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Ultrasound Assessment of Heart, Lung and Diaphragm as a Predictor of Weaning Outcome from Mechanical Ventilation

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Abstract

Background: Mechanical ventilating was an essential life supporting method for crucially ill cases. The weaning outcomes influence the morbidities and mortalities of cases when their main disorder advances.

Aim and objectives: To evaluate the predictive value of heart, lung and diaphragmatic US in the process of weaning in mechanically ventilated patients over 48 hours.

Methods: This is a prospective observational single group research which was performed at Menoufia University hospitals between (May 2019 and May 2020). The study included 62 mechanically ventilated patients over 48 hours fulfilling weaning criteria underwent one Hour Spontaneous Breathing Trail (SBT). Before extubating, data collection comprised US evaluation of LVEF, LVDF was assessed using Left Atrial Area (LAA), early diastolic transmitral flowing velocity wave (E), late diastolic transmitral flow velocity wave (A), early diastolic mitral annulus velocity E' (average septal and lateral E'), E/A, E de-acceleration time, E/E', lungs losing of ventilation scoring and diaphragmatic movements.

Results: A high significant relation was found among weaning and LVEF, E', E/E' and LAA ($p<0.001$) and statistically significant relation between weaning and E/A.Using aeration score it was shown that above 15.5, it can predict failure of weaning with Area Under Curve (AUC) of 0.781. Using diaphragmatic dysfunction, it was shown that if there were full diaphragmatic dysfunction, it can predict failure of weaning with AUC of 0.639.

Conclusion: The US characteristics of heart, lung, and diaphragm providing serious information around cardio-pulmonary and diaphragmatic job throughout SBT. Unsuccessful weaning was more predominant if markers of left ventricular diastolic dysfunctions, increased Lung aeration score and diaphragmatic dysfunction were present.

Keywords: Weaning • Mechanical ventilation • Diaphragmatic dysfunction • Aeration score • Ultrasound

Abbreviations: AUC: Area Under Curve • LAA: Left Atrial Area • ECG: Electro Cardio Gram • RR: Respirational Rate • TV: Tidal Volume

Introduction

Mechanically ventilations are a life-saving tool to support cases when they have no ability for ventilation and oxygenation by themselves. It progresses gas exchanging and reduces a case's work of breath, and it was utilized in treating cases that have acute or chronical respirational distress. But there are significant dangers accompanying with its usage. Cautious monitor and detailed understand of the mechanically ventilating complications and their treatments are vital for better outcomes. So weaning was a high importance. The 3 stages of weaning from mechanically ventilations are; identifying when a case is ready to wean, knowing when a case is ready to extubate and the weaning procedure itself [1].

Current guide line for weaning recommended the implementation of SBT as a device to expect weaning outcomes. But 13%-26% of cases who are extubated subsequent to an effective SBT want to be intubated in 2 days [2].

In the last few years various weaning indices were suggested to be useful, e.g., Minute Ventilations (VE), Respirational Rate (RR), Tidal Volume (VT), Max Inspiratory Pressure (PI max), Trans-Diaphragmatic Pressure (Pdi) and fast shallow breath index (respirational rate per tidal volume, f/VT) are a clinical prognosticator of failures of weaning from mechanically ventilations and they are extensively utilized in clinic researches and practices. But, the estimate rate of these factors mayn't be acceptable [3].

US of multiorgan systems has been more frequently utilized in the ICU owing to its movability, rapidity, security and the inspire outcomes gotten for management of multi-entities [4]. As US delivers both morphological and functional info in live time, it was utilized to recognise cardiac, respirational or diaphragmatically risk-factors of weaning failures. More, US can be helpful in delivering a visual evaluation of cardio-respiratory state at dissimilar weaning phases [5].

Patient and methods

This was a prospective observational single group study which was performed at Menoufia University hospitals between (May 2019 and May 2020) thereafter agreement of the local Ethics Committee and an informed agreement was taken from the case if possible or from his relatives. 62 patients who were registered to Menoufia University Hospitals ICU were recruited after meeting the following inclusion criteria: Adult above 18 years old and mechanically ventilated patients over 48 hours fulfilling weaning criteria. Patients were excluded if they had heart failure, significant mitral regurge or atrial fibrillation, neuromuscular diseases and weaning from mechanical ventilation before 48 hours.

