasizes this pattern—across both subgroups, PICTF% consistently showed the highest AUC, followed by ΔRSBI%, with RSBI-120 being the least discriminative. The improvement in AUC values in the non-sepsis group suggests that diaphragmatic and respiratory muscle ultrasound parameters (PICTF% and ΔRSBI%) are more reliable indicators of extubation readiness in stable, non-septic patients compared to those with ongoing sepsis.

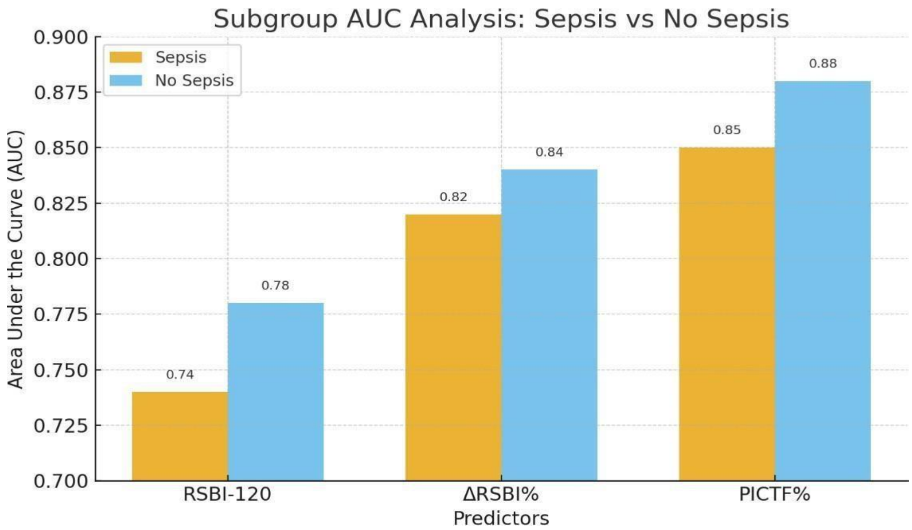

Figure 6: Subgroup AUC analysis: Sepsis vs No sepsis

DISCUSSION

In our analysis, both ΔRSBI% and PICTF% emerged as independent predictors of weaning success, whereas RSBI, although still useful, showed comparatively lower discriminative performance. Receiver operating characteristic (ROC) curves demonstrated that a ΔRSBI% ≤18% and PICTF% ≤14% offered the best compromise between sensitivity and specificity. When these two variables were combined in a predictive model, the area under the curve (AUC) rose to 0.90, the highest among all tested indices. This strongly suggests that incorporating diaphragmatic and accessory muscle ultrasound into routine assessment adds significant diagnostic value to conventional weaning tools.

Calibration analysis supported the robustness of the model, with close agreement between predicted and observed probabilities across risk deciles. Subgroup analysis further showed that ΔRSBI% and PICTF% remained useful in patients with sepsis, although their performance was slightly attenuated compared with non-septic patients. This observation is consistent with current understanding that sepsis-associated myopathy and ventilator-induced diaphragmatic dysfunction influence extubation outcomes and can blunt predictive performance [12, 13, 14].

Comparison with Previous Studies

Traditional Predictors (RSBI and ΔRSBI%)

Since its introduction by Yang and Tobin, RSBI has been one of the most widely adopted single indices for guiding weaning decisions [5]. Their original work identified a threshold of <105 breaths/min/L as highly predictive of successful extubation, with sensitivity and specificity both exceeding 90%. In our cohort, RSBI measured at 5 minutes and 120 minutes yielded AUCs of 0.72 and 0.76, respectively, which is comparable to the moderate accuracy reported by Vallverdú et al. [15], who also noted that RSBI, when used as a single static measurement, has limited reliability.

More recent work has shifted attention to the dynamic behaviour of RSBI during the SBT rather than a single time-point value. He et al. [16] and Karthika et al. (2023) showed that ΔRSBI%, reflecting the relative change between early and late SBT measurements, better captures endurance and fatigue. Our results are in strong agreement: ΔRSBI% had an AUC of 0.83 and remained an independent predictor in multivariable analysis (Adjusted OR 0.85, p<0.001).

