BENHA MEDICAL JOURNAL bmj
Print ISSN 1110-208X.
Online ISSN 2357-0016

Original article

Predicting Weaning Outcome of Mechanically Ventilated Patients Using Ultrasound Diaphragmatic Excursion-Based Shallow Breathing Index Compared to Traditional Shallow Breathing Index

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Abstract:

Background: Mechanical ventilation is crucial incident in intensive care unit management. Weaning is method of decreasing ventilatory support. This study aimed to predict weaning outcome of MV patients using diaphragmatic excursion dependent shallow breathing index and compare it with traditional shallow breathing index. **Methods:** The study was prospective observational study that included 58 MV patients randomized into 2 equal groups, Group (I): were assessed using rapid shallow breathing index and Group (II) underwent ultrasonographic assessment for diaphragmatic excursion and assessed using diaphragmatic rapid shallow breathing index. All cases underwent continuous oxygen saturation monitoring, arterial blood gas analysis, and ECG. **Results:** Glasgow coma scale was higher in weaning success group compared to weaning failure group (P<0.001). ICU stay and hospital stay were significantly shorter in weaning success group compared to weaning failure group (P<0.001, <0.001). The ventilator hours till SBT was significantly longer in the weaning failure group compared to weaning success group (P<0.001). RSBI in group I was significantly higher in weaning failure group compared to weaning success group (P<0.001) and DRSBI in group II was significantly higher in weaning failure group compared to weaning success group (P<0.001). **Conclusion:** RSBI and DRSBI were significantly higher in weaning failure than weaning success. RSBI at AUC of 0.917 can significantly predict the weaning success, at cutoff value ≤71, with 88.89% sensitivity, 63.64% specificity, 80.0% PPV and 77.8% NPV. DRSBI at AUC of 0.988 can significantly predict the weaning success, at cutoff value ≤1.58, with 95.24% sensitivity, 87.50% specificity, 95.2% PPV and 87.5% NPV.

Keywords: Weaning Outcome; Mechanically Ventilated; Ultrasound; Diaphragmatic Excursion; Shallow Breathing Index.

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Received:
Accepted:

Introduction

Mechanical ventilation (MV) is a crucial incident in the intensive care unit (ICU) management. It is a life-saving procedure in critical patients suffering from acute respiratory failure and whose natural ventilation is insufficient to sustain life after suffering from life-threatening hypoxia and/or respiratory acidosis [(1)].

Weaning from MV is a method of decreasing ventilatory support. Eventually, the patient will be capable of breathing spontaneously and being extubated [(2)].

The most important stage in the weaning method is the prompt identification of weaning capacity and willingness to extubate to prevent further MV prolongation [(3)].

Trial (SBT) is most commonly conducted to evaluate the patient's capacity to maintain spontaneous breathing when extubated. SBT can be performed using a T-piece or with minimal ventilatory support [(4)]. During the SBT many physicians usually consider the patient's ability to withstand an SBT without becoming distressed, as well as the respiratory rate (RR), and tidal volume (VT). The RR/VT ratio, also known as the RSBI, one of the most widely used clinical measurements to predict results of weaning, represents the balance between mechanical load set on the inspiratory muscles, and the capacity of inspiratory muscles to withstand it throughout the weaning phase [(5-7)].

RSBI is demonstrated by the ratio between RR and VT measured by a spirometer with the patient spontaneously breathing for 1 min (RSBI1). Some respiratory therapists were observed to use continuous CPAP, and some used pressure support ventilation (PSV) to calculate the RSBI (8), but RSBI on PSV was more efficient for extubation, less stressful for the patient, and obtained easier. Values above 105cycles/min/L were thought to be predictive of failure of weaning and extubation [(6)].

The disproportion between the mechanical force on the diaphragm and its capacity handling is one of the primary variables of weaning failure. Therefore, it may be important to evaluate diaphragmatic function during the weaning mechanism [(9, 10)]. Classical techniques for diaphragmatic evaluation like fluoroscopy, trans-diaphragmatic pressure measurements, and phrenic nerve conduction show a lot of restrictions and drawbacks inside the ICU due to exposure to ionizing radiation, the inaccessibility to these methods, and the need to transport the patient [(11)].