Materials and Methods

After the patient admission, detailed history and thorough clinical examination was done. Acute Physiology and Chronic Health Evaluation-

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II (APACHEII) score and the Simplified Acute Physiology-III (SAPA-III) Score were calculated within a day of ICU admittance. The cause of ICU admission and period of ventilation were documented. The cases received mechanical ventilation through (MAQUET-servo I ventilator or dragger EVITA-4) (Figure 1). We followed up the patients to determine ICU stay and mortality. Hemodynamic, laboratory and imaging information have been gathered.

The cases have been observed clinically well to assess their readiness for weaning when they satisfy the next criteria:

- Clinical improvements of the original acute reason of respirational failures
- Favourable cough reflexes
- Lack of excess and/or infected tracheobronchial secretions
- Steady cardio-vascular condition (i.e. heart rate<120 beats per minutes, SBP:90 mmhg-160 mmhg and no or minimum dosage vasopressor usage)
- Steady metabolic condition (i.e. electrolytes and blood sugar within ordinary range, temp<38°C, haemoglobin ≥ 8 g/d-10 g/dL)
- Satisfactory oxygenations (i.e. SaO_2>92% with FiO_2 ≤ 0.5 with PEEP ≤ 8 cmH_2O)
- Acceptable pulmonic functions (i.e. RR ≤ 30 breaths/min with VT ≥ 5 mL per kg Ideal Body Weight (IBW) and nonsignificant respirational acidosis)

The SBT was performed through a CPAP with pressure support ≤ 10 cmH_2O and PEEP 5 cmH_2O as a routine procedure in the unit and the duration will be an hour, pressure supporting is an impulsive mode of ventilations where the case breathes impulsively and the ventilator supporting the breathing with a present pressure value for each breathing. Decremented pressure supporting ventilations are the standard mode of weaning in our unit.

Extubating at pressure supporting up to 10 cmH_2O is a suitable habit in our unit and an impulsive breath trial using T-tube is not mandated for weaning. Failed weaning was defined as the necessity for reintubation, noninvasive ventilatory supporting or death within 2 days thereafter extubating.

The following was measured and calculated at 2 points in time (at the first and an hour of the SBT)

RSBI, RR, VT, static compliance of the respiratory system (CST, RS), PaO_2/FiO_2 ratio.

The static compliance of the respirational system (CST, RS) has been measured in volume control ventilations thereafter evaluating the digital display of the ventilators to confirm the pressure-time curve with no inspiratory efforts of the cases. An Inspiratory holding for 0.5 sec to 1.0 sec has been utilized to determine the compliances. CST, RS has been determined by dividing the VT by the variance amid inspiratory plateau pressure and PEEP.

Figure 1. Dragger EVITA-4.

The following was measured and calculated prior to extubating (Cardiac US)

The cardiac US have been done using Philips ultrasound system, *via* sector phased array 3Sc-RS cardiac probe (frequency ranged from 1.3 MHz to 4.0 MHz). The LVSF has been evaluated by determining the EF, *via* bi-plane Simpson's technique of discs, and/or acquisitions 2D and M-Mode measures at the base of the LV, liable on the images qualities. LVDF has been evaluated *via* left atrial area in contributors who didn't have haemo-dynamically significant mitral regurgitations or atrial fibrillations, E-wave, A-wave, E′ (average septal and lateral E′), E/A, E decelerations time, E/E′ (Figure 2).

Lung and diaphragm US

Has been done before extubating by means of the curved array 4C-RS probe (frequency ranged between 1.8 MHz and 6.0 MHz). Lung US has been done on all members in a semi recumbent location at 30° to 50° by means of the six-zone technique of every lung; each inter-costal cavity was sensibly tested by longitudinal slide of the probe over the chest in all regions. An aeration scoring has been allocated to every region built on the existence and degree of aeration losses. Score-1 considered a normal aerated zone with the lack of/fewer than 3 B-lines. Score 2 signified moderately aerated region with 3 or more separate B-lines; Score-3 considered severe losing of aeration with multi and attached B-lines; Score-4 considered association; Score-5 considered consolidations with pleural effusions (Figure 3).

