# RESPIRATORY MUSCLE ULTRASOUND VERSUS RAPID SHALLOW BREATHING INDEX AS A WEANING PREDICTOR IN PROLONGED MECHANICALLY VENTILATED PATIENTS.

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## Introduction

Mechanical ventilation is a life-saving intervention in intensive care units (ICUs), but prolonged use can lead to complications such as ventilator-induced diaphragmatic dysfunction (VIDD) and increased mortality. Weaning patients from mechanical ventilation is a critical process, with approximately 15% of patients requiring reintubation within 48 hours. Traditional weaning predictors, like the Rapid Shallow Breathing Index (RSBI), have limitations in accuracy. Respiratory muscle ultrasound, particularly diaphragmatic and parasternal intercostal muscle thickening fractions, offers a non-invasive, real-time method to assess respiratory muscle function. This approach has gained attention as a potential tool to improve weaning outcomes and reduce extubation failure rates by providing more precise insights into respiratory muscle performance.

## Aim of the Work

The aim of this study was to propose a systematic ultrasound-based evaluation of the respiratory muscle pump compared with rapid shallow breathing index in ICU patients with prolonged mechanical ventilation.

## Patients and Methods

This prospective observational study included 34 mechanically ventilated patients admitted to the Critical Care Medicine Department at Alexandria University Hospitals. Patients were intubated for over one week and met weaning readiness criteria. Respiratory muscle ultrasound was performed to measure diaphragmatic and parasternal intercostal muscle thickening fractions during spontaneous breathing trials (SBT). The RSBI was also calculated. Patients were categorized into successful (n=19) and failed (n=15) weaning groups based on extubation outcomes 48 hrs. post-extubation. Statistical analysis compared ultrasound parameters and RSBI in predicting weaning success, with a focus on sensitivity, specificity, and predictive accuracy.

## Results

**Table 1:** Comparison between the two groups according to different parameters

| | Total (n = 34) | Successful (n = 19) | Fail (n = 15) | Test of Sig. | p |
|---|---|---|---|---|---|
| **RSBI (breath/min/L)** | | | | | |
| Min. – Max. | 25.93 – 87.50 | 25.93 – 73.68 | 50.0 – 87.50 | t= 4.599* | <0.001* |
| Mean ± SD. | 59.29 ± 16.89 | 49.97 ± 12.84 | 71.10 ± 13.89 | | |
| Median (IQR) | 52.40 (47.92 – 73.68) | 48.0 (45.14 – 53.17) | 71.79 (60.07 – 82.35) | | |
| **Tdi ee (mm)** | | | | | |
| Min. – Max. | 1.30 – 2.60 | 1.38 – 2.40 | 1.30 – 2.60 | t= 0.574 | 0.570 |
| Mean ± SD. | 1.93 ± 0.35 | 1.96 ± 0.28 | 1.89 ± 0.42 | | |
| Median (IQR) | 1.95 (1.70 – 2.20) | 2.10 (1.80 – 2.11) | 1.90 (1.55 – 2.21) | | |
| **Tdi pi (mm)** | | | | | |
| Min. – Max. | 1.50 – 3.07 | 1.80 – 3.07 | 1.50 – 2.90 | t= 2.470* | 0.019* |
| Mean ± SD. | 2.40 ± 0.46 | 2.56 ± 0.36 | 2.19 ± 0.50 | | |
| Median (IQR) | 2.50 (2.05 – 2.75) | 2.65 (2.40 – 2.80) | 2.20 (1.75 – 2.60) | | |
| **TF di (%)** | | | | | |
| Min. – Max. | 11.11 – 38.10 | 19.05 – 38.10 | 11.11 – 30.33 | t= 9.338* | <0.001* |
| Mean ± SD. | 24.27 ± 8.69 | 30.78 ± 4.47 | 16.03 ± 4.71 | | |
| Median (IQR) | 27.60 (15.38 – 30.43) | 30.43 (28.35 – 33.33) | 15.38 (13.19 – 16.23) | | |
| **Tic.ee (mm)** | | | | | |
| Min. – Max. | 1.70 – 5.50 | 1.70 – 5.50 | 1.80 – 5.50 | U= 84.50* | 0.043* |
| Mean ± SD. | 3.34 ± 1.04 | 3.63 ± 0.99 | 2.96 ± 1.01 | | |
| Median (IQR) | 3.35 (2.40 – 4.0) | 3.60 (3.20 – 4.15) | 2.80 (2.20 – 3.45) | | |
| **Tic pi (mm)** | | | | | |
| Min. – Max. | 2.20 – 6.70 | 2.20 – 5.80 | 2.30 – 6.70 | t= 1.180 | 0.247 |
| Mean ± SD. | 3.81 ± 1.06 | 3.99 ± 0.96 | 3.56 ± 1.17 | | |
| Median (IQR) | 3.80 (2.91 – 4.40) | 4.0 (3.55 – 4.40) | 3.40 (2.70 – 4.06) | | |
| **TF ic (%)** | | | | | |
| Min. – Max. | 4.76 – 33.33 | 4.76 – 29.41 | 9.52 – 33.33 | U= 45.00* | <0.001* |
| Mean ± SD. | 15.68 ± 8.54 | 11.38 ± 7.59 | 21.12 ± 6.42 | | |
| Median (IQR) | 12.15 (8.0 – 22.50) | 8.11 (7.79 – 9.23) | 21.43 (18.93 – 24.41) | | |

