Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/her69k30

ULTRASONOGRAPHIC ASSESSMENT OF DIAPHRAGMATIC PARAMETERS FOR PREDICTING WEANING OUTCOME IN PATIENTS ON MECHANICAL VENTILATION IN THE ICU SETTING

[*1]Dr. Sakshi Khandelwal, [2]Dr. Vandana Talwar, [3]Dr. Pratibha Mudgal, [4]Dr. Rohan Khandelwal, [5]Dr. Ankush Garg, [6]Dr. Bharani kumar B

[*1]MBBS MD Anaesthesia, Senior resident, Department of Anaesthesia, Vardhman Mahavir Medical College and Safdarjung hospital, Delhi-110021, India. Mail id - sakshigupta2705@gmail.com, ORCID- 0009-0000-3366-5234
[2]MBBS MD Anaesthesia, medical superintendent, professor, Department of Anaesthesia, Vardhman Mahavir Medical College and Safdarjung hospital, Delhi-110021, India. ORCID- 0000-0003-1009-8315
[3]MBBS MD Anaesthesia, Assistant professor, Department of Anaesthesia, Vardhman Mahavir Medical College and Safdarjung hospital, Delhi-110021, India. ORCID- 0000-0002-2612-9158
[4]MBBS MD Anaesthesia, Senior resident, Department of Anaesthesia, Vardhman Mahavir Medical College and Safdarjung hospital, Delhi-110021, India. ORCID- 0009-0004-4212-2687
[5]Senior Resident, VMMC and Safdarjung Hospital, West Punjabi Bagh, New Delhi, India
Mail id - ankushgargdr@gmail.com, ORCID: 0009-0000-3725-1805
[6]Senior Resident, VMMC and Safdarjung Hospital, Madurai, Tamil Nadu, India
Email id - bharani.kumarmmc@gmail.com, ORCID: 0000-0003-4568-7902

***Corresponding Author:** Dr. Sakshi Khandelwal
[*]MBBS MD Anaesthesia, Senior resident, Department of Anaesthesia, Vardhman Mahavir Medical College and Safdarjung hospital, Delhi-110021, India. Mail id - sakshigupta2705@gmail.com, ORCID- 0009-0000-3366-5234

ABSTRACT

INTRODUCTION

A great number of critically ill patients require mechanical ventilation as a part of their care. Nevertheless, mechanical ventilation or the underlying ailment can lead to diaphragmatic dysfunction, a condition that may contribute to weaning failure. Extended time on the ventilator greatly increases patient morbidity and mortality. Symptoms and signs of muscle disease in ICU patient are often difficult to evaluate because of concomitant confounding factors. In recent times, the use of ultrasound has risen as a simple, non-invasive method for quantification of diaphragmatic excursion and contractile activity.

MATERIAL AND MEHTODS

The study was conducted in the Department of Anaesthesia and Intensive care. This cohort study was conducted on 50 adult patients of either sex, admitted in Intensive Care Unit and scheduled to undergo extubation. The patient's readiness to wean was assessed by clinical judgment. When the patient was ready to be weaned, he/she was put on pressure support ventilation (PSV). The pressure support was

gradually reduced to 6cm H_2O. If the patient remained stable and extubation was planned, T-piece trial was given. Baseline parameters (Heart rate, non-invasive blood pressure, respiratory rate, tidal volume, RSBI, SpO_2, signs of respiratory distress- nasal flaring, sweating, agitation, use of accessory muscles, ABG analysis, Maximum Inspiratory Pressure (MIP), Maximum Expiratory Pressure (MEP) were recorded. Diaphragmatic excursion (DE) and diaphragmatic thickness fraction (DTF) were assessed ultrasonographically and diaphragmatic RSBI was later calculated.

RESULTS

In our study, 34 of the 50 patients were successfully weaned from mechanical ventilation and 16 failed the extubation trial. Of the 16 patients who failed weaning trial, 12 were re-intubated within 24 hours and 4 died within 48 hours of extubation.

