Original Article

EFFECTS OF THRESHOLD INSPIRATORY MUSCLE TRAINING VERSUS CONVENTIONAL PHYSIOTHERAPY ON THE WEANING PERIOD OF MECHANICALLY VENTILATED PATIENTS: A COMPARATIVE STUDY

Akansha Dixit *[1], Shashwat Prakash [2].

[1]Assistant Professor in People's College of Paramedical Sciences & Research Centre, Bhopal.
[2]Teaching Associate in Department of Physiotherapy, GJUS&T, Hisar, India.

ABSTRACT

Objective: To check the effectiveness of Conventional Physiotherapy and Threshold Inspiratory Muscle Training (TIMT) on the weaning period of mechanically ventilated patients.

Background: Prolonged Mechanical ventilation (MV) of ICU patients is associated with high health care costs and respiratory muscle weakness which also has been suggested as a possible cause of delayed weaning from MV. Hence, TIMT may be seen as a possible accelerator for successful weaning.

Study Design: Experimental and comparative design.

Methods: Total 30 subjects were selected on the basis of inclusion criteria and divided randomly with 15 subjects in each group.

To the Group-A Conventional Physiotherapy was given whereas in the Group-B TIMT was also added. The Maximal Inspiratory Pressure (MIP) was measured before commencement of the treatment and post-extubation.

Result: The data was analyzed using unpaired 't' test. In Group-B (TIMT), MIP mean increased to -43.87 ± 8.01 cm H_2O (post extubation) from pre-treatment value of -29.29 ± 3.61 cm H_2O, as compared to Group-A's values of -35.68 ± 4.49 cm H_2O (post extubation) from -28.77 ± 2.93 cm H_2O (pre-treatment). Also the weaning period was reduced more significantly in Group-B (mean duration of 4.27 ± 1.49 days) than the Group-A (mean duration of 6.27±1.71 days).

Conclusion: The results of the study indicate that TIMT along with conventional physiotherapy produces more significant changes in MIP and weaning period of patients receiving mechanical ventilation as compared to conventional physiotherapy alone.

KEYWORDS: Mechanical ventilation (MV), Threshold Inspiratory Muscle Training (TIMT), Conventional physiotherapy, Maximal Inspiratory Pressure (MIP), Weaning period.

Address for correspondence: Dr. Akansha Dixit, MPT (Cardiothoracic) Assistant Professor, People's College of Paramedical Sciences & Research Centre, Bhopal. India. Contact No.: +91-7898491418
Email: drakansha@gmail.com

Access this Article online

Quick Response code

International Journal of Physiotherapy and Research
ISSN 2321- 1822
www.ijmhr.org/ijpr.html

Received: 21-01-2014 Accepted: 13-02-2014
Peer Review: 21-01-2014 Published: 11-04-2014

INTRODUCTION

Breathing is one of the fundamental bases of human life, necessary for the survival and is accomplished by the intricate mechanism of respiratory system. Respiratory failure is the inability to maintain either the normal delivery of O_2 to the tissues or the normal removal of CO_2 from the tissues. [1]

MV is the defining event of ICU management. It is the advanced respiratory support used for patients under respiratory failure[2] Once the triggering cause of acute respiratory failure is stabilized, patients are weaned from MV, which is followed by extubation. [3] Weaning is the gradual removal of MV to re-establish spontaneous breathing & involves the patient breathing spontaneously for increasing periods of the day and graduation to partial-support modes and then non-invasive modes of ventilatory support.

While being necessary for survival of respiratory failure patients, MV do come with multitude of complications and risks associated with prolonged unnecessary mechanical ventilation, including reduced inspiratory muscle strength, ventilator induced lung injury, ventilator associated pneumonia, increased length of ICU and hospital stay, and increased cost of care delivery.[4] Various studies done on mechanically-ventilated humans documented approximately 55% atrophy in human diaphragm following 19 to 56 hours of controlled MV.[5,6] The resultant degree of respiratory muscle weakness is found to be related to the duration of MV[7] and has been suggested as a possible cause of delayed weaning from MV.[8]

Weaning from MV is thus the most essential element in the care of critically ill intubated patients. Hence, many studies have been carried out to find solution for early weaning and discontinuation from MV.