Bedside Ultrasonography is a non-invasive technique, which has been established to be a safe, accurate, simple to use bedside modality, overcoming many of the standard restrictions of imaging techniques [(12)]. Measurement of the excursion amplitude can be used to compare the motion of the two hemi-diaphragms and to monitor the diaphragm function [(13)]. Diaphragmatic excursion (DE) reflects the ability of the diaphragm to generate force and thus VT during the inspiratory phase. Diaphragmatic dysfunction (stated as DE<10 mm) has been proved to be an indicator of weaning failure in MV patient [(12)].

The aim of this study was to predict weaning outcome of mechanically ventilated patients using diaphragmatic excursion dependent shallow breathing index and compared it with traditional shallow breathing index.

Patients and methods

The study was a prospective observational study that included 58 MV patients and was carried out in the Department of Critical Care Medicine in Benha University Hospitals, during the period from July 2023 to July 2024.

An informed written consent was obtained from the patients. Every patient received an explanation of the purpose of the study and had a secret code number. The study was done after being approved by the Research Ethics Committee, Faculty of Medicine, Benha University.

Inclusion criteria were patients intubated and mechanically ventilated for more than 48 hours, at their first SBT, with Richmond agitation and sedation scale score ranging between -1 and +1 and who fulfilling criteria of weaning from MV according to European respiratory society guidelines (adequate cough reflex, absent of excessive tracheobronchial secretion, stable cardiovascular status, stable metabolic status, adequate oxygenation and adequate pulmonary function).

Exclusion criteria were patients <18 years, pregnant females, with pneumothorax, thoracotomy, or pneumomediastinum, with flail chest or rib fractures, neuromuscular disease, use of muscle relaxants agents within 48 hours before the study, with history of paralysis or new detection of paradoxical movement of a single hemidiaphragm on diaphragmatic ultrasonography, unconscious non-cooperative patients and patient with intra-abdominal hypertension.

Grouping: Patients were randomized into 2 equal groups, 29 in each group, using closed envelope technique: **Group (I):** were assessed using rapid shallow breathing index (RSBI) and **Group (II):** underwent ultrasonographic assessment for diaphragmatic excursion and assessed using diaphragmatic rapid shallow breathing index (DRSBI).

All studied cases were subjected to the following: Detailed history taking, including [Personal history: age, sex, BMI and smoking history, present history: history of present illness, onset of symptoms to admission, course and duration, past history of chronic medical disorders or comorbidities like DM, HTN, ischemic heart disease, heart failure, AF, renal or hepatic failure, drug history, cause of MV and family history of respiratory diseases or other relevant chronic conditions]. Full clinical examination: General examination including [mental state assessment by Glasgow coma scale (GCS) [(14)], vital signs and chest examination was done at time of admission and after 2 hours of beginning of therapy and after 24 hours follow up period (including inspection, palpation, percussion and auscultation)]. Laboratory investigations including [complete blood count, random blood glucose, renal and liver function tests, urine analysis, electrolytes. Investigations including [Chest x ray or CT on admission, continuous oxygen saturation (SpO_2) monitoring, ABG analysis at time of admission, after 2 hours of beginning of therapy then when indicated and after 24 hours, and ECG on admission.

Spontaneous Breathing Trial (SBT):

SBT was performed in the following sequence: the enrolled patients were lying in the semi-recumbent position, with the head of the bed elevated at an angle between 30° and 45°. The patients underwent a SBT that comprised spontaneous ventilation through PSV at low-pressure support (PS) (5-8 cmH_2O) and PEEP 5 cm H_2O with the FiO_2 set at the same level used during mechanical ventilation. After 30 min, the patients breathing patterns were examined to be sure that the patient is stable for continuing our study.

Group (I): Calculate rapid shallow breathing index after 30 minutes from the beginning of the SBT, which is the ratio between RR and VT in liters, was calculated to the enrolled patients on PSV with PS 7 cmH2O & PEEP 5 cmH2O.

