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ARAŞTIRMA / RESEARCH

The power of diaphragm ultrasonography to predict weaning success

Diyafram ultrasonografisinin weaning başarısını tahmin etmedeki gücü

Mine Altınkaya Çavuş[1], Şerife Gökbulut Bektaş[2], Hilal Sipahioğlu[3], Gözde Ertürk Zararsız[4], Sema Turan[5]

[1]University of Health Sciences, Kayseri City Hospital, Department of Intensive Care, Kayseri, Turkey
[2]University of Health Sciences, Ankara City Health Application and Research Center, Department of Intensive Care, Ankara, Turkey
[3]Erciyes University Faculty of Medicine, Deparment of Biostatistics, Kayseri, Turkey

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Abstract

Purpose: The aim of this study; to evaluate the effects of diaphragm thickness on weaning with ultrasonography (USG).
Materials and Methods: In this prospective study; demographic characteristics of the patients, indications for hospitalization in the intensive care unit and mechanical ventilation, comorbidity, diaphragm thickness, Sequential Organ Failure Assessment (SOFA) score and Simplified Acute Physiology Score (SAPS) II, mortality rate, peripheral oxygen saturation (SpO_2), invasive mechanical ventilator (IMV) duration, minute volume, respiratory rate (RR), expiratory volumes (VTE), RSBI values were recorded. The patients were ventilated spontaneously for 30 minutes in pressure support (PS) mode in IMV. Diaphragm thickness (DT) was measured using a 7-10 MHz linear ultrasound probe set to B mode. The right hemidiaphragm was visualized in the midaxillary line between the 8th and 10th intercostal spaces, at the junction of the diaphragm and rib cage. After the measurements were stabilized, the patients were taken to the T-tube for one hour. The patients who successfully completed T-tube spontaneous breathing trials (SBT) were extubated. The patients were divided into two groups as successful and unsuccessful weaning.
Results: A total of 72 patients were evaluated by meeting the inclusion criteria. Four of the patients were excluded from the study because they received IMV support for less than 24 hours. There was no difference between the groups in the ratios of diaphragm thickness index (DTI) and diaphragmatic thickening fraction (DTF). The thickness measurements of the diaphragm, defined as diaphragm thickness at the end of inspiration (DTV) and diaphragm thickness at the end of expiration (DFRV),

Öz

Amaç: Bu çalışmada amaç; diyafram kalınlığının weaning üzerine etkilerini ultrasonografi (USG) ile değerlendirmektir.
Gereç ve Yöntem: Prospektif olarak yapılan bu çalışmada; hastaların demografik özellikleri, yoğun bakıma yatış ve mekanik ventilasyon endikasyonları, ek hastalıkları, diyafram kalınlığı, Sıralı Organ Yetmezliği Değerlendirmesi (SOFA) skoru ve Basitleştirilmiş Akut Fizyoloji Skoru (SAPS) II, mortalite oranı, periferik oksijen satürasyonu (SpO_2), IMV süresi, dakika hacmi, solunum sayısı (RR), ekspiratuar hacimleri, RSBI değerleri kaydedildi.Hastalar invaziv mekanik ventilatör (IMV) basınç desteği (PS) modunda 30 dakika boyunca spontan olarak ventile edildi . Diyafram kalınlığı (DT), B moduna ayarlanmış 7-10 MHz lineer ultrason probu kullanılarak ölçüldü. Sağ hemidiyafram, 8. ve 10. interkostal boşluklar arasındaki midaksiller çizgide diyafram ve göğüs kafesinin birleştiği bölgede görüntülendi. Ölçümler sonrasında hastalar stabil hale geldikten sonra 1 saat boyunca T-tüpe alındı. T-tüpte spontan solunum denemeleri (SBT)'ni başarıyla tamamlayan hastalar ekstübe edildi. Hastalar başarılı ve başarısız weaning olmak üzere 2 gruba ayrıldı.
Bulgular: Toplam 72 hasta çalışmaya dahil edilme kriterlerini sağlayarak değerlendirilmeye alındı. Hastaların 4 tanesi 24 saatten daha kısa süre IMV desteği aldığı için çalışma dışı bırakıldı. Diyafram kalınlık indeksi (DTI) ve diyafram kalınlaşma fraksiyonu (DTF) oranlarında gruplar arasında bir farklılık gözlenmedi. İnspirasyon sonunu diyafram kalınlığı (DTV) ve ekspirasyon sonunu diyafram kalınlığı (DFRV) olarak tanımlanan diyaframın kalınlık ölçümleri başarılı weaning grubunda daha yüksekti. Weaning başarısını tahmin etmek için DTV'nin en iyi eşik değeri 0.72, DFRV değeri 0.669 olarak bulundu.