Maximal Inspiratory Pressure (MIP) is the index used to measure inspiratory muscle strength[9]. The most observed symptom due to respiratory muscle weakness is dyspnoea[10] and it interferes or delays weaning and increase patient's dependence on the MV. Hence, few researchers suggest the need of inspiratory muscle training (IMT) for successful weaning.[11]

There are numerous methods of giving IMT; the method used in present study is threshold inspiratory muscle training (TIMT) by a commercially available device. The benefit of threshold inspiratory muscle trainer lies in its ability of making patient to generate required negative training pressure independent of their breathing flow-rates and patterns. Hence, TIMT helps in objectively increasing training pressures for successful strengthening of inspiratory muscles.

The purpose of this study is to check the effectiveness of conventional physiotherapy and TIMT on the weaning period of mechanically ventilated patients. By this we can modulate our treatment protocols so as to have early weaning from mechanical ventilation, thereby reducing total cost of stay in ICU and getting better functional out comes for patients in a lesser time.

METHODOLOGY

The study was experimental design, conducted in the GICU of Sri Aurobindo Institute of MedicalSciences, Indore. 30 subjects who fulfilled the inclusion and exclusion criteria were taken and equally divided into two groups by simple random sampling method.

Inclusion Criteria:

1. Patients who have been on MV for at least 24 hours and start to wean from medical order
2. Age- above 18 years.
3. Gender- both.
4. Ventilator mode: SIMV, CPAP, SIMV+PS and PSV.
5. Good consciousness, cooperation and can sit in 60^0 propped-up position for at least 15 minutes.
6. Normal ABG

   PaO_2 > 60mm Hg on FiO_2 < 0.5 or

   SaO_2 >90%

   $PaCO_2$<50 mm Hg

   pH 7.35-7.45
7. Cardiovascular stability
8. Maximal Inspiratory Pressure: >-35cm H_2O

Exclusion criteria:

1. Persistent hemodynamic instability.
2. Severe breathlessness at rest, when spontaneously breathing.
3. Life threatening arrhythmias.
4. Any progressive neuromuscular disease that would interfere with responding to inspiratory muscle training.
5. Spinal cord injury above T8.
6. Skeletal pathology (scoliosis, flail chest, spinal instrumentation) that would seriously impair the movement of the chest wall and ribs.
7. Patients on heavy sedation and respiratory muscle paralysis.

Procedure:

An informed consent was taken from each subject prior to participation. Patients were evaluated on day 1 of spontaneous ventilation (weaning) before commencement of treatment and post-extubation using patient assessment chart and by MIP measuring device (digital manometer with custom adaptor for endotracheal tube).

MIP measurements were repeated three times with a two minute rest period on MV support

between each attempt; with the most negative value being recorded.

Group-A Treatment

Conventional Physiotherapy including:

- Positioning
- Diaphragmatic retraining and recruitment strategies
- Segmental expansion exercises
- Thoracic expansion exercises
- Percussion and vibrations
- Postural drainage
- Coughing and huffing
- Active and passive ranges of motion

Frequency- twice a day; 7 days a week till extubation.

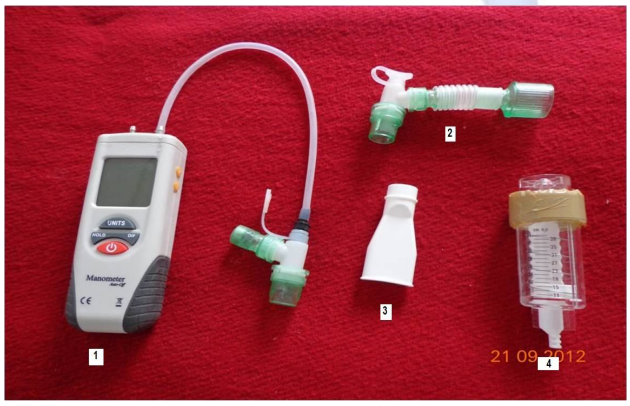
Group-B Treatment

Conventional Physiotherapy with Threshold Inspiratory Muscle Training:

- Patient position- 45 degrees propped up on bed.
- The device was adapted and connected to patient's endotracheal tube. Patients were instructed to breathe until an auditory cue comes from the device.
- 5 sets of 6 breath repetitions.
- 1 minute rest between each set; on MV support.
- Training threshold pressure setting was initially kept at 30% of MIP and then adjusted to an exertion rating of 6-8 on scale of maximal 10 RPE.
- RPE scale was measured following each set
- Threshold training pressure was increased daily by 10% of patient's MIP.
- Conventional physiotherapy was continued (as mentioned in control group) in another session to prevent fatigue.

Frequency: twice a day; 7 days a week till extubation.

Fig. 1 Digital Manometer and Threshold Inspiratory Muscle Trainer.



1. Digital Manometer
2. Attachment used for Endotracheal Tube
3. Mouth Piece of Trainer
4. Threshold Inspiratory Muscle Trainer

STATISTICAL ANALYSIS & RESULTS:

The dependent variables were MIP & duration of weaning period. An **unpaired t-test** was used to examine changes in the dependent variables. The significance level set for this study was **p<0.05**.

In Group-B (TIMT), MIP mean increased to -43.87 ± 8.01 cm H_2O (post extubation) from pre-treatment value of -29.29 ± 3.61 cm H_2O, as compared to Group-A's values of -35.68 ± 4.49 cm H_2O (post extubation) from -28.77 ± 2.93 cm H_2O (pre-treatment). Also the weaning period was reduced more significantly in Group-B (mean duration of 4.27 ± 1.49 days) than the Group-A (mean duration of 6.27±1.71 days).

The statistical analysis of the study shows that MIP was improved in both study groups but was improved more significantly in the TIMT group than the conventional Physiotherapy group.

Table.1. Pre and Post treatment comparison of both the groups in terms of Inspiratory Muscle Strength (MIP in cm H_2O)

Parameters	Pre		Post	
	Group A	Group B	Group A	Group B
Mean ± SD	-28.77±2.93	-29.29±3.61	-35.68±4.48	-43.87±8.01
p value	0.3359		0.0009	
t value	0.214		1.7269	

Fig.2. Mean of MIP for both study groups.

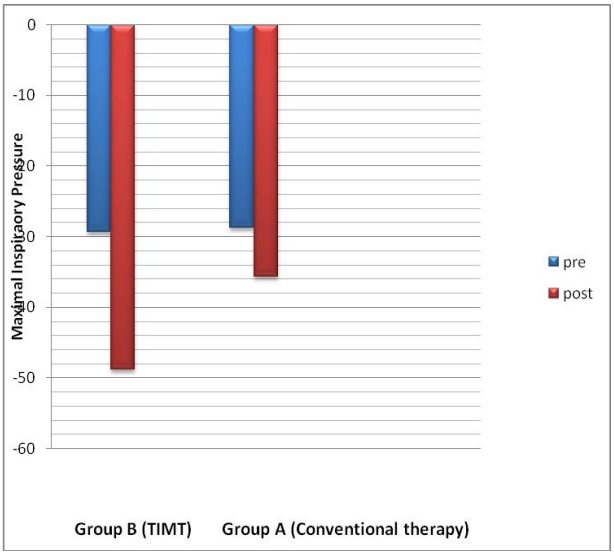
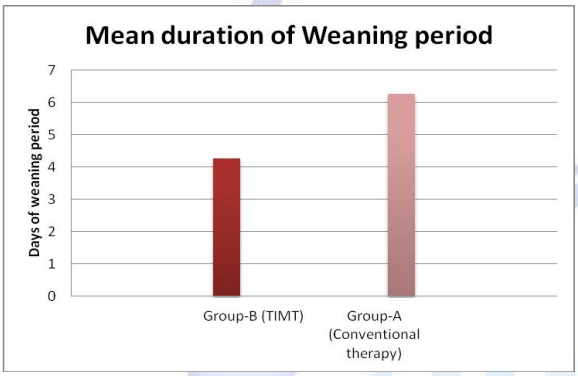


Table.2. Analysis of weaning period in both groups.