Group (II): Ultrasonographic assessment of the right hemidiaphragm was performed after 30 minutes from the beginning of the SBT for stable patients, ultrasonographic assessment of the left hemidiaphragm was performed to detect paralysis or paradoxical movement of a single hemidiaphragm, patients were excluded from the study if paralysis or paradoxical movement of a single hemidiaphragm was detected on diaphragmatic ultrasonography.

Rapid shallow breathing index:

RSBI was calculated directly from MV parameters. All patients were on pressure

DOI: 10.21608/bmfj.2024.315377.2179

support ventilation (PSV) at 7 cmH_2O, without sedation, and with the head of the bed at 45°, having been preoxygenated with an FiO_2 of 1.0 for 2 min and their airways having previously been aspirated. All patients were continuously monitored by pulse oximetry and electrocardiography. Spontaneous VT was calculated by dividing minute ventilation by respiratory rate, and the RSBI was calculated by dividing respiratory rate by VT in liters (RSBI = RR/VT breaths/ minute/ liter).

Ultrasound diaphragmatic excursion measurement:

Abnormal mobility was considered if <1 cm in supine position using the following technique: Right hemi-diaphragmatic excursion was assessed by placing the probe between the midclavicular and anterior axillary lines, in the subcostal area, and directed medially, cranially, and dorsally, so that the ultrasound beam reaches perpendicularly the posterior third of the right hemidiaphragm. The right diaphragmatic excursion was measured from the M mode sonography by placing the first caliber at the foot of the inspiration slope on the diaphragm echoic line and the second caliper at the apex of this slope. Several respiratory cycles were recorded, and measurements of average at least three different cycles were taken, left diaphragmatic excursion was assessed by placing the probe between the anterior and mid axillary lines at a subcostal or low intercostal probe position to obtain the best imaging of the left hemi-diaphragmatic dome. The left DE was measured from the M mode sonography in the same manner as the right hemidiaphragm. DRSBI was calculated by substituting VT with the ultrasonographic evaluation of right DE, (DRSBI = RR/DE breaths/ minute/ mm).

Follow up and treatment:

All patients were followed up by medical evaluation and serial ABG. They also received their standard treatment.

Outcomes:

Primary outcome: Compare diaphragmatic rapid shallow breathing index with traditional shallow breathing index in predicting successful weaning. A successful weaning attempt was registered when patients are extubated and breathed spontaneously for more than 48 hours. A failed weaning attempt was registered when patients are reintubated within 48 hours or the use of non-invasive ventilation (NIV) within 48 hours of extubation. **Secondary outcome:** Determine the relation between weaning outcome and Glasgow coma scale, ventilator hours till SBT, ICU stay, and hospital stay of enrolled patients.

Approval Code: MS 24-5-2023

Sample size:

The sample size was calculated using G power software version 3.1.9.4 at effect. Size 0.859, power 95% and α error .05, This yielded a total sample size of 58 patient to be allocated in 2 groups [(15)].

Statistical analysis:

Statistical analysis was done by SPSS v28 (IBM Inc., Armonk, NY, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing unpaired Student's t- test. Qualitative variables were presented as frequency and percentage (%) and were analyzed utilizing the Chi-square test or Fisher's exact test when appropriate. A two tailed P value < 0.05 was considered statistically significant. The diagnostic performance was measured using diagnostic sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV).

Results

In this study, 87 patients were assessed for eligibility, 16 patients did not meet the criteria and 13 patients refused to participate in the study. The remaining 58 patients were randomly allocated into 2 equal groups (29 patients in each group). All allocated patients were followed-up and analyzed statistically. **Figure 1**

There was an insignificant difference between the studied groups regarding the baseline characteristics (age, sex, weight, height and BMI), associated comorbidities (HTN, DM, hepatic, renal and cardiac diseases), indications of MV, vital signs (HR, MAP, and temperature) and Glasgow coma scale was insignificantly different between both groups regarding the Glasgow coma scale. **Table 1**

