Original Research Paper

Volume - 14 | Issue - 12 | December - 2024 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Anaesthesiology

HAND GRIP STRENGTH USED AS A PREDICTOR OF DIFFICULT WEANING IN MECHANICALLY VENTILATED PATIENTS - A PROSPECTIVE STUDY

Dr. Jaya Lalwani MD, FICA Professor Department Of Anaesthesiology And Pain Medicine Pt. J.N.M. Medical College & Dr. B.R.A.M. Hospital, Raipur (C.G.), India

Dr. Omprakash Sundrani MD, EDIC Professor And Head Of The Department Department of Critical Care Medicine Pt. J.N.M. Medical College & Dr. B.R.A.M. Hospital, Raipur (C.G.), India

Dr. Yogeshwar Prasad Swarnkar 3rd Year Postgraduate Resident Department Of Anaesthesiology And Pain Medicine Pt. J.N.M. Medical College & Dr. B.R.A.M. Hospital, Raipur (C.G.), India.

ABSTRACT **Background And Aim:** Weaning from mechanical ventilation is a crucial process for critically ill patients. Assessment of weaning from mechanical ventilation (MV) is an important process. ICU acquired weakness (ICUAW) has been shown to be associated with prolonged duration of mechanical ventilation and extubation failure. Rapid shallow breathing index (RSBI) is a standard tool to evaluate a patient's readiness before the spontaneous breathing trial (SBT). Handgrip strength (HGS) is an alternative method for assessment of respiratory muscle strength. The aim of present study is to assess handgrip strength as a predictor of difficult weaning. **Methodology:** A prospective study was conducted on 115 patients, aged ≥ 18 years who required mechanical ventilation for at least ≥ 48 hrs and were ready to wean. Patient's demographic profile, vitals and Apache II score were documented at the time of admission. After passing spontaneous breathing trial (SBT) handgrip strength was recorded at 48 hrs after intubation, 10min, 30min, 60min after SBT and 48 hrs after extubation. They were further followed up till 28 days after extubation, discharge or death of the patients. RSBI was also measured before SBT. **Result:** Out of 115, 104 patients were included in the study in which 62.5 % were males while 37.5% were females with a mean age of 57.88±8.02 years. Mean Apache II score was 13.40±2.06 and most common cause of intubation was pneumonia (37.5%). A total of 9.6% patients were re- intubated and most common cause for re-intubation was laboured breathing. At 28 days after extubation most patients were discharged (85.6%). It was found that both RSBI and HGS significantly correlated in predicting weaning failure (p=0.0001). Also, there was a negative correlation between RSBI and HGS. **Conclusion** : RSBI and HGS are good predictors of weaning failure but HGS was better predictive tool with better sensitivity and specificity than RSBI. Low handgrip strength corresponded to significantly increased re-intubation rate. Both, HGS and RSBI are negatively correlated to each other and no association was found between Apache II score and weaning outcomes. Hence HGS can be used as an adjunct to RSBI in predicting weaning outcomes.

KEYWORDS :

INTRODUCTION

Respiratory failure is the main illness requiring mechanical ventilation (MV). Mechanical ventilation plays a crucial role in supporting patients who are unable to breathe adequately, it helps to maintain adequate oxygenation and ventilation when the body's natural respiratory efforts are compromised. Weaning is the gradual process of transition from full ventilatory support to spontaneous breathing, including, the removal of the endotracheal tube. Evaluation of readiness for weaning from MV is an essential process for reducing morbidity and mortality. Premature or delayed weaning both has a drastic effect on the outcome of patients, early weaning lead to stress on both respiratory as well as cardiovascular system while delayed weaning leads to diaphragmatic atrophy, venous thromboembolism and pneumonia.

Rapid shallow breathing index being the most accurate predictor of failure in weaning patients from mechanical ventilation is widely used. RSBI is a standard tool to evaluate a patient's readiness before the spontaneous breathing trial (SBT). Handgrip strength (HGS) is an alternative method for assessment of respiratory muscle strength. HGS is a simple, non-invasive tool and it can be monitored very quickly and easily at the bedside. It may be a useful tool for the weaning assessment from prolonged MV at a long-term. Patient in ICU develops muscle weakness (ICUAW) as a result of combination of muscle and nerve injuries developed during ICU stay in 25 to 63% of mechanically ventilated patients mainly involving limbs and respiratory group of muscles, which may lead to delayed weaning of the patient or failed extubation and also increase the ICU stay length[10,11]. Through this study we aimed estimate handgrip strength as a predictor of difficult weaning in mechanically ventilated patients.