Para meters	Group B (TIMT)	Group A (Conventional therapy)
Mean	4.27	6.27
Standard Deviation	1.49	1.71
't' Value	1.7094	
'p' Value	0.0009	

Fig.3. Mean of duration of days of weaning period in both groups.



DISCUSSION

MIP has been demonstrated to be an effective indicator of inspiratory muscle strength (Tobin M et al).[12] A study done by Sahn and Lakshminarain describes MIP values of 30 cmH_2O as efficient individual predictor of weaning.

The results of this study show that the MIP improved more significantly in the TIMT group than the conventional Physiotherapy group and also the weaning period and hence total mechanical ventilation period was shorter in TIMT group than the conventional Physiotherapy group. This is in accordance with the findings of previous studies done by Cader et al[13] and Sprague & Hopkins.[14] The data analyzed in a systematic review done by Lisa Moodie et al[15] confirms that inspiratory muscle training improves MIP significantly, but it remains unclear whether these benefits translate to weaning success and a shorter duration of MV.

Traditionally physiotherapy has been associated with routine medical and nursing care in ICU management of mechanically ventilated patients. But its role is still not clearly identified and holds varying level of importance with different physicians.

Mehtap Malkoc et al[16] in their study found that use of chest physiotherapy can result in reducing the period of MV required in ICU. The decrease in duration of MV on administration of chest physiotherapy is supposed to be due to enhanced airway clearance, prevention of atelectasis and reduction of ventilation-perfusion mismatching.

The rationale behind using the IMT in the mechanically ventilated patients is to prevent and correct inspiratory muscle weakness and hence improve weaning outcome. Its use in mechanically ventilated patients is of short duration and the resultant inspiratory muscle strength gain is believed to be due to neural adaptation[17] rather than due to muscle hypertrophy, leading to a more efficient motor program.[18]

Threshold inspiratory muscle trainer imposes a threshold or critical opening pressure that must be overcome prior to inspiratory flow commencing (Flynn et al[19]). During the task, inspiratory muscles initially perform an isometric contraction until the threshold valve opens to allow inspiratory flow, after which the contraction becomes isotonic in nature; hence allow both strength and endurance training. In contrast to resistive loading, threshold loading has the advantage of inspiratory pressure being largely independent of flow rate (Nickerson and Keens[20]) such that manipulations in breathing pattern to change inspiratory flow rates will not alter the inspiratory load imposed by the device. The poppet valve at the end of the device will not open and allow inspiration unless the patient generates the designated negative pressure. The device also offers an auditory feedback on successful breath completion, caused by oscillatory motion of spring.

Inspiratory muscles being skeletal muscles respond to the training in terms of the principles of overload, specificity, and reversibility[21]. Hence, training causes improved performance of these muscles and decreased fatigue. In our training it was evident by increased training threshold pressures in consecutive sessions. There were no adverse effects seen during TIMT in our study and all vital signs remained stable throughout. The chances of re-intubation were also nil in both TIMT and conventional physiotherapy groups.

Limitations of the study:

- The sample size of the study was small.
- Study group was heterogeneous with patients having respiratory failure due to various conditions.
- During study several patients took Leave Against Medical Advice, hence there was a loss to follow-up.

CONCLUSION

The present study hence concludes that threshold inspiratory muscle training along with conventional physiotherapy produces significant changes in MIP and weaning period of patients receiving mechanical ventilation as compared to conventional physiotherapy alone.

Thus, threshold inspiratory muscle training can be incorporated in the routine management of mechanically ventilated patients to facilitate their early weaning and recovery.