Of the 34 patients successfully weaned, 32 patients had DE more than 10mm (p value <0.0001), 33 had DTF> 30% (p value <0.0001) and 32 had diaphragmatic RSBI <1.75 breaths/min/mm (p value<0.0001)**.** DE and DTF were found to have similar sensitivity (94.12% and 97.06%), specificity (75%), positive predictive values (88.89 and 88.19% respectively) and negative predictive values (85.71% and 92.31% respectively). Overall Diaphragmatic thickness fraction was comparable to diaphragmatic excursion in terms of diagnostic accuracy (88% and 90% respectively). (p value=1)

Diaphragmatic RSBI and RSBI were found to be good predictors of weaning success. (p values <0.0001 and 0.00959 respectively). Diaphragmatic RSBI was comparable to RSBI as a predictor of weaning success and no significant difference was found between the two statistically. (p value=0.0562).

CONCLUSION

Diaphragmatic Excursion and Diaphragmatic thickness fraction are rapid and non- invasive ultrasonographic indices with a high diagnostic accuracy for predicting weaning outcome. They provide objective and accurate results and are comparable to each other for predicting weaning outcome. Diaphragmatic RSBI is a good predictor of weaning outcome and is comparable to clinical RSBI.

INTRODUCTION

A great number of critically ill patients require mechanical ventilation as a part of their care. Nevertheless, mechanical ventilation or the underlying ailment can lead to diaphragmatic dysfunction, a condition that may contribute to weaning failure. Conservative assessment of weaning success lacks specific, non-invasive, time-saving, and easily performed bedside tools or requires patient cooperation. In recent times, the use of ultrasound has risen as a simple, non-invasive method of quantification of diaphragmatic excursion and contractile activity.

Diaphragm is the principal muscle for generation of tidal volume (TV) in normal patients at rest. When its muscle fibres are activated in isolation, they shorten, the dome of the diaphragm descends, pleural pressure falls, and abdominal pressure rises. Studies have shown that the decrease in diaphragmatic motion is probably related to changes in the main respiratory function measurements.[1]

Ultrasonography is a feasible, relatively inexpensive, radiation-free imaging modality which allows the visualization of muscle contractions; and has been shown to reliably assess diaphragm thickness and excursion. It has been used successfully to evaluate diaphragm dysfunction, which is taken to be diaphragmatic excursion < 10mm and diaphragmatic thickness fraction <30%.

Diaphragmatic excursion (DE) is the movement of the diaphragm during breathing. It represents the endurance of the diaphragm as compared to its strength. Diaphragmatic thickening fraction (DTF) reflects the magnitude of diaphragmatic effort and is calculated as thickness at the end of inspiration (TI) minus thickness at the end of expiration (TE), divided by thickness at the end of expiration, then multiplied by 100. The rapid shallow breathing index (RSBI) is defined as the ratio of respiratory frequency to tidal volume. A patient with a RSBI of less than 105 has an approximately 80% chance of being successfully extubated. The diaphragmatic RSBI, which is the ratio between respiratory rate

(RR) and the ultrasonographic evaluation of diaphragmatic excursion (DE), is a new tool to predict weaning outcome. It is found to be 1.43 ± 0.32 in normal population.[2]
The aim of this study was to ultrasonographically assess the diaphragmatic parameters for predicting weaning outcome in patients on mechanical ventilation in the ICU setting.

Commented [AB1]: Do include what are various literature on diaphragmatic indices for prediction of weaning outcome in ICU setting. What are gaps in literature and what you study adds to existing literature. What is your study hypiothesis, primary and secondary objectives. Study introduction shpuld be concise (maximu 250-300 words)

Commented [SK2R1]: Required changes have been made

Primary objective:
To assess the diagnostic accuracy of diaphragmatic excursion and diaphragmatic thickness fraction by ultrasonography to predict weaning outcome in critically ill patients on mechanical ventilation.

Secondary objectives:
1. To correlate diaphragmatic dysfunction with reintubation within 48 hours of extubation.
2. To assess which of the two-diaphragmatic excursion or diaphragmatic thickness fraction is a better predictor.
3. To compare diaphragmatic rapid shallow breathing index (RSBI) with clinical RSBI.