There was an insignificant difference between both groups regarding the ABG parameters (pH, PaO_2, $PaCO_2$, PaO_2/FIO_2 prior and at the end of SBT, and PEEP) and the laboratory findings (Hb, PLT, WBCs, Na, K, phosphorous and Mg). **Table 2**

ICU stay, hospital stay and ventilator hours till SBT and weaning outcome were insignificantly different between both groups. **Table 3**

Table 1: Baseline characteristics, comorbidities, indications of MV, clinical examinations and Glasgow coma scale of the studied groups

		Group (I) (n=29)	Group (II) (n=29)	P value
Age (years)	**Mean ± SD**	43.4 ± 8.12	47.1 ± 8.56	0.101
	Range	32 - 60	31 - 60	
Sex	**Male**	21 (72.41%)	24 (83%)	0.334
	Female	8 (27.59%)	5(17%)	
Weight (Kg)	**Mean ± SD**	79.0 ± 11.33	80.0 ± 12.04	0.746
	Range	62 - 98	60 - 98	
Height (m)	**Mean ± SD**	1.67 ± 0.04	1.66 ± 0.04	0.358
	Range	1.6 - 1.72	1.59 - 1.72	
BMI (Kg/m^2)	**Mean ± SD**	28.5 ± 4.82	29.2 ± 4.93	0.602
	Range	21.45 - 38.28	21.8 - 37.81	
Comorbidities	**HTN**	9 (31.03%)	11 (37.93%)	0.581
	DM	7 (24.14%)	5 (17.24%)	0.517
	Hepatic disease	2 (6.9%)	3 (10.34%)	1.00
	Renal disease	3 (10.34%)	5 (17.24%)	0.706
	Cardiac disease	10 (34.48%)	9 (31.03%)	0.780
Indications of MV	**Traumatic brain injury**	12 (41.38%)	15 (51.72%)	0.847
	Sepsis	7 (24.14%)	5 (17.24%)	
	Pneumonia	6 (20.69%)	6 (20.69%)	
	Postoperative respiratory failure	4 (13.79%)	3 (10.34%)	
Clinical examinations				
HR (beats/min)	**Mean ± SD**	83.03 ± 8.21	83.1 ± 7.42	0.973
	Range	70 - 95	70 - 93	
MAP (mmHg)	**Mean ± SD**	85.97 ± 5.4	85.03 ± 5.87	0.532
	Range	77 - 96	77 - 95	
Temperature (°c)	**Mean ± SD**	37.2 ± 0.43	37.2 ± 0.42	0.780
	Range	36.5 - 37.8	36.5 - 37.8	
Glasgow coma scale	**Mean ± SD**	7.4 ± 1.7	6.7 ± 1.65	0.105
	Range	5 - 9	5 - 10	

BMI: body mass index, HTN: hypertension, DM: diabetes mellitus, ICU: intensive care unit, MV: mechanical ventilation, HR: heart rate, MAP: mean arterial pressure, SBT: spontaneous breathing trial.

DOI: 10.21608/bmfj.2024.315377.2179

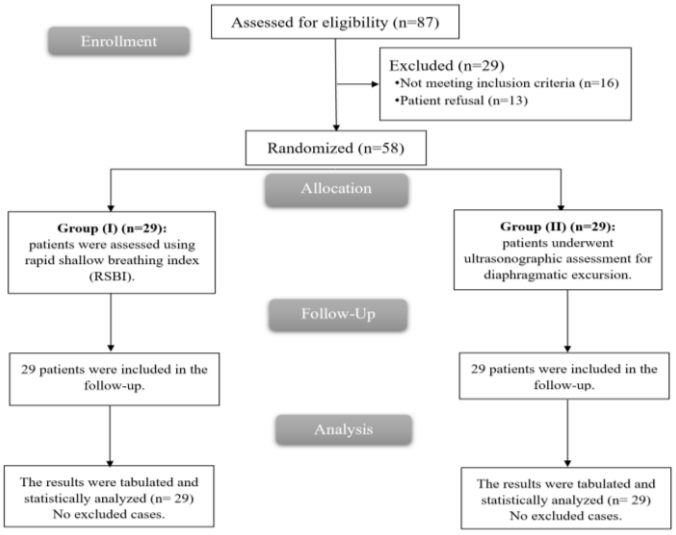

Figure 1: CONSORT flowchart of the enrolled patients

Table 2: Arterial blood gas (ABG) parameter and laboratory investigations of the studied groups