Acknowledgement: None

Conflicts of interest: None

Source of Funding: Self-funding

REFERENCES

1. Greene KE, Peters JI: Pathophysiology of acute respiratory failure. Clin Chest Med 1994;15:1-12.
2. Esteban A, Anzueto A, Alia I, Gordo F, Apezteguía C, Pálizas F et al. How is mechanical ventilation employed in the intensive care unit? An international utilization review. Am J Respir Crit Care Med 2000;161:1450-8.
3. Stauffer JL. Complications of translaryngeal intubation. In: Tobin M, editor. Principles & practice of mechanical ventilation, 1st ed. New York: McGraw-Hill;1994.p.711-47.
4. Chang AT, Boots RJ, Hennderson R, Paratz JD, Hodges PW. Case report: Inspiratory muscle training in chronic critically ill patients- a report of 2 cases. Physiother Res Int 2005;10(4):222-6.
5. Levine S, Nguyen T, Taylor N, Friscia ME, Budak MT, Rothenberg P et al. Rapid disuse atrophy of diaphragm fibers in mechanically ventilated humans. N Engl J Med 2008;358:1327-35.
6. Powers SK, Shanely RA, Coombes JS, Koesterer TJ, McKenzie M, Van Gammeren D et al. Mechanical ventilation results in progressive contractile dysfunction in the diaphragm. J Appl Physiol 2002;92:1851-8.
7. Sahn SA, Lakshminarayan S, Petty TL. Weaning From Mechanical Ventilation.JAMA 1976;235(20):2208-12.
8. Karpel JP, Aldrich TK. Respiratory failure and mechanical ventilation: pathophysiology and methods of promoting weaning. Lung 1986;164:309.
9. Green M, Road J, Sieck GC, Similowski T. Tests of respiratory muscle strength. Am J Respir Crit Care Med 2002;166(4):528-47.
10. Ntoumenopoulous G, Presneill J, McElholum M, Cade J. Chest physiotherapy for the prevention of ventilator-associated pneumonia. Intens Care Med 2002;28(7):850-6.
11. Chang AT, Boots RJ, Brown MG, Paratz J, Hodges PW. Reduced inspiratory muscle endurance following successful weaning from prolong mechanical ventilation. Chest 2005;128:553-9.
12. Tobin M: Medical progress: advances in mechanical ventilation, N Engl J Med 2001;344:1986-96.
13. Cader SA, Vale RG, Castro JC, Bacelar SC, Biehl C, Gomes MC et al. Inspiratory muscle training improves maximal inspiratory pressure and may assist weaning in older intubated patients: a randomized trial. Journal of Physiotherapy 2005;56(3):171-7.
14. Sprague SS, Hopkins PD. Use of Inspiratory Strength training to wean six patients who were ventilator-dependent. Phys Ther 2003;83(2):171-81.
15. Moodie L, Reeve J, Elkins M. Inspiratory muscle training increases inspiratory muscle strength in patients weaning from mechanical ventilation: a systematic review. J Physiother 2011;57:213-21.
16. Malkoc M, Karadibak D, Yildirim Y. The effect of physiotherapy on ventilator dependency and length of stay in an intensive care unit. Int J Rehabil Res 2009;32(1):85-8.
17. Scheinhorn DJ, Chao DC, Stearn-Hassenpflug M. Approach to patients with long-term weaning failure. Respir Care Clin N Am 2000;6(3):437-61.
18. Yue G, Cole KJ. Strength increases from the motor program: Comparison of training with maximal voluntary and imagined muscle contraction. J Neurophysiol 1992;67(5):1114-23.
19. Flynn M, Barter C, Nosworthy J, Pretto J, Rochford P, Pierce R. Threshold pressure training, breathing pattern, and exercise performance in chronic airflow obstruction. Chest 1989;95:535-40.
20. Nickerson BG, Keens TG. Measuring ventilatory muscle endurance in humans as sustainable inspiratory pressure. J Appl Physiol 1982; 52(3): 768–72.
21. McConnell AK, Romer LM, Weiner P. Inspiratory muscle training in obstructive lung disease: how to implement and what to expect. Breathe 2005;2:39-50.

How to cite this article:

Akansha Dixit, Shashwat Prakash. EFFECTS OF THRESHOLD INSPIRATORY MUSCLE TRAINING VERSUS CONVENTIONAL PHYSIOTHERAPY ON THE WEANING PERIOD OF MECHANICALLY VENTILATED PATIENTS: A COMPARATIVE STUDY. Int J Physiother Res 2014;2(2):424-28.