LACUNAE IN EXISTING KNOWLEDGE
There is paucity of literature regarding ultrasonographic assessment of DE and DTF to predict weaning outcome in critically ill patients on mechanical ventilation in an ICU setting, in the Indian scenario.

RESEARCH QUESTION
Will the ultrasonographic assessment of diaphragmatic function help in predicting weaning outcome in critically ill patients on mechanical ventilation?

HYPOTHESIS
Ultrasonographic assessment of diaphragmatic function will predict weaning outcome in critically ill patients on mechanical ventilation.

REVIEW OF LITERATURE
Nagger et al. conducted a prospective study on diaphragmatic ultrasound as a predictor of successful extubation from mechanical ventilation. 31 patients revealed successful liberation from mechanical ventilation. Diaphragmatic mobility and thickening fraction showed high sensitivity and specificity compared with other weaning tools. The cut off value was 10 mm for mobility and 30% for diaphragmatic thickening fraction. The study concluded that diaphragmatic ultrasonography can be used as a new tool for prediction of weaning process.[3]
Vivier et al. conducted a prospective study to assess whether diaphragm dysfunction detected by ultrasound prior to extubation could predict extubation failure in ICU. 191 at- risk patients were studied. Among them, 33 (17%) were considered extubation failures.
The proportion of patients with diaphragmatic dysfunction was similar between those whose extubation succeeded and those whose extubation failed: 46% vs. 51% using excursion (P = .55), and 71% vs. 68% using thickening (P = .73), respectively. Values of excursion and thickening did not differ between the success and the failure groups: on right side, excursion was 14 ± 7 mm vs. 11 ± 8 (P = .13), and thickening was 29 ±29% vs. 38 ± 48% (P = .83), respectively.[4]

Hallaby et al. conducted a prospective observational cross-sectional study on sonographic evaluation of diaphragmatic excursion and thickness in healthy infants and children. Reference values for diaphragmatic excursion and thickness were determined in different age groups. There were no significant differences with respect to sex.
Significant positive correlations were found between excursion of the right hemi diaphragm and body weight in all age groups.[5] DiNino et al. conducted a prospective study on diaphragmatic ultrasound as a predictor of successful extubation from mechanical ventilation. Of the 63 subjects studied, 27

patients were weaned with spontaneous breathing and 36 were weaned with pressure support. The positive predictive value and negative predictive value were 91% and 63%, respectively. Ultrasound measures of diaphragm thickening in the zone of apposition were found to be useful to predict extubation success or failure.[6]

Wan Yoo et al. conducted a prospective study on comparison of clinical utility between diaphragm excursion and thickening change using ultrasonography to predict extubation success. Sixty patients were included, and 78.3% (47/60) of these patients were successfully extubated, whereas 21.7% (13/60) were not. The median degree of excursion was greater in patients with extubation success than in those with extubation failure (1.65 cm vs. 0.8 cm, p < 0.001). Patients with extubation success had a greater diaphragm thickness faction than those with extubation failure (42.1% vs. 22.5%, p =0.03). Diaphragm excursion seems more accurate than a change in the diaphragm thickness to predict extubation success.[7]

MATERIAL AND MEHTODS

The study was conducted in the Department of Anaesthesia and Intensive care. This cohort study was conducted on 50 adult patients of either sex, admitted in Intensive Care Unit and scheduled to undergo extubation.

The patient's readiness to wean was assessed by clinical judgment. When the patient was ready to be weaned, he/she was put on pressure support ventilation (PSV). The pressure support was gradually reduced to 6cm H_2O. If the patient remained stable and extubation was planned, T-piece trial was given. Baseline parameters (Heart rate, non-invasive blood pressure, respiratory rate, tidal volume, RSBI, SpO_2, signs of respiratory distress- nasal flaring, sweating, agitation, use of accessory muscles, ABG analysis, Maximum Inspiratory Pressure (MIP), Maximum Expiratory Pressure(MEP) were recorded. Written consent was taken from patient's attendant.