		Group (I) (n=29)	Group (II) (n=29)	P value
ABG				
pH	**Mean ± SD**	7.40 ± 0.03	7.40 ± 0.03	0.834
	Range	7.35 - 7.45	7.35 - 7.45	
PaO_2	**Mean ± SD**	102.3 ± 5.45	102.6 ± 4.23	0.789
(mmHg)	**Range**	94 - 110	94 - 109	
$PaCO_2$	**Mean ± SD**	38.3 ± 2.85	37.2 ± 3.56	0.179
(mmHg)	**Range**	33.9 - 44	33 - 46	
PaO_2/FIO_2 prior to SBT	**Mean ± SD**	315.6 ± 32.81	322.5 ± 28.36	0.398
	Range	260 - 370	279 - 366	
PaO_2/FIO_2 at the end of SBT	**Mean ± SD**	270.8 ± 35.66	275.7 ± 30.25	0.570
	Range	210 - 335	228 - 329	
PEEP (cmH_2O)	**Mean ± SD**	6.2 ± 1.05	6.6 ± 1.12	0.151
	Range	5 - 8	5 - 8	
Laboratory investigations				
Hb (g/dL)	**Mean ± SD**	10.7 ± 0.9	10.9 ± 0.97	0.495
	Range	9.5 - 12.3	9.5 - 12.2	
PLT ($*10^9$/L)	**Mean ± SD**	260.3 ± 39.18	278.5 ± 45.77	0.109
	Range	201 - 337	203 - 347	
WBCs ($*10^9$/L)	**Mean ± SD**	7.6 ± 1.87	7.6 ± 2.01	0.925
	Range	4.7 - 11	4.5 - 11	
Na (mEq/L)	**Mean ± SD**	140.3 ± 3.05	140.2 ± 3.04	0.864
	Range	136 - 145	135 - 145	
K (mEq/L)	**Mean ± SD**	4.7 ± 0.52	4.9 ± 0.56	0.278
	Range	3.5 - 5.5	3.6 - 5.5	
Phosphorus (mg/dL)	**Mean ± SD**	3.5 ± 0.53	3.3 ± 0.71	0.429
	Range	2.5 - 4.5	2.5 - 4.5	
Mg (mg/dL)	**Mean ± SD**	2.02 ± 0.27	2.01 ± 0.31	0.821
	Range	1.5 - 2.5	1.5 - 2.5	

PaO2: partial pressure of oxygen, PaCO2: partial pressure of carbon dioxide, FiO2: inspiratory fraction of oxygen, PEEP: positive end-expiratory pressure, SBT: spontaneous breathing trial, Hb: hemoglobin, PLT: platelets, WBCs: white blood cells, Na: sodium, K: potassium, Mg: magnesium

Glasgow coma scale was higher in weaning success group compared to weaning failure group (P<0.001). ICU stay and hospital stay were significantly shorter in weaning success group compared to weaning failure group (P<0.001, <0.001). The ventilator hours till SBT were significantly longer in weaning failure group compared to weaning success group (P<0.001). RSBI in group I was significantly higher in weaning failure group compared to weaning success group (P<0.001) and DRSBI in group II was significantly higher in weaning failure group compared to weaning success group (P<0.001). **Table 4**

In group I, RSBI at AUC of 0.917 can significantly predict the weaning success (P<0.001), at cutoff value ≤71, with 88.89% sensitivity, 63.64% specificity, 80.0% PPV and 77.8% NPV. In group II, DRSBI at AUC of 0.988 can significantly predict the weaning success (P<0.001), at cutoff value ≤1.58, with 95.24% sensitivity, 87.50% specificity, 95.2% PPV and 87.5% NPV. **Figure 2**

Table 3: ICU stay, hospital stay, ventilator hours till SBT and weaning outcome of the studied groups