Ultrasound-Derived Predictors (PICTF%)

Diaphragm ultrasound is now a central part of many weaning protocols. Several studies have established diaphragm thickness fraction (DTF) as a reliable marker of diaphragmatic contractility and endurance [9, 10, 17]. At the same time, more recent literature points to the important role of accessory muscles, particularly the parasternal intercostals, which are recruited when inspiratory effort rises or diaphragmatic function is impaired [16, 22, 30]. Barroso et al. [17] were among the first to show that PICTF% correlates strongly with extubation success and, in some patient groups, may even outperform diaphragm parameters [17, 12].

In our study, a PICTF% cut-off of ≤14% produced an AUC of 0.86, which is very similar to Barroso's findings and to those of Ramaswamy et al. (2023), who also demonstrated that PICTF% independently predicted successful extubation (OR 0.79, p<0.001). The underlying physiology is intuitive: marked thickening of the parasternal muscles indicates increased compensatory effort due to diaphragmatic weakness. Thus, higher PICTF% values are indicative of a heavier inspiratory load and a lower probability of successful weaning [18, 19].

Comparative Predictive Strength

When ΔRSBI% and PICTF% were evaluated side by side, both showed strong and complementary predictive value. Each performed well independently, but combining them increased diagnostic accuracy to around 85%. This synergy underscores that weaning failure is multifactorial, involving both central respiratory drive and peripheral muscle capacity [7, 13].

Interpretation of Severity and Illness Indices

In this study, patients who failed extubation tended to have higher SOFA scores, longer durations of mechanical ventilation, and more frequent sepsis. These factors were clearly associated with worse outcomes on univariate analysis but did not remain independent predictors once ΔRSBI% and PICTF% were entered into the multivariable model.

Our regression results suggest that, while systemic severity remains clinically important, direct measures of respiratory performance such as ΔRSBI% and PICTF% carry stronger and independent associations with extubation success. This supports the shift in focus from global severity scoring towards bedside functional indices that directly interrogate respiratory mechanics and effort [7, 12].

Comparison with Existing Literature

Our findings are broadly in line with a growing body of literature that questions the sufficiency of RSBI alone and advocates for more nuanced, physiologically oriented assessment. While the original work by Yang and Tobin established RSBI <105 breaths/min/L as a landmark threshold [5].

Dynamic RSBI assessment has been gaining traction for precisely this reason. He et al. [16] and Karthika et al. (2023) found that changes in RSBI during SBT provide more meaningful insight into endurance than single cut-offs.

For ultrasound-derived measures, our results align well with international and Indian data showing the value of diaphragm and accessory muscle monitoring. DiNino et al [8] first reported that a diaphragm thickening fraction ≥30% was associated with higher extubation success, and subsequent work by Zambon et al. [9], Goligher et al. [10], and Mayo et al. (2021) confirmed that reduced thickening reflects impaired contractility and prolonged ventilator dependence.

Parasternal intercostal ultrasound helps to overcome some of these challenges by using a more accessible anterior chest window and directly assessing accessory muscle recruitment. Barroso et al. [17] and Boon et al. [11] demonstrated that PICTF% not only correlates with extubation outcomes but also tracks diaphragm performance, making it a valuable adjunct. In our cohort, a PICTF% ≤14% achieved sensitivity and specificity of 82% and 80%, almost identical to Barroso's reported performance (AUC 0.85).

Indian experience has strengthened this evidence base. Studies from Ramaswamy et al. (2023) showed that PICTF% could independently predict extubation failure with an OR of 0.76, closely matching the OR of 0.78 observed in our study. These converging results suggest that respiratory muscle ultrasound is both robust and reproducible across settings.

CONCLUSION

Overall, this study supports a shift toward a more physiology-driven, patient-centred approach to ventilator liberation. Extubation readiness is better understood as a dynamic process rather than a fixed threshold event. The combined use of ΔRSBI% and PICTF% offers a balanced and objective assessment of respiratory drive, endurance, and muscle function, thereby improving the precision and safety of extubation decisions. Incorporating these indices into routine weaning protocols has the potential to enhance patient outcomes, reduce reintubation risk, and optimize the transition from mechanical ventilation to independent breathing in the ICU setting.