Diaphragmatic US

The side method has been utilized for diaphragm imaging, with the contributors in a supine and head-up location at 30° and 50°. An identical land-marks and methods have been utilized on the left and right hemi diaphragms. The probe has been located crosswise and vertically on the lower intercostal cavities of the side chest wall among mid and backward

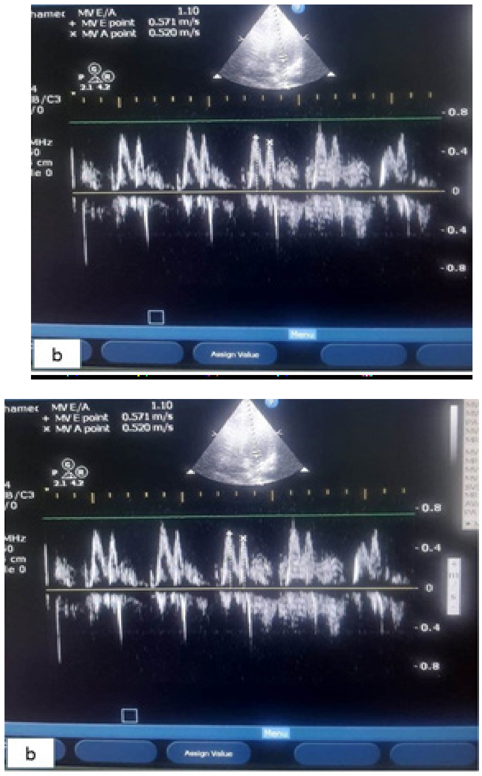

Figure 2. (a): The left ventricular systolic function; (b): The left ventricular diastolic function E/A.

axillary line. The way of the US beam was vertical or near vertical to the craniocaudal axis throughout breath. The scans of the hemi diaphragm movements have been documented for at minimum 3 successive respirational cycles. The movement ranged between 2 points for all recorded cycles has been calculated and averaged. The scans throughout forced breaths, sighs and throughout suctioning have been omitted. Diaphragmatically movements of more than 10 mm considered ordinary. Uni-lateral dysfunction has been described when a uni-lateral hemi diaphragm movement <10 mm; bi-lateral dysfunction has been described as movement of <10 mm in the two hemi diaphragm.

Data collection

The next data have been documented: Demographic data, cause of ICU admission, comorbidities and duration of mechanical ventilation. APACHEII and SAPAIII on admission. Respiratory rate, tidal volume, PO_2/FiO_2 ratio, RSBI, ABG and static compliance at the first and one hour of the SBT. Heart, lung and diaphragmatic ultrasound Prior to extubation (one hour of the SBT), continuous monitoring of hemodynamics and hospital mortality and ICU stay.

Statistical analysis

With assumption of 5 samples of weaning and 25% of error, the calculated sample size should be 62 with alpha 0.05 and power 80. Analysis of the collected data has been performed *via* IBM SPSS-20.0. Qualitative data have been presented as numbers and percentage. The Kolmogorov-Smirnov testing has been utilized to verify the normally of distributed data. Quantitative data have been presented as range (min and max), mean ± SD, median and Inter-Quartile Range (IQR). Result considered Significant at 5% level. The utilized examinations were: Chi-square testing: For categorical variables, for comparison between different groups. Student t-testing: For variables with normal distribution, to compare among 2 groups. Spearman coefficient: For descriptive data, for correlating 2 variables. ROC: It is produced by plotting sensitivity (TP) on Y axis *vs*. 1-specificity (FP) on X axis at various cut-off values.

Results

Our results showed that, 46 (74.2%) patients successfully weaned from mechanical ventilation and 16 (25.8%) patients failed weaning 3 of

Figure 3. Lung aeration scores (a): Score 1; (b): Score 2; (c): Score 5.

Table 1. Comparing between successful and failed weaning according to demographic data and patients clinical characteristics.

Parameter	Total (N= 62)		Weaning				Test	p
			Successful (n=46)		Failed (n=16)			
Age (years)								
Range	21-60		21-60		22-60		t=1.126	0.265
Mean ± SD	46.1 ± 9.96		46.93 ± 9.39		43.69 ± 11.4			
BMI (kg/m²)								
Range	23-31.9		23-31.9		23.8-31.9		t=1.615	0.112
Mean ± SD	27.51 ± 2.55		27.21 ± 2.62		28.39 ± 2.19			
Duration of MV (days)								
Range	2-6		2-6		2-6		t=0.534	0.595
Mean ± SD	3.82 ± 1.17		3.87 ± 1.17		3.69 ± 1.2			
APACHE II score								
Range	15-25		15-25		15- 25		t=1.040	0.303
Mean ± SD	20.23 ± 3.18		19.98 ± 3.06		20.94 ± 3.51			
SAPS III score								
Range	46-70		47-67		46-70		t=0.136	0.892
Mean ± SD	56.16 ± 5.11		56.11 ± 4.77		56.31 ± 6.14			
Gender (male/female)	44/18		31/15		13/3		χ^2=1.107	0.355
Comorbidity	**No.**	**%**	**No.**	**%**	**No.**	**%**	**Test**	**p**
Ischemic heart disease	17	27.4	10	21.7	7	43.8	χ^2=2.890	0.089
Diabetes mellitus	18	29	11	23.9	7	43.8	χ^2=2.267	0.132
COPD	11	17.7	8	17.4	3	18.8	χ^2=0.015	0.902
Cause of admission								
Angina	14	22.6	14	30.4	0	0	χ^2=8.524	0.036
Trauma	11	17.7	9	19.6	2	12.5		
Sepsis	24	38.7	14	30.4	10	62.5		
Postoperative	13	21	9	19.6	4	25		