Yazışma Adresi/Address for Correspondence: Dr. Mine Altınkaya Çavuş, University of Health Sciences, Kayseri City Hospital, Department of Intensive Care, Kayseri, Turkey E-mail: minealtinkaya@yahoo.com
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were higher in the successful weaning group. The best threshold value of DTV to predict weaning success was found to be 0.72 and DFRV value to be 0.669.
Conclusion: Weaning success is closely related to diaphragm functions, diaphragm thickness parameters and lung capacities. USG is a practical, bedside, noninvasive method that can be used to evaluate the diaphragm. DTV and DFRV are among the parameters that can predict success in the weaning process. DTF and DTI were found to be insufficient in predicting weaning success.
Keywords:. Diaphragmatic thickening index (DTI), diaphragmatic thickening fraction (DTF), ultrasonography, RSBI (rapid shallow breathing index), weaning, intensive care.

Sonuç: Weaning başarısı diyafram fonksiyonları, diyafram kalınlık parametreleri ve akciğer kapasiteleri ile yakından ilişkilidir. USG, diyaframı değerlendirmek için kullanılabilecek pratik, hasta başı uygulanabilen, noninvaziv bir yöntemdir. DTV ve DFRV weaning sürecinde başarıyı tahmin edebilecek parametreler arasındadır. DTF ve DTI weaning başarısını öngörmede yetersiz bulundu.

Anahtar kelimeler: Diyafragmatik kalınlaşma indexi (DTI), diyafragmatik kalınlaşma fraksiyonu (DTF), ultrasonografi, RSBI (hızlı sığ solunum indeksi), weaning, yoğun bakım.

INTRODUCTION

Mechanical ventilation (MV) is a respiratory support method that is frequently used in critically ill patients in intensive care units (ICU)[1]. Prolongation of MV support and failure to wean from MV in critically ill patients in the ICU is among the most important risk factors for morbidity and mortality, and cause high economic costs[2]. MV applications may lead to infectious and non-infectious complications[3]. Weaning from MV is a difficult decision. In order to avoid the risk of weaning failure; decisions need to be made using reliable, validated clinical, radiological and laboratory parameters[4]. These criteria include tidal volume (VT), vital capacity (VC), respiratory frequency (F), minute ventilation (VE), maximum voluntary ventilation (MVV), maximal inspiratory power (PImax) and airway occlusion pressure ($P_{0.1}$) are univariate "weaning" criteria. Such as CROP index, rapid shallow breathing index (RSBI), work of breathing (WOB), "weaning" index (WI), pressure-time indexes (PTI), and tension-time index (TTI) are multivariate "weaning" criteria[5]. The most commonly used of such parameters is the RSBI (F/VT)[6]. The diaphragm is the most important of the muscles in the respiratory system and the role of diaphragm function in weaning success is very important[7]. Since the breathing process is performed by the diaphragm and supplementary respiratory muscles, even if the diaphragm function is insufficient, RSBI can be at desired values with the compensation of the supplementary respiratory muscles, and it may be misleading in predicting success in weaning[8].

Over or under pressure support in MV, critical illness polyneuropathy, patient-ventilator mismatch, and infection adversely affects the functions of the diaphragm. This condition, which is defined as ventilator-induced diaphragm dysfunction (VIDD); it may cause myofiber atrophy and impaired diaphragm functions[9]. VIDD causes longer ICU stay, difficulty in weaning from MV, and increased mortality[10].