		Group (I) (n=29)	Group (II) (n=29)	P value
ICU stay (days)	**Mean ± SD**	9.1 ± 2.89	8.1 ± 2.23	0.121
	Range	5 - 15	5 - 13	
Hospital stay (days)	**Mean ± SD**	15.2 ± 3.97	13.9 ± 3.15	0.193
	Range	10 - 23	10 - 21	
Ventilator hours till SBT	**Mean ± SD**	69.7 ± 13.39	74.2 ± 13.07	0.112
	Range	48- 88	53 - 99	
Weaning outcome	**Success**	18 (62.07%)	21 (72.41%)	0.401
	Failure	11 (37.93%)	8 (27.59%)	

ICU: intensive care unit, SBT: spontaneous breathing trial.

Table 4: Glasgow coma scale, ICU stay, hospital stay and ventilator hours till SBT regarding weaning outcome and RSBI regarding weaning outcome in both groups

		Weaning success (n=39)	Weaning failure (n=19)	P value
Glasgow coma scale	**Mean ± SD**	7.55 ± 1.70	6.62 ± 1.72	**0.043***
	Range	5 - 10	5 - 9	
ICU stay (days)	**Mean ± SD**	7.6 ± 1.55	10.9 ± 2.54	**<0.001***
	Range	5 - 10	7 - 15	
Hospital stay (days)	**Mean ± SD**	12.8 ± 1.63	18.8 ± 1.89	**<0.001***
	Range	10 - 15	16 - 22	
Ventilator hours till SBT	**Mean ± SD**	69.5 ± 11.17	82.3 ± 12.06	**<0.001***
	Range	50 - 88	60 - 99	
Group I		**Weaning success (n=18)**	**Weaning failure (n=11)**	
RSBI	**Mean ± SD**	59.27 ± 7.62	74.09 ± 7.20	**<0.001***
	Range	50-76	61-83	
Group II		**Weaning success (n=21)**	**Weaning failure (n=8)**	
DRSBI	**Mean ± SD**	1.42 ± 0.16	2.005 ± 0.26	**<0.001***
	Range	1.08-1.7	1.58-2.38	

ICU: intensive care unit, SBT: spontaneous breathing trial, RSBI: rapid shallow breathing index, DRSBI: diaphragmatic rapid shallow breathing index, *: statistically significant as p value <0.05.