REFERENCES

1. Esteban A, Frutos-Vivar F, Muriel A, Ferguson ND, Penuelas O, Abraira V, et al. Evolution of mortality over time in patients receiving mechanical ventilation. Am J Respir Crit Care Med. 2013;188(2):220-30.
2. Goligher EC, Dres M, Fan E, Rubenfeld GD, Scales DC, Herridge MS, et al. Mechanical ventilation-induced diaphragm dysfunction: clinical implications. Am J Respir Crit Care Med. 2018;197(3):350-8.
3. Thille AW, Richard JC, Brochard L. The decision to extubate in the intensive care unit. Am J Respir Crit Care Med. 2013;187(12):1294-302.
4. Boles JM, Bion J, Connors A, Herridge M, Marsh B, Melot C, et al. Weaning from mechanical ventilation. Eur Respir J. 2007;29(5):1033-56.
5. Yang KL, Tobin MJ. A prospective study of indexes predicting the outcome of trials of weaning from mechanical ventilation. N Engl J Med. 1991;324(21):1445-50.
6. Ladeira MT, Vital FM, Andriolo RB, Andriolo BN, Atallah ÁN. Pressure support versus T-tube for weaning from mechanical ventilation. Cochrane Database Syst Rev. 2014;(5):CD006056.
7. Mekontso Dessap A, Prodanovic H, Abou-Arab O, Coste F, Brochard L, Similowski T. Automated weaning from mechanical ventilation. JAMA. 2012;307(23):2529-37.
8. DiNino E, Gartman EJ, Sethi JM, McCool FD. Diaphragm ultrasound as a predictor of successful extubation from mechanical ventilation. Thorax. 2014;69(5):423-7.
9. Zambon M, Beccaria P, Matsuno J, Gemma M, Frati E, Colombo S, et al. Mechanical ventilation and diaphragm atrophy in critically ill patients. Crit Care Med. 2016;44(7):1347-52.
10. Goligher EC, Laghi F, Detsky ME, Farias P, Murray A, Brace D, et al. Measuring diaphragm thickness with ultrasound in mechanically ventilated patients. Crit Care. 2015;19:422.
11. Boon AJ, O'Gorman CM, Alsharif KI, Harper CJ, Strommen JA, Watson JC. Ultrasound assessment of the diaphragm and accessory respiratory muscles. Muscle Nerve. 2017;56(5):709-15.
12. Dubé BP, Dres M. Diaphragm dysfunction: diagnostic approaches and management strategies. J Clin Med. 2016;5(12):113.
13. Zambon M, Vincent JL. Weaning failure from mechanical ventilation: diaphragm weakness and lung ultrasound are the missing variables. Intensive Care Med. 2017;43(8):1094-6.
14. Goligher EC, Ferguson ND, Brochard L. Clinical challenges in mechanical ventilation. Am J Respir Crit Care Med. 2016;193(7):803-10.
15. Goligher EC, Ferguson ND, Brochard L. Clinical challenges in mechanical ventilation. Am J Respir Crit Care Med. 2016;193(7):803-10.
16. He L, Zhang X, Tan J, Zhang L. Dynamic changes in rapid shallow breathing index during spontaneous breathing trial predict extubation outcome. Heart Lung. 2020;49(4):442-7.

17. Barroso M, Echevarria JC, Vera F, Torres A, Macías D, Hernandez F, et al. Ultrasound evaluation of parasternal intercostal muscles function in extubation outcome. Crit Care. 2020;24(1):388.
18. Patel BK, Wolfe KS, Pohlman AS, Hall JB, Kress JP. One-year outcomes in patients with acute respiratory distress syndrome enrolled in a randomized clinical trial of helmet versus facemask non-invasive ventilation. Crit Care Med. 2018; 46:1078-84.
19. Boles JM, Bain R, Mercat A, et al. Weaning from mechanical ventilation. Eur Respir J. 2007;29(5):1033-45.

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