t:Student t-testing; χ^2:Chi square testing; p: p value for comparison among various groups

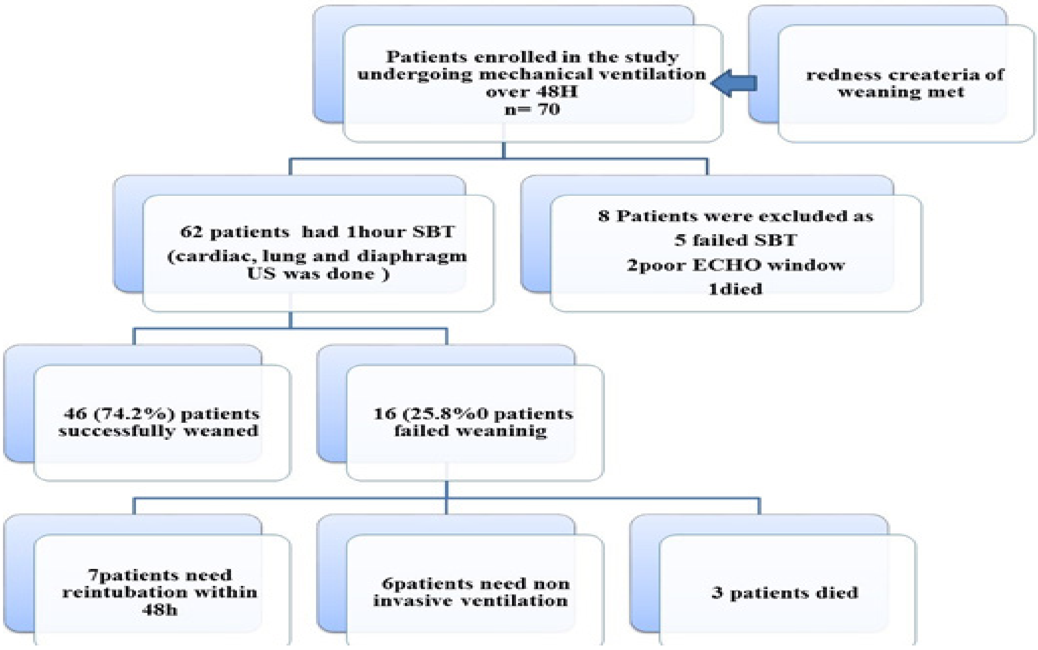

Figure 4. Flow diagram of the study cohort.

Table 2. Comparing between effective and unsuccessful weaning as regard weaning trial parameters.