DOI: 10.21608/bmfj.2024.315377.2179

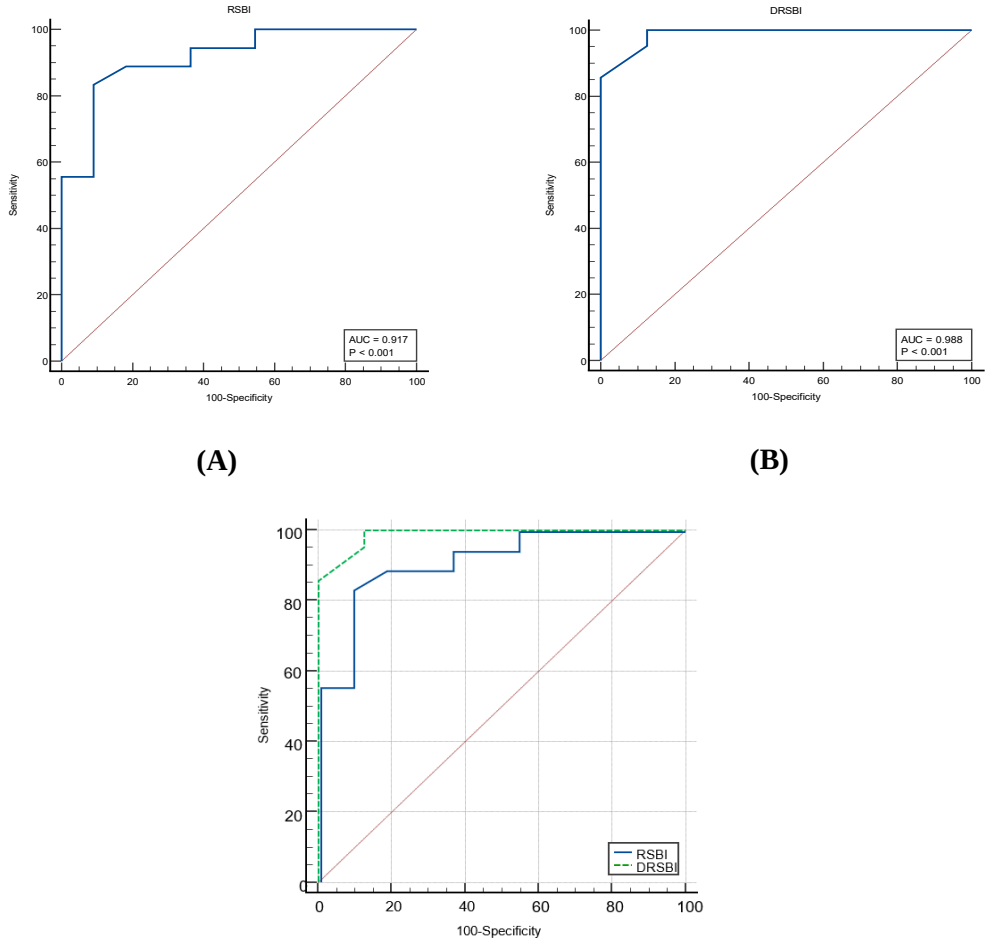

Figure 2: ROC curve analysis of (A) of RSBI for prediction of weaning success in group I, (B) DRSBI for prediction of weaning success in group II, and (C) Comparison ROC curve analysis for prediction of weaning success

Discussion

In our study, there was an insignificant difference between the studied groups regarding the baseline characteristics including age, sex, weight, height, and BMI. There was an insignificant difference between both groups regarding the associated comorbidities (including HTN, DM, hepatic, renal and cardiac diseases).

In agreement with us, Mowafy and Abdelgalel [16] reported that there were no statistically significant differences between the patient's characteristics (age, weight, height, and sex).

In the present study, the indications of MV including traumatic brain injury, sepsis, pneumonia, and postoperative respiratory failure were insignificantly different between both groups.

In agreement with our results, Song & co-workers [17] reported that Patients who had pneumonia, heart failure, septic shock, traumatic brain injury, poisoning, post-surgery, acute stroke, cardiopulmonary resuscitation, hemorrhagic shock, and others were 30, 12, 8, 8, 3, 5, 13, 2, 5, and 2 respectively.

According to our study, the clinical examination of the vital signs revealed an insignificant difference between the studied groups regarding HR, MAP, and temperature. Glasgow coma scale was insignificantly different between both groups regarding the Glasgow coma scale. There was an insignificant difference

between both groups regarding the ABG parameters including pH, PaO_2, $PaCO_2$, PaO_2/FIO_2 prior and at the end of SBT and positive end-expiratory pressure (PEEP). There was an insignificant difference between both groups regarding the laboratory findings including Hb, PLT, WBCs, Na, K, phosphorous and Mg. ICU stay, and hospital stay were insignificantly different between both groups. Ventilator hours till SBT were insignificantly different between both groups.

In agreement with us, Mowafy and Abdelgalel [16] studied the ventilator hours till SBT in 106 mechanically ventilated patients. They showed that there was no statistically significant difference among the RSBI (n=53) and DRSBI groups (n=53) regarding the mean ventilatory hours till SBT.

Regarding the weaning outcome in our study, successful weaning was observed in 18 (62.07%) patients in group I and 21 (72.41%) patients in group II. There was an insignificant difference between both groups regarding the weaning outcome. Glasgow coma scale was higher in weaning success group compared to Weaning failure group (P<0.001).

In alignment with us, Waheedy & co-workers [18] reported that of the 100 included cases, 21 cases (21%) were successfully weaned and 79 subjects (79%) had weaning failure.

In the present study, ICU stay, and hospital stay were significantly shorter in the weaning success group compared to the weaning failure group (P<0.001, <0.001). The ventilator hours till SBT were significantly longer in the weaning failure group compared to the weaning success group (P<0.001).