Ultrasonography (USG) is a non-invasive tool used to measure diaphragm excursion (DE) and thickness, and to evaluate diaphragmatic structure and diaphragmatic function[11,12]. Decreased diaphragmatic thickness is indicative of diaphragmatic atrophy, and the diaphragmatic thickening fraction (DTF) reflects diaphragmatic function[13]. Increasing evidence has shown that ultrasonographic evaluation of diaphragm functions is feasible, reproducible, and highly reliable[14]. Recently, the importance of USG measurements of the diaphragm has been emphasized in determining the most appropriate time for weaning[15].

In this study, it was aimed to determine that diaphragm measurements differ in successful and unsuccessful weaning. It is thought that the results to be obtained can be a guide for clinical practice in terms of planning weaning and predicting its success. In addition, it was also aimed to investigate other (Demographic, clinical…etc) factors that may affect the results associated with weaning success in this study. With this study, we planned to evaluate the diaphragm functions and diaphragm thickness by ultrasonography and to evaluate its power in predicting weaning success in critically ill patients who are hospitalized in the intensive care unit and receiving mechanical ventilation support.

MATERIALS AND METHODS

Sample and design

Our prospective study was carried out in the 3rd degree intensive care unit under the responsibility of the intensive care specialist at SBU Ankara Turkey Yüksek İhtisas Training and Research Hospital and Kayseri City Hospital between December 2018 and

June 2020, after the necessary permissions and ethical approvals were obtained. Ethical approval was obtained for this study from the Clinical Research Ethics Committee of SBU Ankara Turkey Yüksek İhtisas Training and Research Hospital with the decision dated 24.04.2018 and numbered 44964.

The patients who received MV supports for more than 24 hours were included in the study. *Exclusion criteria were*; spinal cord injury higher than T8, arrhythmias and hemodynamic instability, pregnancy, the patients with pneumothorax, pneumomediastinum, thoracostomy, chest injuries, pleural lesions, use of sedative agents or neuromuscular blocking agents.

Extubation criteria were; PEEP ≤ 8 cmH_2O, fraction of inspired oxygen (FiO_2) < 0.5, respiratory rate (RR) < 30 breaths/min, RSBI < 105, partial pressure of oxygen (PaO_2)/ FiO2 ⩾ 150, systolic blood pressure(SBP) 90–160 mmHg, heart rate < 140 beats/min, SpO_2⩾ 90%. The failure criteria; changes in mental status, restlessness, sweating, respiratory rate> 37 breaths/minute and hemodynamic instability (heart rate> 140 beats/minute, systolic blood pressure > 180 mm/Hg, <90 mm/Hg) [17].

The patients were divided into 2 groups as successful and unsuccessful weaning. Groups age (year), height (cm), weight (kg), Body mass index (BMI) (kg/m^2), SOFA, SAPS II, MV time (day), SpO_2, volume per minute (L), RR, expiratory tidal volumes (VTE) (ml), RSBI compared in terms of parameters. The sensitivity and specificity of the cut-off values of the diaphragm measurements were evaluated.

Data collection

Demographic characteristics of the patients, indications for hospitalization in the intensive care unit and mechanical ventilation, comorbidities, diaphragm thickness, SOFA and SAPS II scores, mortality rate, peripheral oxygen saturation, MV duration, minute volume, respiratory rate, expiratory volumes, and RSBI values were recorded.

Ultrasound evaluation of diaphragm thickness

The patients were spontaneously ventilated in pressure support (PS) mode in MV for 30 minutes [positive end-expiratory pressure (PEEP): 5 mmHg, pressure support: 10 cmH_2O, fraction of inspired oxygen (FiO_2): 50%). DT were measured while the patients were ventilated in PS mode in MV by intensive care specialist (11 years of intensive care experience). In all the patients, USG was applied to the right diaphragm in the supine position with the bed head elevated between 20-40°. DT was measured using a Philips ClearVue 550 system with S1-4 MHz linear ultrasound probe set to B mode. The right hemidiaphragm was visualized in the midaxillary line between the 8th and 10th intercostal spaces, at the junction of the diaphragm and the rib cage. Measurements of the right diaphragm were taken diaphragm thickness at the end of inspiration (DTV) and the diaphragm thickness at the end of expiration (DFRV). The diaphragm thickness index (DTI) was calculated using the formula "Final inspiratory thickness – final expiratory thickness / end inspiratory thickness x100". The diaphragm thickening fraction (DTF) was calculated using the equation: "End-inspiratory thickness – end-expiratory thickness / end-expiratory thickness x100" [16]. RSBI and diaphragm thickness values were obtained by calculating the average of 3 serial measurements. After the measurements, the patients were taken to the T-tube for 1 hour after they stabilized.