Parameters		Total (N=62)	Weaning: Successful (n=46)	Weaning: Failed (n=16)	Test	p
Respiratory rate (breathe/ minute)			At beginning			
	Range	12-30	12-25	19-30	t=5.473	<0.001*
	Mean ± SD	20.19 ± 4.57	18.65 ± 3.78	24.63 ± 3.7		
			After 1 hour			
	Range	12-27	12-16	17-27	t=11.565	<0.001*
	Mean ± SD	15.95 ± 3.88	14.07 ± 1.5	21.38 ± 3.5		
Tidal volume (L)			At beginning			
	Range	0.38-0.65	0.38-0.65	0.4-0.65	t=0.172	0.864
	Mean ± SD	0.52 ± 0.09	0.52 ± 0.09	0.52 ± 0.08		
			After 1 hour			
	Range	0.46-0.82	0.46-0.82	0.46-0.73	t=2.244	0.029*
	Mean ± SD	0.62 ± 0.1	0.64 ± 0.1	0.58 ± 0.08		
PaO_2/FiO_2			At beginning			
	Range	251.2-471.6	251.2-471.6	263-453.3	t=0.002	0.998
	Mean ± SD	386.74 ± 63.77	386.75 ± 65.91	386.71 ± 59.21		
			After 1 hour			
	Range	255.5-485.7	256.1-485.7	255.5-450	t=1.076	0.286
	Mean ± SD	389.37 ± 64.9	394.59 ± 66.51	374.34 ± 59.42		
Static compliance (mL/cmH_2O)			At beginning			
	Range	45.1-71.1	45.1-71.1	45.2-69.1	t=0.354	0.724
	Mean ± SD	56.65 ± 6.59	56.83 ± 6.61	56.14 ± 6.71		
			After 1 hour			
	Range	50.5-91.1	59.2-91.1	50.5-75.9	t=3.617	0.001*
	Mean ± SD	69.97 ± 8.54	72.09 ± 7.92	63.89 ± 7.45		
RSBI			At beginning			
	Range	23.1-71.4	23.1-63.2	36.9-71.4	t=4.268	<0.001*
	Mean ± SD	39.7 ± 10.89	36.63 ± 9.47	48.54 ± 10.05		
			After 1 hour			
	Range	15.9-53.1	15.9-33.3	29.3-53.1	t=10.429	<0.001*
	Mean ± SD	26.32 ± 8.27	22.44 ± 3.97	37.49 ± 7.18		

*: Statistical significance at p value ≤ 0.05

them died, 7 of them reintubated within 48 hours and 6 of them need non-invasive mechanical ventilation (Figure 4). Regarding demographic data (age, gender and BMI) and clinical characteristic of patients (comorbidity, duration of mechanically ventilations, APACHEII score and SAPSIII score) and weaning outcome were nonsignificant difference (p value>0.05). With significant variance between weaning outcome and cause of admission as most of failed weaning had sepsis (p value ≤ 0.05) (Table 1).

A high significant change was found among weaning outcome and respiratory rate and RSBI (p<0.001) and statistically significant difference between weaning outcome and tidal volume and static compliance after 1 hour (p ≤ 0.05) (Table 2).

A high significant change was found among weaning outcome and

Table 3. Comparing among effective and unsuccessful weaning according to echocardiographic.

Parameters	Total (N=62)		Weaning				Test	p
			Successful (n=46)		Failed (n=16)			
LVEF (%)								
Min-Max	44.0-70.0		48.0-70.0		44.0-59.0		t=3.733	<0.001*
Mean ± SD	56.68 ± 7.18		58.50 ± 7.02		51.44 ± 4.70			
E (cm/s)								
Min-Max	64.0-110.0		64.0-105.0		64.0-110.0		t=1.608	0.113
Mean ± SD.	85.18 ± 13.37		83.59 ± 11.81		89.75 ± 16.71			
E/A								
Min-Max	0.64-1.83		0.67-1.65		0.64-1.83		t=2.778	0.007*
Mean ± SD	1.11 ± 0.28		1.05 ± 0.23		1.27 ± 0.36			
EDT (ms)								
Min-Max	127.0-254.0		130.0-254.0		127.0-242.0		t=0.115	0.908
Mean ± SD	184.0 ± 36.76		183.7 ± 38.16		184.9 ± 33.55			
E' (cm/s)								
Min-Max	4.0-12.0		8.0-12.0		4.0-10.0		t=6.962	<0.001*
Mean ± SD	9.40 ± 1.97		10.17 ± 1.30		7.19 ± 1.91			
E/E'								
Min-Max	5.80-22.0		5.80-12.10		6.40-22.0		t=7.271	<0.001*
Mean ± SD	9.60 ± 3.23		8.30 ± 1.27		13.31 ± 4.20			
LAA								
Min-Max	16.0-32.0		16.0-23.0		18.0-32.0		t=4.993	<0.001*
Mean ± SD	20.82 ± 3.76		19.63 ± 2.13		24.25 ± 5.20			
IAS fixed curvature	**No.**	**%**	**No.**	**%**	**No.**	**%**	**Test**	**p**
No	38	61.3	32	69.6	6	37.5	χ^2=5.144	0.023*
Yes	24	38.7	14	30.4	10	62.5		

Table 4. Comparing among successful and unsuccessful weaning according to lung ultrasound and diaphragmatic dysfunction.