Commented [AB3]: Was the trial conducted after taking approval from institute ethics committee. Was it registered in CTRI or other registry? Was your manuscript write-up follow STROBE guidelines? What were inclusion and exclusion crtiteria?

Commented [SK4R3]: Yes sir. Approval from ethics committee was taken and this study is CTRI registered. Changes as per STROBE protocol have been made. Inclusion exclusion criteria has been added in the materials and methods.

Commented [AB5]: How written informed consent was taken from patient

Commented [SK6R5]: We meant to write patient's attendant. And as most patients were ready for extubation- the process was explained to them. adequate changes are made in the text.

INCLUSION CRITERIA

Readiness for weaning from mechanical ventilation as assessed by:

- Recovery from the cause of respiratory failure
- Stable haemodynamic status with no requirement for vasopressors
- Fully conscious, GCS >/= 14
- Fio2<0.5, PEEP</= 5cm H_2O, respiratory rate< 30/min, PaO2/FiO2>200

EXCLUSION CRITERIA

- Pneumothorax, pleural effusion, collapse, fibrosis
- History of neuromuscular disease, diaphragmatic palsy, thoracic surgery, any mass or mechanical factor in chest or abdomen
- Tracheostomy tube in situ
- Pregnancy, ascites, morbid obesity
- Surgical dressings over the right lower rib cage

Baseline characteristics of the patient were recorded- APACHE II score, co-morbidities, diagnosis/ cause of respiratory failure, duration of ICU stay, duration of mechanical ventilation

Lab findings (Hb, platelet, total leukocyte count, kidney function test, serum electrolytes) before extubation and intake of any drugs affecting diaphragmatic dysfunction such as neuromuscular blockers, steroids, aminoglycosides and organophosphates was also recorded.

The patient's readiness to wean was assessed daily by clinical judgment, recovery from the cause of respiratory failure, stable haemodynamic status with no requirement for vasopressors, fully conscious, Glasgow Coma Scale >/=14 and fraction of inspired oxygen (Fio_2) <0.5, positive end expiration pressure (PEEP) </=5cm H2O, respiratory rate<30, partial pressure of oxygen (PaO_2)/FiO_2>200.

When the patient was ready to be weaned, he/she was put on pressure support ventilation (PSV). The pressure support was gradually reduced to 6 cm H_2O, as per clinical status of the patient. If the patient remained stable and extubation was planned, T-piece trial was given. Patient was monitored for heart rate, non-invasive blood pressure (NIBP), respiratory rate, tidal volume, RSBI, SpO_2, signs of respiratory distress (nasal flaring, sweating, agitation), use of accessory muscles of respiration, ABG analysis- PaO_2, $PaCO_2$, PaO_2/FiO_2, Maximum Inspiratory Pressure and Maximum Expiratory Pressure.

Ultrasound was done prior to extubation.

DE was measured using a 6-13 MHz linear probe in B-mode on Sonosite USG machine. The right hemi-diaphragm was visualized in the zone of apposition, on the mid-axillary line between the 8th and 10th intercostal spaces. On B-mode diaphragm was seen as a thick echogenic linear structure between highly reflective pleural and peritoneal membranes.

DTF was recorded on M-mode sonography in real time. During M-mode imaging, the normally functioning diaphragm was visualised as an echogenic line that moved freely during inspiration and expiration. Thickness was measured by placing callipers on reflective lines at the end of inspiration (TI) and expiration (TE).

DTF was calculated by formula: $\frac{TI - TE}{TE} \times 100$

Diaphragmatic RSBI was calculated by formula: $\frac{\text{Respiratory rate}}{DE}$

FLOWCHART

Written informed consent was taken from the patient's relative

↓

Baseline characteristics of the patient were recorded:

- APACHE II score
- Co-morbidities
- Diagnosis/ cause of respiratory failure
- Duration of ICU stay
- Duration of mechanical ventilation
- Lab findings (Hb, platelet, KFT, serum electrolytes) before extubation
- Intake of any drugs affecting diaphragmatic dysfunction such as Neuromuscular blockers, steroids, aminoglycosides, organophosphates.