Successful and unsuccessful weaning criteria

The patients who successfully completed T-tube spontaneous breathing trials (SBT) were extubated. Weaning was defined as successful in the patients who continued to breathe spontaneously for >48 hours after extubation. Weaning failure was defined as the inability to maintain spontaneous breathing for at least 48 hours without respiratory support or failure in SBT.

Statistical analysis

As a result of the power analysis made with hypothetical expectations, it was calculated that at least 34 people (at least 17 people for each group) should be included in the study in order to achieve 80% power with 95% confidence.

Histogram, q-q plots and Shapiro-Wilk's test were applied to assess the data normality. Levene test was used to test variance homogeneity. To compare the clinical parameters between successful and unsuccessful weaning groups, a two-sided independent sample's *t* test, Welch *t* test or Mann-Whitney U test were applied. Moreover, a receiver-operating characteristic curve (ROC) analysis was used to assess the diagnostic effect of diaphragm thickness measurements on weaning. The area under the ROC curve was calculated with 95% confidence intervals. The Youden index was used to identify the optimal cut-off value. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated with 95% confidence intervals based on the identified cut-off values. Analyses were conducted using TURCOSA (Turcosa Analytics Ltd Co, Turkey, www.turcosa.com.tr) statistical software. Data analysis and interpretation was done by MAÇ, GEZ.

RESULTS

Diaphragm measurements of 72 patients were made in total. Four patients whose diaphragm thickness was measured by ultrasonography were excluded from the study because they received MV support for less than 24 hours. 68 patients were evaluated for the study. 38 patients (55.9%) were male. 36 (52.9%) without additional disease, cerebrovascular disease (CVD) 8 (11.7%), cancer (CA) 6 (8.8%), coronary artery disease (CAD) 6 (8.8%), chronic obstructive pulmonary disease (COPD) 4 (5.9%), kidney failure was 4 (5.9%). 42 (61.8%) of the patients started to receive MV support because of pneumonia and 26 (38.2%) of the patients due to low Glasgow coma score (GCS) (Table 1).

Between groups (successful weaning, failed weaning); DTI (%), DTF (%), height (cm), weight (kg), body mass index (BMI) (kg/m²), IMV duration (days), saturation (%), ICU duration (days), RR (minutes), minute volume (L), VTE (ml), RSBI variables were not statistically significant.

Table 1. Demographic and clinical characteristics

Variable	Distribution (n=68)
Gender (female/male)	30(44.1)/38(55.9)
Age (years)	78(56-84)
Height (cm)	167±11
Weight (kg)	73±17
BMI (kg/m²)	26.93±5.31
SOFA score	9(8-12)
SAPS II	52.5(39-70)
IMV duration (days)	5(2-7)
SpO2 (%)	96(92-99)
RR (minutes)	23(14-26)
Minute volume (L)	8.1(5.6-11.5)
Additional diseases	
No disease	36(52.9)
CVD	8(11.7)
CA	6(8.8)
CAD	6(8.8)
COPD	4(5.9)
Kidney failure	4(5.9)
Others	4(5.9)
Indication for intubation(%)	
Pneumonia	42(61.8)
Low Glasgow coma scale (GKS<8)	26(38.2)
Mortality	48(70.6)

Values are expressed as *n*(%), mean±SD or median(1st-3rd quartiles). CVD: Cerebrovascular disease, CA: Cancer, CAD: Coronary artery disease, COPD: Chronic obstructive pulmonary disease, SpO_2: Peripheral oxygen saturation SOFA: Sequential Organ Failure Assessment Score, SAPSII: Simplified Acute Physiology Score, BMI: Body mass index, IMV: Invasive mechanical ventilation, RR: Respiratory rate

Table 2. Comparison of clinical parameters between successful and unsuccessful weaning groups