In agreement with our results, Song & co-workers [17] reported that patients who were successfully weaned had significantly lower lengths of ICU and hospital stay than those who failed weaning (P <0.001, P=0.001, respectively).

In contrast with us, Shamil & colleagues [15] reported that the total number of days of ICU stay, and the total duration of mechanical ventilation before the first SBT were not significantly different in the two outcomes groups.

According to our results, RSBI in group I was significantly higher in the weaning failure group compared to the weaning success group (P<0.001). Diaphragmatic rapid shallow breathing index (DRSBI) in group II was significantly higher in the weaning failure group compared to the weaning success group (P<0.001).

In agreement with our results, Song & colleagues [17] revealed that DE-RSBI was significantly higher in the weaning failure group compared to the weaning success group (P<0.001).

These findings were in contrast with Alam & co-workers [19] who found that 31 patients were extubated with the advice of an ICU consultant using the ICU weaning regimen and diaphragm ultrasonography was performed. Successful extubation was significantly higher in patients with increased DE (P<0.001). RSBI was insignificantly different between patients with weaning success and failure (p=0.41).

Regarding to the present study, in group I, RSBI at AUC of 0.917 can significantly predict the weaning success (P<0.001), at cutoff value ≤71, with 88.89% sensitivity, 63.64% specificity, 80.0% PPV and 77.8% NPV. In group II, DRSBI at AUC of 0.988 can significantly predict the weaning success (P<0.001), at cutoff value ≤1.58, with 95.24% sensitivity, 87.50% specificity, 95.2% PPV and 87.5% NPV.

In parallel with us, Shamil & co-workes [15] reported that RSBI at AUC of 0.7 can significantly predict the weaning success (P<0.05), at cutoff value of 45.72, with 40.5% sensitivity, 100% specificity, 49% PPV and 78.7% NPV. At a cut-off of 1.767, D-RSBI had a sensitivity, specificity, PPV, and NPV of 100%, 90.24%, 100%, and 69.23%, respectively.

In disagreement with our results, Song & colleagues [17] reported that RSBI at AUC

DOI: 10.21608/bmfj.2024.315377.2179

of 0.639 can significantly predict the weaning success (P<0.018), at cutoff value of 51.2, with 64.9% sensitivity, 65.8% specificity, 49% PPV and 78.7% NPV. DRSBI at an AUC of 0.813 can significantly predict the weaning success (P<0.001), at cutoff value of 1.38, with 89.2% sensitivity, 65.8% specificity, 56.9% PPV and 92.3% NPV. This could be explained by larger sample size used in their study.

Moreover, El-Beheidy & colleagues [20] studied predictive values of the traditional RSBI in 53 children who admitted to PICU units. They showed that the best cutoff value of RSBI in prediction of failure of weaning was ≥ 3.5 (breath/min/ml/kg) with AUROC 1.00, sensitivity 100%, specificity 75%, PPV 72.4%, NPV 100%, +LR 4, -LR 0, accuracy 84.91 (p<0.05).

Conclusion

According to our results, there was an insignificant difference between both groups regarding the weaning outcome. RSBI and DRSBI were significantly higher in weaning failure group compared to weaning success group. RSBI at AUC of 0.917 can significantly predict the weaning success, at cutoff value ≤71, with 88.89% sensitivity, 63.64% specificity, 80.0% PPV and 77.8% NPV. DRSBI at AUC of 0.988 can significantly predict the weaning success, at cutoff value ≤1.58, with 95.24% sensitivity, 87.50% specificity, 95.2% PPV and 87.5% NPV.

Conflict of interest

None of the contributors declared any conflict of interest

Sources of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contribution

Authors contributed equally to the study.

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To cite this article: Enas W. Mahdy , Saad I. Saad , Muhammad G. Muhammad , Engy A. Okab . Predicting Weaning Outcome of Mechanically Ventilated Patients Using Ultrasound Diaphragmatic Excursion-Based Shallow Breathing Index Compared to Traditional Shallow Breathing Index. BMFJ XXX, DOI: 10.21608/bmfj.2024.315377.2179.