Methodology

A prospective study was conducted in the Department of Anaesthesiology and Pain Medicine and Department of Critical Care Medicine, Pt. J.N.M. Medical College and Dr. B.R.A.M. Hospital, Raipur (C. G.) after approval from Institutional Scientific & Ethics Committee. Out of a total 115 patients enrolled 104 were included in the study with an age of ≥ 18 years who required mechanical ventilation for at least ≥ 48 hrs and were able to do handgrip test. The exclusion criteria were patient's refusal, death before weaning from mechanical ventilation, transfer of patient to other hospital, self extubation, accidental extubation, reintubation before enrollment to study, tracheostomised patients, treatment with vasopressor/inotropic drugs, history of cerebrovascular accident, any rheumatological condition, amputation, neuromuscular disease or cachexia. The demographic profile, APACHE II score, hemodynamic parameters of patients who were eligible for weaning trial were noted. They were then subjected for Spontaneous Breathing Trial (SBT) for 30–120 minutes which consisted of breathing with a minimum pressure support of 5–8 cm H_2O with a positive end- expiratory pressure of 5 cm H_2O. At the same time Rapid shallow breathing index and Handgrip strength was measured. HGS was measured using a digital hand-grip dynamometer. Participants were positioned as close to upright as possible, shoulder neutrally rotated shoulder, an elbow flexion of 90º and the arm was not supported. Participants were instructed to squeeze the handle of dynamometer with their dominant hand as hard as possible for 3 consecutive attempts for 3 seconds separated by a brief pause of 30 seconds and the maximum contractile force (kg) was recorded.

If the patient failed the SBT trail, they were then further evaluated for the reason of failure. If patients succeeded the SBT trail, they were extubated and serial HGS was taken at 10, 30, 60 min after SBT and 48 hrs after extubation and they were further followed uptill 28 days after extubation, discharge or death. Successful weaning was defined when patient was extubated and breathing spontaneously without any invasive or non-invasive ventilatory support for ≥ 48hrs whereas weaning failure was defined as either the failure of SBT or the need for re- intubation within 48 hrs following extubation.

Table 1: Causes of Intubation

Causes of Intubation	Number of patients	Percent (%)
AECOPD	3	2.89
Airway Protection	17	16.35
CCF	12	11.54
Pneumonia	39	37.50
Pulmonary Oedema	6	5.77