The pressure support was gradually reduced to 6cm H_2O, as per clinical status of the patient

↓

Commented [AB7]: Which USG machine? Kindly check the frequency setting of linear probe

Commented [SK8R7]: Corrected sir

Commented [AB9]: This is not the [part of methodology

Commented [SK10R9]: Required changes have been made sir

↓

- Pressure support ventilation (PSV) followed by T-piece trial was given for 1 hour. Patient was monitored for
  - Heart rate
  - NIBP
  - Respiratory rate
  - SpO_2,
  - Signs of respiratory distress
  - ABG analysis- PaO_2, $PaCO_2$
  - Minimum Inspiratory Pressure, Maximum Expiratory Pressure
  - RSBI
  - Tidal Volume
- If the SBT failed patient was put back on mechanical ventilation
- If the patient met the criteria for extubation, diaphragmatic parameters were assed ultrasonographically. Patient was extubated and monitored closely for 48 hours for re-intubation, resumption of ventilator support and/ or death.

STATISTICAL ANALYSIS

The study of Naggar[3], et al. observed that sensitivity and specificity of DE and DTF for predicting successful extubation was 82% and 88% respectively. Taking these values as reference, the minimum required sample size with desired precision of 15%, 80% power of study and 5% level of significance is 47 patients. To reduce the margin of error; total sample size taken is 50.

The presentation of the Categorical variables was done in the form of number and percentage (%). On the other hand, the quantitative data were presented as the means ± SD and as median with 25th and 75th percentiles (inter quartile range). The following statistical tests were applied for the results:

The association of the variables which were quantitative in nature, were analysed using Independent t test.

The association of the variables which were qualitative in nature, were analysed using Fisher's exact test as at least one cell had an expected value of less than 5.

Inter-rater kappa agreement was used to find the strength of agreement between RSBI (breaths/min/L) and Diaphragmatic RSBI (breaths/min/mm).

Receiver operating characteristic curve was used to find cut off point of RSBI, diaphragmatic RSBI and APACHE II score for predicting weaning success. Sensitivity, specificity, PPV and NPV was calculated. Mcnamer test was used for comparison of sensitivity and specificity. DeLong et al test was used for comparison of area under curve.

The data entry was done in the Microsoft EXCEL spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, ver 21.0.

For statistical significance, p value of less than 0.05 was considered statistically significant.

RESULTS

In our study, 34 of the 50 patients were successfully weaned from mechanical ventilation and 16 failed the extubation trial. Of the 16 patients who failed weaning trial, 12 were re-intubated within 24 hours and 4 died within 48 hours of extubation. (Table 1)

Commented [AB11]: Sample size calculation is not specified

Commented [SK12R11]: Required changes have been made.

Commented [AB13]: Kindly mention study flow chart as per STROBE

Commented [SK14R13]: Added sir

Table 1: Incidence of Weaning Success and failure.

Weaning success	Frequency		Percentage
Yes	34		68.00%
No	16		32.00%
	Re-intubated	12	75%
	Died	4	25%

Of the 34 patients successfully weaned, 32 patients had DE more than 10mm (p value <0.0001), 33 had DTF> 30% (p value <0.0001) and 32 had diaphragmatic RSBI <1.75 breaths/min/mm (p value<0.0001). (Table 2)

Table 2: Association of Diaphragmatic Excursion, Diaphragmatic Thickness Fraction and Diaphragmatic RSBI with weaning success.

	Diaphragmatic Excursion >10mm (n=34)	Diaphragmatic Thickness Fraction>30% (n=34)	Diaphragmatic RSBI<1.75 breaths/min/mm (n=34)
Weaning success	32 (94.12%)	33 (97.06%)	32 (94.12%)
Weaning failure	2 (5.88%)	1 (2.94%)	2 (5.88%)
p value	<0.0001	<0.0001	<0.0001

Out of the 16 patients who failed the extubation trial and were re-intubated within 48 hours, 12 (75%) had DE<10mm (p value <0.0001), 12 had DTF<30% (p value <0.0001) and 12 had diaphragmatic RSBI>1.75 breaths/min/mm (p value <0.0001). (Table 3)

Table 3: Association of Diaphragmatic Excursion, Diaphragmatic Thickness fraction and Diaphragmatic RSBI with weaning failure.