Parameters	Total (N=62)		Weaning				Test	p
			Successful (n=46)		Failed (n=16)			
Lung US Aeration score of left and right lungs total								
Min-Max	7-28		7-22		11- 28		t=4.089	<0.001*
Mean ± SD	14.37 ± 5.42		12.89 ± 4.77		18.63 ± 5.02			
Diaphragmatic dysfunction	**No.**	**%**	**No.**	**%**	**No.**	**%**	**Test**	**p**
No diaphragmatic®	33	53.2	26	56.5	7	43.8	χ^2=15.187	0.001*
Hemi diaphragm	22	35.5	19	41.3	3	18.8		
Diaphragm	7	11.3	1	2.2	6	37.5	-	-

Table 5. Comparing between successful and failed weaning according to ICU outcomes.

Parameters	Total (N=62)		Weaning				Test	p
			Successful (n=46)		Failed (n=16)			
Length of stay								
Min-Max	6.0-20.0		6.0-15.0		8.0-20.0		t=1.283	0.204
Mean ± SD	9.66 ± 3.05		9.37 ± 2.95		10.50 ± 3.29			
Time from weaning to ICU discharge								
Min-Max	1.0-7.0		1.0-5.0		2.0-7.0		t=2.298	0.025*
Mean ± SD	3.11 ± 1.33		2.89 ± 1.23		3.75 ± 1.44			
Hospital LOS								
Min-Max	13.0-31.0		13.0-31.0		15.0-28.0		t=1.062	0.293
Mean ± SD	19.68 ± 4.15		19.35 ± 4.14		20.63 ± 4.15			
In-hospital mortality	**No.**	**%**	**No.**	**%**	**No.**	**%**		
No	59	95.2	46	100	13	81.3	χ^2=9.064	0.015*
Yes	3	4.8	0	0	3	18.8		

Table 6. Roc curve analyzing for the usage of aeration score and diaphragm dysfunction to predict failure of weaning.

Parameters	Cut-off	AUC	Sens%	Spec%	PPV%	NPV%	Accuracy%
Aeration score	>15.5	0.781	81.2	65.2	44.8	90.9	69.4
Diaphragm dysfunction	>1.5	0.639	37.5	97.8	85.7	81.8	82.3