Septic Shock	27	25.97
Total	104	100

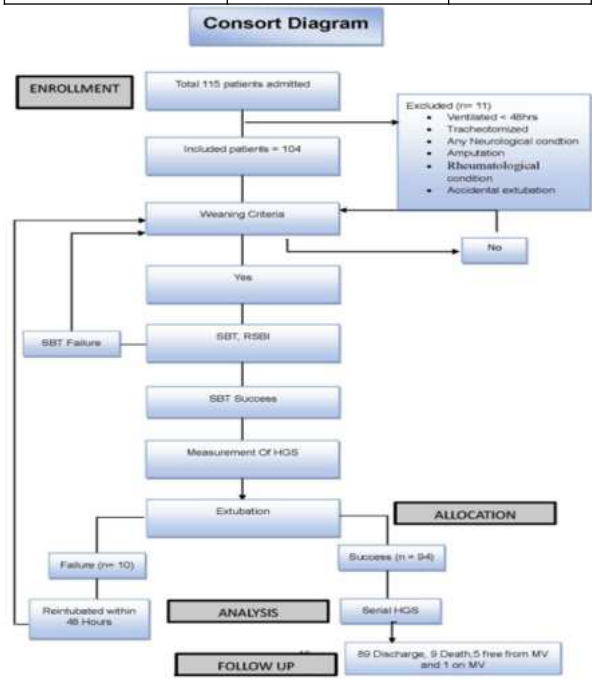


Figure 1: Consort diagram

Table 2: Demographic Profile Of The Patients

Variables		Weaning success	Weaning failure	p-value
Age (years)		57.54 ± 8.04	61.45 ± 7.36	0.163
Sex	**Male**	57 (87.7%)	08 (12.3%)	0.30
	Female	37 (94.9%)	02 (15.1%)	
HGS (kg)	**Male**	16.79 ± 1.8	7.52 ± 1.14	0.30
	Female	15.64 ± 1.43	7.40 ± 0.70	
APACHE II Score		13.35 ± 2.06	13.80 ± 1.91	0.552
RSBI (breaths /min /L)		99.79±4.15	119.80 ±7.16	0.0001

Table 3: Handgrip strength at different intervals

Handgrip Strength (kg)			
Time Interval	**Weaning Success**	**Weaning Failure**	**p-value**
48 hrs after Intubation	16.45±1.42	7.48±1.04	0.0001
10 min after SBT	16.76±1.42	7.99±1.14	0.0001
30 min after SBT	17.03±1.43	8.60 ± 1.01	0.0001
60 min after SBT	17.24±1.40	9.1 ± 1.03	0.0001
48 hrs after extubation	17.54±1.47	9.46 ± 1.13	0.0001

Table 4: Comparison of Handgrip strength and RSBI between weaning success and failure

	Weaning Success (N=95)	**Weaning Failure (N=9)**	**p-value**
RSBI (breaths /min /L)	99.77±4.17	119.78±7.18	0.0001
48 hrs after Intubation (kg)	16.47±1.44	7.47±1.05	0.0001
10 min after SBT (kg)	16.74±1.44	7.97±1.16	0.0001
30 min after SBT (kg)	17.01±1.45	8.58 ± 1.03	0.0001
60 min after SBT (kg)	17.22±1.42	9.08 ± 1.05	0.0001
48 hrs after Extubation (kg)	17.52±1.49	9.44 ± 1.15	0.0001

Table 5: Pearson correlation Relation between handgrip strength and rapid shallow breathing test

		RSBI	48hrs HGS	10 min after SBT	30 min after SBT	60 min after SBT	48 hrs after extubation
RSBI	Pearson Correlation	1	**-0.785****	**-0.774***	**-0.765****	**-0.754***	**-0.734***
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000
	N	104	104	104	104	104	104
48hrs HGS	Pearson Correlation	**-0.785****	1	0.997**	0.994**	0.989**	0.979**
	Sig. (2-tailed)	.000		0.000	0.000	0.000	0.000
	N	104	104	104	104	104	104

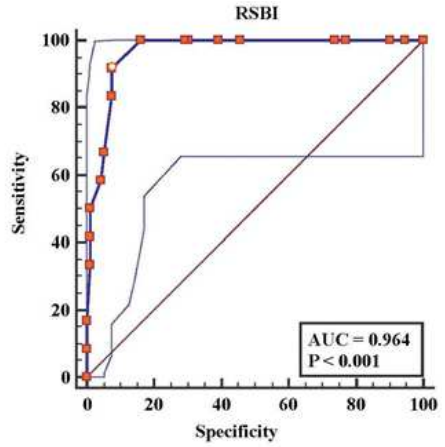
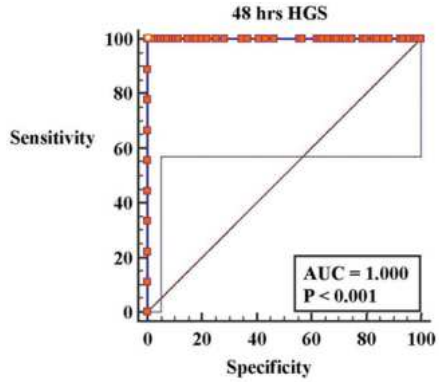


Figure 2: ROC Curve of Rapid Shallow Breathing Index



Sensitivity	**Specificity**	**AUC**	**Cutoff**	**95% CI**
91.67%	92.39%	0.964	< 104	0.937- 0.998