	Diaphragmatic Excursion<10 mm(n=16)	Diaphragmatic Thickness Fraction<30 %(n=16)	Diaphragmatic RSBI> 1.75 breaths/min/mm(n=16)
Weaning failure	12 (75%)	12 (75%)	12 (75%)
Weaning success	4 (25%)	4 (25%)	4(25%)
p value	<0.0001	<0.0001	<0.0001

DE and DTF were found to have similar sensitivity (94.12% and 97.06%), specificity (75%), positive predictive values(88.89 and 88.19% respectively) and negative predictive values (85.71% and 92.31% respectively). Overall Diaphragmatic thickness fraction was comparable to diaphragmatic excursion in terms of diagnostic accuracy (88% and 90% respectively). (p value=1) (Table 4)

Table 4: Comparison of Diaphragmatic Excursion and Diaphragmatic Thickness Fraction in predicting weaning outcome.

Weaning outcome	Diaphragmatic excursion (mm)	Diaphragmatic thickness fraction (%)
Sensitivity (95% CI)	94.12% (80.32% to 99.28%)	97.06% (84.67% to 99.93%)
Specificity (95% CI)	75% (47.62% to 92.73%)	75% (47.62% to 92.73%)
AUC (95% CI)	0.85(0.72 to 0.93)	0.86(0.73 to 0.94)
Positive Predictive Value (95% CI)	88.89% (73.94% to 96.89%)	89.19% (74.58% to 96.97%)
Negative Predictive Value (95% CI)	85.71% (57.19% to 98.22%)	92.31% (63.97% to 99.81%)

Diagnostic accuracy	88.00%	90.00%
P value after comparison of sensitivity	1	
P value after comparison of specificity	1	

Diaphragmatic RSBI and RSBI were found to be good predictors of weaning success. (p values <0.0001 and 0.00959 respectively). Though diaphragmatic RSBI was a better predictor of weaning success than RSBI, no significant difference was found between the two statistically. (p value=0.0562). (Table 5)

Table 5: Comparison of RSBI and Diaphragmatic RSBI for predicting weaning outcome.

Weaning outcome	**RSBI(breaths/min/L)**	**Diaphragmatic RSBI (breaths/min/mm)**
Area under the ROC curve (AUC)	0.66	0.878
Standard Error	0.0961	0.0613
95% Confidence interval	0.512 to 0.788	0.754 to 0.953
P value	0.00959	<0.0001
Cut off	≤73	≤2.11
Sensitivity(95% CI)	70.59% (52.5 - 84.9%)	94.12% (80.3 - 99.3%)
Specificity(95% CI)	68.75% (41.3 - 89.0%)	75% (47.6 - 92.7%)
PPV(95% CI)	82.8%(64.2 - 94.2%)	88.9% (73.9 - 96.9%)
NPV(95% CI)	52.4%(29.8 - 74.3%)	85.7% (57.2 - 98.2%)
Diagnostic accuracy	70.00%	88.00%
Comparison of AUC	0.0562	

DISCUSSION

This prospective, cohort, randomized and observational study was conducted in 50 adults of age more than 18 years of either gender requiring mechanical ventilation in intensive care unit setting.

Prediction of weaning outcome is routinely done using clinical parameters such as respiratory rate and hemodynamic variables, blood gas analysis, MIP, MEP and RSBI. We undertook this study with an intention to objectively assess diagnostic accuracy of diaphragmatic excursion and diaphragmatic thickness fraction to predict weaning outcome.