Variable	Groups		*p*-value
	Failed weaning (*n*=50)	Success weaning (*n*=18)	
DTV (cm)	0.86±0.19	0.99±0.19	**0.010**
DFRV (cm)	0.65±0.16	0.73±0.11	**0.031**
DTI (%)	0.24±0.09	0.26±0.06	0.220
DTF (%)	0.31±0.16	0.36±0.11	0.225
Age (years)	81(69-86)	53(38-76)	**<0.001**
Height (cm)	165.80±12.13	170.00±9.04	0.185
Weight (kg)	73.12±16.68	74.50±20.07	0.777
BMI (kg/m²)	27.18±5.32	26.23±5.38	0.518
SOFA	10(9-13)	7(6-8)	**<0.001**
SAPS II	61(45-74)	36(27-40)	**<0.001**
IMV duration (days)	5(2-7)	7(3-9)	0.177
Saturation (%)	96(92-100)	96(95-98)	0.844
ICU duration (days)	6(4-9)	7(5-9)	0.209
RR (minutes)	23(14-26)	23(15-24)	0.978
Minute volume (L)	7.6(5.5-11.4)	9.7(7.0-11.5)	0.389
VTE (ml)	404(306-478)	389(298-546)	0.846
RSBI	62(30-94)	39(27-73)	0.090

Values are expressed as mean±SD or median(1st-3rd quartiles). Statistically significant results are shown in bold characters. DTV: Diaphragmatic thickness at tidal volume, DFRV: Diaphragmatic thickness at functional residual volume, DTI: Diaphragmatic thickening index, DTF: Diaphragmatic thickening function, SOFA: Sequential Organ Failure Assessment Score, SAPSII: Simplified Acute Physiology Score II, VTE: Expiratory tidal volumes, BMI: Body mass index, RSBI: Rapid shallow breathing index, IMV: Invasive mechanical ventilator, ICU: Intensive care unit, RR: Respiratory Rate.

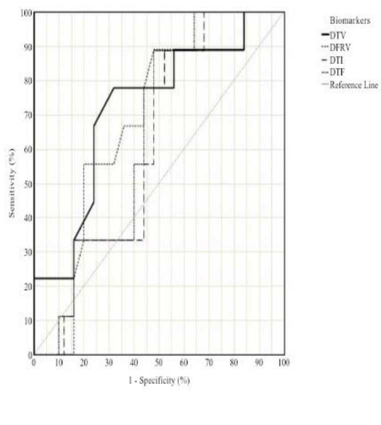

Figure 1. ROC curves displaying the diagnostic performance of diaphragm thickness measurements variables on predicting in the patients on mechanical ventilator.

In the successful weaning group, age was 53 (38-76) years, SOFA 7 (6-8), SAPS II 36 (27-40). These values were lower than the failed weaning group. This difference was statistically significant (p<0.05). There was no difference between the groups in the ratios of DTI and DTF. The thickness measurements of the diaphragm, defined as DTV and DFRV, were higher in the successful weaning group (p<0.05) (Table 2).

ROC analysis of the performance of ultrasound parameters was performed to predict weaning failure or success (Table 3).

The best cut-off of DTV to predict weaning success was >0.97 cm with 0.72 AUC; application of this threshold resulted in 78% sensitivity and 68% specificity (p < 0.05). The best DFRV value to predict weaning success was >0.63 cm with 0.669 AUC, resulting in a sensitivity of 89% and specificity of 52% (p < 0.05) (Table 3).

ROC curves showing the diagnostic performance of diaphragm thickness measurement variables in predicting mechanically ventilated the patients are shown with a graph (Figure 1). Box plots were drawn showing the distribution of diaphragm thickness measurement variables between successful and unsuccessful weaning groups (Figure 2).

Table 3. ROC analysis results for diaphragm thickness measurements variables in order to predict in the patients on mechanical ventilator.