Figure 3: ROC Curve of Handgrip Strength 48 hrs after Intubation

Table 6: Causes of Re-intubation

Cause of Re-intubation	**Incidence**	**Percent (%)**
Altered Sensorium	1	11.11
Desaturation And Tachypnoea	2	22.22
Laboured Respiration	3	33.34
Pulmonary Oedema	2	22.22
Tachypnoea	1	11.11

Table 7: Outcomes at the end of 28 Day

	Incidence	**Percent**
Discharge	89	85.6
Death	9	8.7
Free from Mechanical ventilation	5	4.8
Mechanical ventilation	1	1.0
Total	104	100.0

RESULT

Table 1 shows the cause for intubation and pneumonia was the most common cause among them.

Table 2 shows demographic profile, mean HGS of male and female, APACHE II score and mean RSBI in weaning success and weaning failure group and among that only RSBI was statistically significant.

The mean HGS in different time intervals is shown in (Table 3) and it was seen that HGS increases with duration. HGS in weaning success is significantly more than weaning failure group over time and there was significant difference in RSBI between both the groups.

The area under ROC curve of RSBI was 0.964 with confidence interval of 95%, cutoff of < 104 breaths / min/ L with a sensitivity of 91.67%

and specificity of 92.39 % whereas area under ROC curve of HGS at 48hrs after intubation was 1 with confidence interval of 95%, cutoff of 9.2 kg with a sensitivity and specificity of 100 % (Figure 2 & 3). According to Pearson correlation both HGS and RSBI are negatively correlated with each other. Both HGS and RSBI are significantly correlated with the weaning outcomes (p=0.0001) (Table 4).

At the end of 28 day after extubation, 94 patients were successfully weaned out of which 89 got discharged while 5 were free from mechanical ventilation and 10 were re-intubated out of which 9 died and 1 remained on ventilator and most common cause for re-intubation was laboured respiration (Table7).

DISCUSSION

Rapid shallow breathing index (RSBI) is one of the most common and standard methods used for weaning. HGS is a simple, non-invasive, bedside tool which can be used as an adjunctive along with RSBI for better results.

The mean age in weaning success group was 57.54 ± 8.04 years while it was 61.45 ± 7.36 years in weaning failure group with a p-value of 0.163, similar result was observed in previous studies [5,6]. Cottereau G et al had found a significant relation with age which was due to greater number of old age subjects in their studies [2,3]. Idilbi N et al resulted that males have higher HGS as compared to females yet this doesn't affect the weaning outcome of females, but there was no correlation of gender with the weaning outcomes and probable reason for higher HGS could be greater muscle mass in males [4].

Most common cause for intubation in our study was pneumonia (37.50%) and similar result was observed in previous studies [2,3,5,6] while other causes were septic shock, airway protection, congestive cardiac failure, pulmonary edema and acute exacerbation of COPD (AECOPD).

Our study resulted that both HGS and RSBI had a significant relation (p=0.0001) with the weaning outcomes and HGS can be used as a predictor of difficult weaning. According to Pearson correlation, both HGS and RSBI correlated with each other and similar result was observed in previous studies[8,9] but another study[5] resulted that RSBI did not had any significant relation with weaning (p=0.590) which was probably due to elderly patients (mean age 71.6 years) in their study and some patients had COPD (13 patients) and these patients might have had air trapping and high lung volume leading to lower RSBI. They speculated that the RSBI values could have been confounded by factors other than respiratory muscle strength (e.g., increased respiratory rates from pneumonia and low tidal volume in pulmonary edema), leading to misleading results.

A.A.R. Mohamed et al[1] observed that HGS may be a good predictor for extubation outcomes, mechanical ventilation, ICU mortality and prognosis as well as HGS was negatively correlated with mechanical ventilation duration (p>0.047), similar result found in other studied as well[4,5,6] which was probably because diaphragmatic strength has been associated with muscle strength handgrip strength might indicate a more global performance status, thus representing a determinant point in the setting of mechanical ventilation weaning.