Diaphragm dysfunction score 0: no dysfunction, 1: hemi-diaphragm, 2: diaphragm

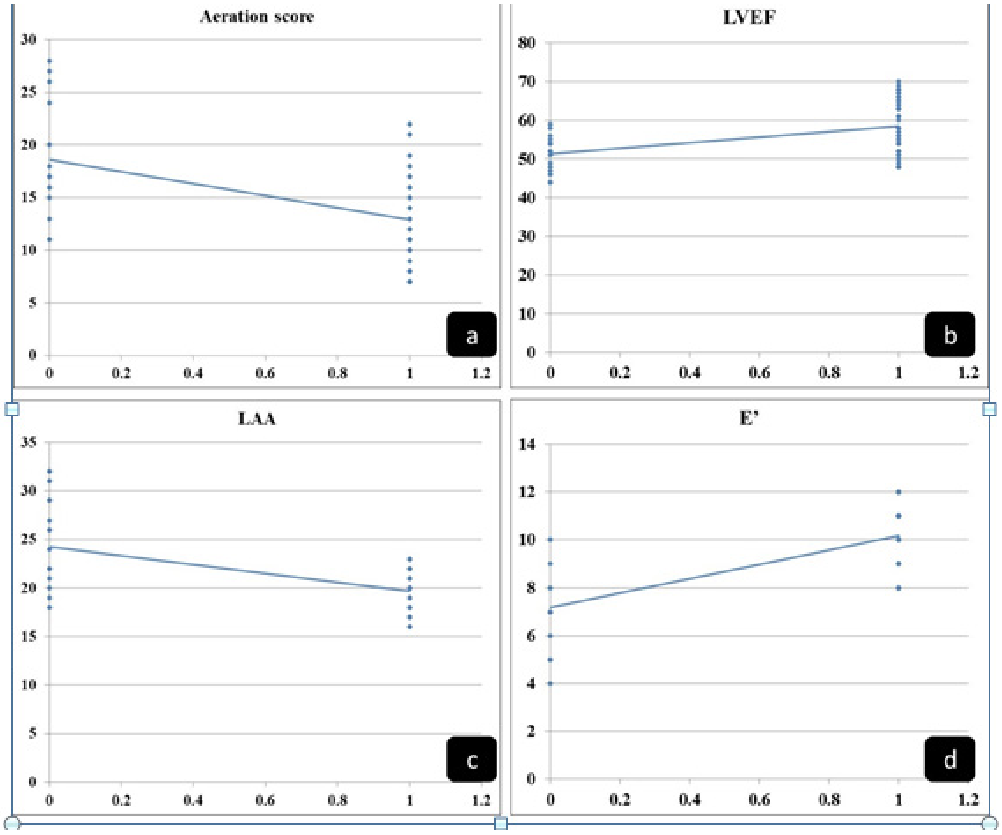

Figure 5. Correlation between weaning success with echo and US.
a): negative correlation between weaning success and aeration score; b): positive correlation between weaning success and LVEF; c): negative correlation between weaning success and LAA; d): positive correlation between weaning success and E'.

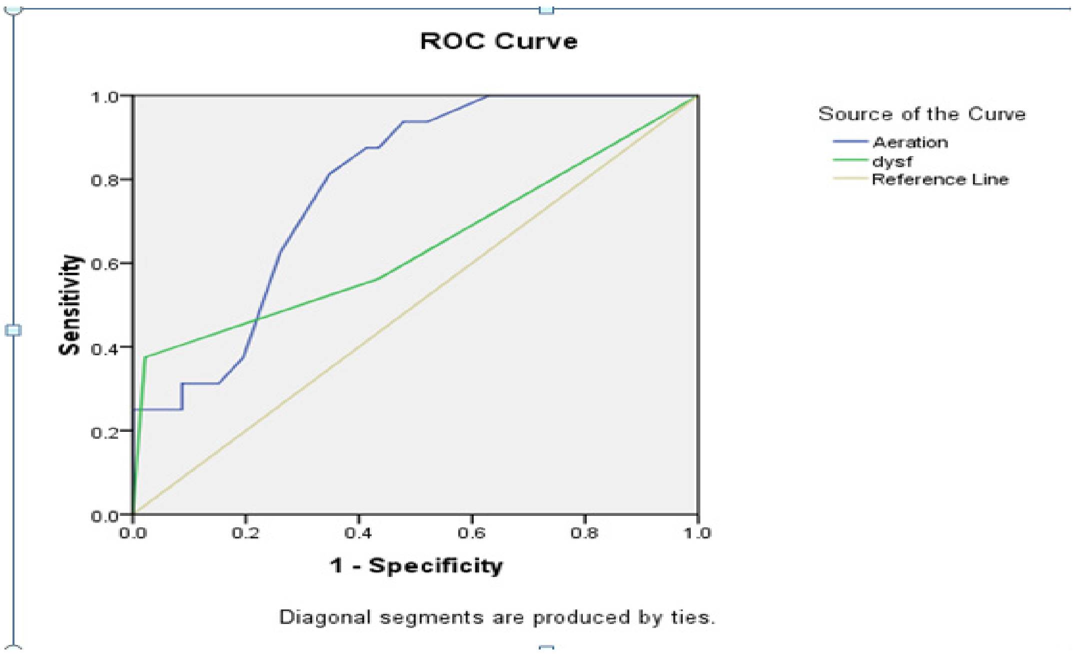

Figure 6. Roc curve for the usage of aeration score and diaphragmatic dysfunction to predict failure of weaning.

LVEF, E', E/E' and LAA (p value<0.001) and significant change among weaning outcome and E/A and IAS (p value ≤ 0.05) (Table 3).

A high significant change was found among weaning outcome and Lung ultrasound (p<0.001) and significant change among weaning outcome and diaphragmatic dysfunction (p value ≤ 0.05) (Table 4).

A significant change was found among weaning outcome and time from weaning to ICU discharge and in-hospital mortality (p ≤ 0.05) (Table 5).

A strong positive association was found among weaning success and E' (p value<0.001), negative association among weaning success and aeration score (p=0.001) and LAA (p=0.001) and positive association among weaning success and LVEF (p value=0.001).

Using aeration score it was shown that above 15.5, it can predict failure of weaning with AUC of 0.781, level of sensitivity 81.2%, specificity 65.2%, PPV 44.8%, NPV 90.9% and accuracy 69.4%. By means of diaphragmatic dysfunction it was revealed that if there were full diaphragmatic dysfunction, it can predict failure of weaning with AUC of 0.639, level of sensitivity 37.5%, specificity 97.8%, PPV 85.7%, NPV 81.8% and accuracy 82.3% (Table 6) (Figures 5-6).