Biomarker	ROC statistic		Diagnostic Statistic			
	AUC (95% CI)	p	SEN	SPE	PPV	NPV
DTV >0.97 cm	0.72(0.581-0.859)	0.006	0.78(0.52-0.94)	0.68(0.53-0.81)	0.47(0.32-0.79)	0.90(0.73-0.94)
DFRV >0.63 cm	0.669(0.532-0.806)	0.035	0.89(0.65-0.99)	0.52(0.37-0.66)	0.40(0.27-0.86)	0.93(0.75-0.96)
DTI >0.21%	0.613(0.479-0.748)	0.156	0.89(0.65-0.99)	0.48(0.34-0.63)	0.38(0.25-0.85)	0.92(0.74-0.96)
DTF >0.26%	0.642(0.512-0.772)	0.075	0.89(0.65-0.99)	0.52(0.37-0.66)	0.40(0.27-0.86)	0.93(0.75-0.96)

AUC: Area under the curve, ROC: Receiver operating characteristics, CI: Confidence interval, SEN: Sensitivitiy, SPE: Specificity, PPV: Positive predictive value, NPV: Negative predictive value, DTV: Diaphragmatic thickness at tidal volume, DFRV: Diaphragmatic thickness at functional residual volume, DTI: Diaphragmatic thickening index, DTF: Diaphragmatic thickening function

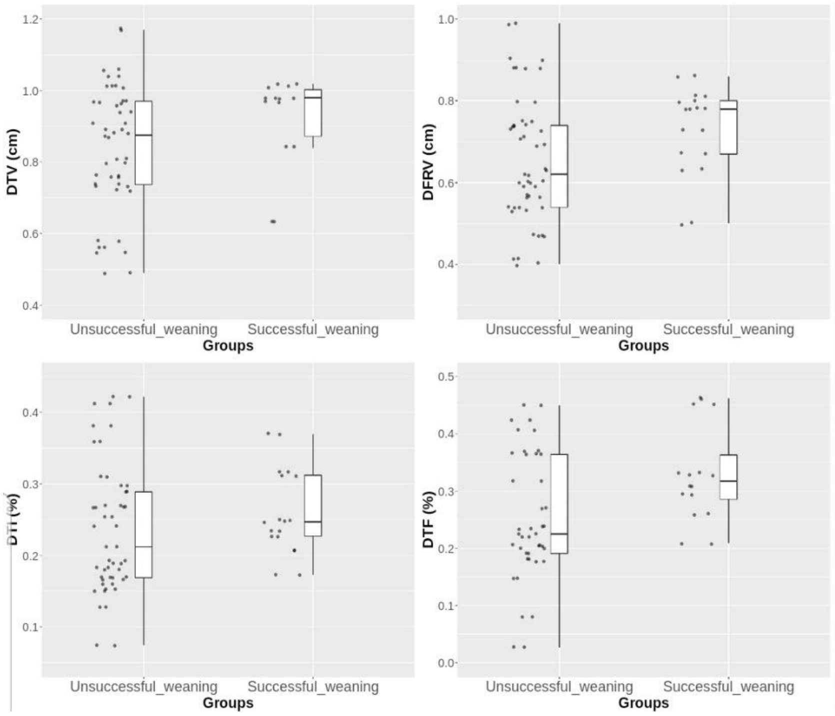

Figure 2. Boxplots displaying the distribution of diaphragm thickness measurements variables between successful and unsuccessful weaning groups.

DISCUSSION

Weaning from MV is a very difficult process for critically ill patients. Today, there are many parameters used to conclude this process successfully. However none of these predictors appears to be sufficiently sensitive or specific in predicting weaning success. Ultrasonography has many uses in ICU. In this study; We evaluated the diaphragm thickness of critically ill patients planned to be weaned by ultrasonography. We conclude that diaphragm thickness measurements can be used to predict weaning success.

The diaphragm is the main respiratory muscle, which plays the most important role in the respiratory movement. Its dysfunction predisposes to long-term mechanical ventilation and respiratory complications. Sonographic evaluation is an imaging modality that is gaining popularity in ICU for the evaluation of diaphragmatic function [18]. Ultrasonography is non-invasive and radiation-free, allowing easy and accurate assessment of diaphragm anatomy and function [19].

The defined RSBI value for successful weaning is 100-105 breaths/minute/liter [6]. Lower predictive values have been reported for RSBI [20]. The patient population or methodological differences cause a wide variety of consequences for RSBI. In our study, RSBI values were quite low in unsuccessful [62(30-94)] and successful weaning [39(27-73)] groups, unlike those in the literature.