IQR: **Inter quartile range**　　SD: **Standard deviation**　　t: **Student t-test**　　U: **Mann Whitney test**
p: p value for comparing between the two studied groups　　*: Statistically significant at $p \leq 0.05$
RSBI: Rapid Shallow Breathing Index　　Tdi ee: Thickness of diaphragm end expiration
Tdi pi: Thickness of diaphragm peak inspiration　　TF di: Thickening Fraction of diaphragm
Tic ee: Thickness of parasternal intercostal muscle end expiration
Tic pi: Thickness of parasternal intercostal muscle peak inspiration
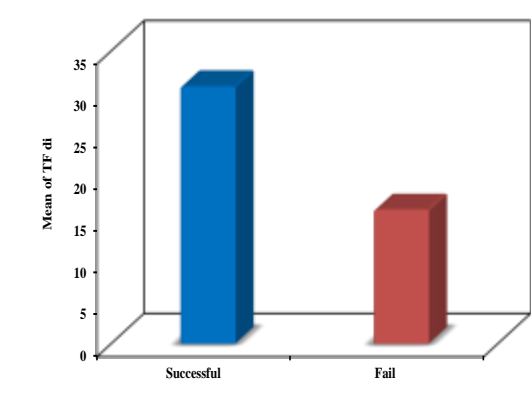TF ic: Thickening Fraction of Parasternal intercostal muscle



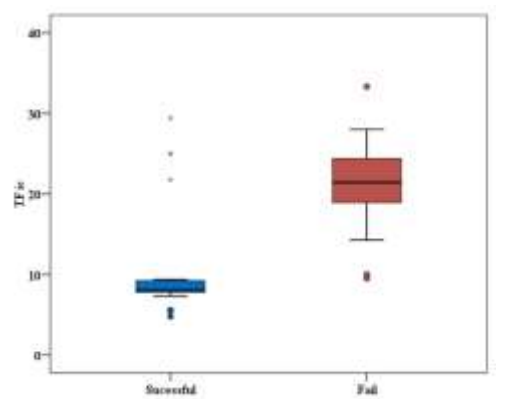**Figure 1:** Comparison between the two groups according to TF di

**Figure 2:** Comparison between the two groups according to TF ic

## Conclusion

Respiratory muscle ultrasonography, particularly diaphragmatic and parasternal intercostal muscle thickening fractions, effectively predicts successful weaning from mechanical ventilation. A higher diaphragmatic thickening fraction (TF di >21.05%) and a lower parasternal intercostal muscle thickening fraction (TF ic ≤10%) were strongly linked to successful extubation, outperforming the Rapid Shallow Breathing Index (RSBI). The combination of these ultrasound parameters achieved high accuracy (AUC: 0.968), sensitivity (94.74%), and specificity (93.33%).
Respiratory muscle ultrasonography offers a non-invasive, bedside tool to improve weaning decisions and reduce extubation failure risks. By providing real-time insights into respiratory muscle function, this approach enhances the ability to identify patients ready for extubation, offering a more reliable evaluation of respiratory muscle performance compared to traditional indices like the RSBI.