Diaphragmatic excursion >10mm and diaphragmatic thickness fraction> 30% predicted weaning success in 94.12% and 97.06% of patients in our study respectively (p<0.0001). Diaphragmatic excursion<10mm, and Diaphragmatic thickness fraction<30% each predicted weaning failure in 75% of patients (p<0.0001). On evaluating specificity, sensitivity, positive and negative predictive values, both DE and DTF were found to be good predictors of weaning outcome were comparable in terms of diagnostic accuracy (88% and 90% respectively).

We also evaluated and compared diaphragmatic RSBI and clinical RSBI and found both to be good predictors of weaning outcome. Neither was found to be significantly better than the other statistically (p=0.0562).

El Nagger[3] et al. conducted a study in 40 patients of which 31 were successfully weaned from mechanical ventilation. Diaphragmatic mobility and thickening fraction showed high diagnostic accuracy in terms of predicting weaning outcome compared with other weaning tools.

Vivier E[4] et al. assessed 191 patients, of which 33 (17%) were considered extubation failures. The proportion of patients with diaphragmatic dysfunction was similar between those whose extubation succeeded and those whose extubation failed. Values of excursion and thickening did not differ between the success and the failure groups.(why)

Abbas[8] et al included a total of 50 acute exacerbations of COPD patients requiring mechanical ventilation. Of these, 37 were successfully liberated from mechanical ventilation. They found D-RSBI to be superior to the clinical RSBI in predicting weaning outcome.

Commented [AB15]:

LIMITATIONS OF OUR STUDY

The limitation of our study was a smaller sample size.
Larger sample size may yield more significant and corroborative results.
Majority of study subjects were post operative patients in ICU in view of elective ventilation. There is a probability of difference in outcome with a different study population.

CONCLUSION

Diaphragmatic Excursion and Diaphragmatic thickness fraction are rapid and non-invasive ultrasonographic indices with a high diagnostic accuracy for predicting weaning outcome. They provide objective and accurate results and are comparable to each other for predicting weaning outcome.
Diaphragmatic RSBI is a good predictor of weaning outcome and is comparable to clinical RSBI.

REFERENCES

1. Talwar D, Dogra V. Weaning from mechanical ventilation in chronic obstructive pulmonary disease: keys to success. J Assoc Chest Physicians 2016; 4:43–9.
2. Theerawit P, Eksombatchai D, Sutherasan Y, Suwatanapongched T, Kiatboonsri C, Kiatboonsri S. Diaphragmatic parameters by ultrasonography for predicting weaning outcomes. BMC pulmonary medicine 2018;18:175.Qian Z, Yang M, Li L, Chen Y. Ultrasound assessment of diaphragmatic dysfunction as a predictor of weaning outcome from mechanical ventilation: a systematic review and meta-analysis. BMJ Open 2018;8:e021189.
3. El Naggar TH, Dwedar IA, Abd- Allah EF. Diaphragm ultrasound as a predictor of successful extubation for mechanical ventilation. Egypt J Bronchol 2019;13:191-5.
4. Vivier E, Muller M, Putegnat JB, Steyer J, Barrau S, Boissier F, et al. Inability of Diaphragm Ultrasound to Predict Extubation Failure. Chest 2016; 6:1131–39.
5. El-Halaby H, Abdel-Hady H, Alsawah G, Abdelrahman A, El-Tahan H. Sonographic Evaluation of Diaphragmatic Excursion and Thickness in Healthy Infants and Children. J Ultrasound Med 2016; 35:167–75.
6. DiNino E, Gartman EJ, Sethi JM, McCool FD. Diaphragm ultrasound as a predictor of successful extubation from mechanical ventilation. Thorax 2014;69:423–27.
7. Yoo JW, Lee SJ, Lee JD, Kim HC. Comparison of clinical utility between diaphragm excursion and thickening change using ultrasonography to predict extubation success. Korean J Intern Med 2018;33:331-39.
8. Abbas A, Embarak S, Walaa M, Lutfy SM. Role of diaphragmatic rapid shallow breathing index in predicting weaning outcome in patients with acute exacerbation of COPD. Int J Chron Obstruct Pulmon Dis 2018;13:1655–61.