Discussion

Weaning disappointment is described as failing an impulsive breathing trial or emerging a postextubation respirational distress that needs reintubation or noninvasive ventilations in 2 days after extubating. Weaning failures is mutual and time dissipating with about 40 percent of the entire ventilating period in "hard to wean" cases is keen to wean. Weaning failures is accompanying with worse outcomes, raised danger of myocardial ischemia and maybe psychological traumas [6].

The present study showed a high significant change was found among weaning outcome and respiratory rate and RSBI (p<0.001) and significant change among weaning outcome and tidal volume and static compliance after 1 hour (p ≤ 0.05). In agreement with our results, study of Youssef as they reported that respiratory rate was recorded for each patient after 30 minutes of SBT and were compared statistically and found to be lower significance in the successful group with p value of 0.013 [7]. However, as regard to RSBI and PaO2/FiO2 ratio, they all showed nonsignificant change in their values when recorded among both groups as their p value were above 0.05.

Regarding impact of ECHO finding (LVEF, LAA, E, A, E, E/A, E, E/E' and LAA). There was strong positive association among weaning success and E' (p value<0.001), negative association among weaning success and LAA (p=0.001) and positive association among weaning success and LVEF (p=0.001). In accordance with our results, study of Xu as they reported that the LAP assessed by E/e' ratio was a good gage of left ventricular diastolic functions, and the multi-variate analysing revealed that LAP (left-atrial pressure) was a non-dependent influencing influence of weaning failures [8]. The probable cause can be that cases with elevated LAP can be more likely to progress pulmonary venous congestions as the haemodynamic stress accompanying with weaning rises.

Using aeration score it was shown that above 15.5, it can predict failure of weaning with AUC of 0.781, level of sensitivity 81.2%, specificity 65.2%, PPV 44.8%, NPV 90.9% and accuracy 69.4%. Using diaphragmatic dysfunction, it was shown that if there were full diaphragmatic dysfunction, it can predict failure of weaning with AUC of 0.639, level of sensitivity 37.5%, specificity 97.8%, PPV 85.7%, NPV 81.8% and accuracy 82.3%.

Our study was supported by Qian who assessed diaphragmatic function using US as a predictor of weaning outcome for MV in there meta-analysis study and found that diaphragmatic ultrasound may identify patients at risk of weaning failure [9]. DD has been found to be a predictor of weaning failure in ICU patients.

Also, Li revealed that RSBI (OR=1.673, p value=0.03), LUS (OR=1.736, p value=0.001), DE (OR=3.942, p value=0.014), and DTF (OR=1.203, p value=0.001) were significantly correlated with an elevated danger of weaning failures [10]. By logistic regression, we tested the possible problems of combining these variables in expecting weaning outcomes. The combinations of DTF ≥ 30%, DE ≥ 1.3 cm, LUS ≤ 11, and RSBI ≤ 102 exhibited the maximum AUC (0.919), with a sensitivity of 96.0% and a specificity of 89%.

According to Rahman, the optimum cut-off value of DTF for expecting weaning success was greater than or equal 23.175 with an AUC of 0.932, the utilization of this threshold findings in a sensitivity of 100% and a specificity of 76.2% (p value<0.001) [11]. The best cut-off value of excursions for expecting weaning accomplishment was greater than or equal 6.2 with an AUC of 0.876, the utilization of this threshold lead to a sensitivity of 87.5% and a specificity of 66.7% (p value<0.001). The best cut-off value of LUS for expecting weaning failures was greater than or equal 12 with an AUC of 0.934, the utilization of this threshold lead to a sensitivity of 85.7% and a specificity of 81.2% (p value<0.001).

In our result revealed that heart and lung interaction reflect weaning outcome on ICU discharge and 28 days in-hospital mortality and supported by Haji [12]. A prospective observational pilot study on the impact of heart, lung and diaphragmatic ultrasound on prediction of failed extubation from mechanical ventilation in critically ill patients.

The current work has restrictions; is that this is a single centre research with a insignificant sample size; its results mayn't be generalizable to other settings. US are an operator-depending method, so it is contingent on the technical expertise of the operator. There are no available several studies about use of ECHO, lung aeration score and diaphragmatic movement as prognosticators of weaning from mechanical ventilations.

Conclusion

The ultrasonic characteristics of heart, lung, and diaphragm providing critical data around cardio-pulmonary and diaphragmatic functions throughout an SBT. Unsuccessful weaning was more dominant if markers of left ventricular diastolic dysfunctions, increased Lungs aeration score and diaphragmatic dysfunction were present.

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