Luna E W et al observed that patients with ICUAW which was diagnosed by HGS below normal range were difficult to wean and had prolonged mechanical ventilation or increase in the length of hospital stay which was propbaly due to inactivity and atrophy of diaphragm within hours to few days following mechanical ventilation secondary to increased proteolysis of diaphragm which resulted in difficult weaning and increased hospital stay while Cottereau G et al[2,3] concluded that muscle weakness, assessed by handgrip strength, was associated with difficult or prolonged mechanical ventilation weaning and ICU stay, but not with extubation outcome.

Out of 104 patients, 10 subjects required re-intubation and the most common cause being laboured respiration and they had significantly lower HGS of 7.48 kg. Similar result was observed in previous study[5]. Cottereau G et al[2,3] observed that in reintubated patients HGS did not differ significantly between both the groups. According to extubation outcome (p = 0.85) which was probably due to several mechanisms involved in extubation failure and the evaluation of one factor among many is not sufficient to predict the outcomes after extubation. Also, their sample size was small (84) which led to a low number of re intubations.

HGS is influenced by multiple muscular and non-muscular factors such as anthropometric characteristics, psychological status, disease severity, inflammation, oxidative stress, physical activity, comorbidities, medications, and environmental factors.

At the end of 28 days after extubation most of the patients were discharged. The patients who died or who continued to be on mechanical ventilation were in the weaning failure group and had significantly lower handgrip strength.

Limitation

In our study weaning was not classified into simple, difficult or prolonged weaning. Duration of SBT was not included which can be as early as 30 min or late as 120 min which can change the outcome of patients. It is possible that we could not elicit maximum handgrip strength even after 3 attempts, HGS can be influenced by multiple muscular and non-muscular factors such as anthropometric characteristics, psychological status, disease severity, inflammation, oxidative stress, physical activity, comorbidities, medications, and environmental factors which were not taken into consideration. The cut off value was not evaluated separately for males and females. We did not consider length of ICU stay prior to weaning and after extubation.

REFERENCES

1) A.A.R. Mohamed-Hussein, H. A. Makhlouf, Z. I. Selim, and W. Gamaleldin Saleh, "Association between hand grip strength with weaning and intensive care outcomes in COPD patients: a pilot study," Clinical Respiratory Journal, 2018; 12:10:2475–2479.
2) Cottereau G, Dres M, Avenel A, Fichet J, Jacobs FM, Prat D et al. Handgrip Strength Predicts Difficult Weaning But Not Extubation Failure in Mechanically Ventilated Subjects. Respir Care. 2015; 60(8):1097-104. 101
3) Cottereau G, Messika J, Megarbane B, Guérin L, da Silva D, Bornstain C et al. Handgrip strength to predict extubation outcome: a prospective multicenter trial. Ann Intensive Care. 2021 2;11(1):144.
4) Idilbi N, Amun W. Hand grip strength as a predictor for success in weaning from ventilation. Isr Med Assoc J. 2022; 15(1):224.
5) Saiphoklang N, Keawon T. Correlation between Handgrip Strength and Rapid Shallow Breathing Index for Assessment of Weaning from Mechanical Ventilation. Crit Care Res Pract. 2020 30;2020: 4637528
6) Saiphoklang N, Mokkongphai N. Handgrip strength cutoff value predicting successful extubation in mechanically ventilated patients. PLoS One. 20221 21;16-10
7) Ali NA, O'Brien JM Jr, Hoffmann Acquired weakness, handgrip strength, and mortality in critically ill patients. Am J Respir Crit Care Med. 2008;178(3):261 8.
8) Chang-Shu Tu, Chih-Hao Chang, Shu-Chin Chang, Chung-Shu Lee, Ching-Ter Chang, "A Decision for Predicting Successful Extubation of Patients in Intensive Care Unit", BioMed Research International, 2018, 6820975-11.
9) Fadaii A, Amini SS, Bagheri B, Taherkhanchi B. Assessment of rapid shallow breathing index as a predictor for weaning in respiratory care unit. Tanaffos. 2012;11(3):28-31.
10) Sharshar T, Bastuji-Garin S, Stevens RD. Presence and severity of intensive care unit-acquired paresis at time of awakening are associated with increased intensive care unit and hospital mortality. Crit Care Med. 2009;37(12):3047–53.
11) Hermans G, Van den Berghe G. Clinical review: intensive care unit acquired weakness. Crit Care. 2015;19(1):274.