Various parameters measured by ultrasound have been proposed to evaluate diaphragmatic function [21]. These are; diaphragm thickness is the ratio of diaphragm movement [22] to diaphragmatic thickening (DTF) during the respiratory cycle. Although some studies have shown that diaphragm thickness has a low predictive value in evaluating diaphragmatic function [23], a meta-analysis reported DTF as the best predictor of weaning outcome [24]. In our study; it can be predicted that DTF is not sufficient to show the success of weaning. However, we would like to emphasize the importance of diaphragm thickness at the end of inspiration and expiration in predicting weaning.

In the study of Abdelwahed et al.; a thickening fraction of the right diaphragm (measured by ultrasound) equal to or greater than 30% were better than RSBI in terms of sensitivity and specificity in predicting failed extubation, reduction in mechanical ventilation time, and weaning [25]. In our study, we did not compare diaphragm measurements with any other predictor. In addition, we found RSBI measurements to be low, unlike the literature.

In the patients extubated in the ICU, when the diaphragm was sonographically evaluated at the T-tube stage, it was determined that RSBI was as powerful like a parameter as extubation success. Examination of the diaphragm with ultrasonography during the weaning process provides both morphological and functional real-time information. Among the sonographic values obtained in T-tube stages, it has a PPV of over 90% in determining extubation success, which is 27.5% for DTF and 64 breaths/minute/liter for RSBI. Using sonographic examinations accompanied by RSBI in Weaning increases success [26]. We found the DTF cut-off value to be 26%.

In the evaluation of diaphragm function, DTF; it has also been shown to outperform RSBI and DE in other studies. Many studies have concluded that measurements of diaphragmatic thickening are more reliable and accurate for assessing diaphragmatic function in those supplemented with MV therapy [(27,28)]. Threshold values of DTF for weaning have ranged from 20% to 36% in studies conducted so far [(16,29)]. In a study in which sonographic examinations were performed at different PS levels (PS 5, 10, and 15 cmH_2O), the cut-off value for DTF was reported as 20%. According to the study findings, DTF was found to be more predictive for extubation as PS decreased [29]. DiNino et al.[6] in their study; they performed sonographic evaluations during PS (5 cmH_2O) and during T-tube inhalation and reported that DTF equally predicted extubation success during PS and T-tube evaluations. In our study; the best cut-off of DTV to predict weaning success was >0.97 cm with 0.72 AUC; application of this threshold resulted in 78% sensitivity and 68% specificity ($p < 0.05$). Its PPV was 47%, while its NPV was 90%. The best DFRV value to predict weaning success was >0.63 cm with 0.669 AUC, resulting in a sensitivity of 89% and a specificity of 52% ($p < 0.05$). While PPV was 40%, NPV was found to be 93%.

Diaphragmatic ultrasonography is a promising diagnostic tool to evaluate weaning success. Further studies and clinical practice are required for standardization of measurements and protocol used in weaning [30].

Measuring diaphragm excursion (DE) and comparing our measurements with a different predictor are among the limitations of our study. We think that further studies are needed to determine the power and cut-off values of diaphragm measurements and RSBI in predicting weaning success.

In conclusion, weaning from MV is a very difficult process for the patients on long-term ventilator support. Weaning success increases when many predictions, measurements, tests or clinical findings used in this process are evaluated together. Younger patients with lower SOFA and SAPS II scores may be more successful in weaning. Ultrasound of the diaphragm is an easy, simple, inexpensive, and noninvasive method. Evaluation of DTV and DFRV measurements by diaphragm ultrasound in B mode may be a new index of discrimination. Therefore, they can be used as predictive parameters to evaluate the outcome of the weaning process.

Yazar Katkıları: Çalışma konsepti/Tasarımı: MAÇ, ŞGB; Veri toplama: MAÇ; Veri analizi ve yorumlama: MAÇ, GEZ; Yazı taslağı: MAÇ, ŞGB; İçeriğin eleştirel incelenmesi: MAÇ, HS; Son onay ve sorumluluk: MAÇ, ŞGB, HS, GEZ, ST; Teknik ve malzeme desteği: MAÇ; Süpervizyon: ST; Fon sağlama (mevcut ise): yok.

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