Journal of Pharmaceutical Research International

33(60B): 1474-1479, 2021; Article no.JPRI.77000
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Effect of Threshold Inspiratory Muscle Training Device on Inspiratory Muscle Strength in Upper Abdominal Surgery Patient: A Case Report

Neha Arya [a] and Vishnu Vardhan [b*†]

[a] Cardio Respiratory Physiotherapy Department, Ravi Nair Physiotherapy College, Datta Meghe Institute of Medical Sciences, Wardha, Sawangi, Maharashtra, Pin- 442001, India.
[b] Datta Meghe Institute of Medical Sciences, Ravi Nair Physiotherapy College, Wardha, Sawangi, Maharashtra, Pin- 442001, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i60B34769

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/77000

Case Study

Received 15 October 2021
Accepted 16 December 2021
Published 23 December 2021

ABSTRACT

Background: Surgical care plays a crucial role in the treatment of a wide spectrum of ailments, as well as in the relief of human suffering. Gastrectomy, pancreatectomy, hepatic resection, cholecystectomy, and splenectomy were among the upper abdominal surgeries performed. The maximum inspiratory pressure (PImax) is an important metric for assessing the strength of the inspiratory muscles. Respiratory muscle training device increase the capacity for activity, strength, and endurance of respiratory muscles. Pressure Threshold IMT devices are typically spring-loaded handheld devices that is obstructed at various intensities. As a result, the current study aims to show the effect of Inspiratory Muscle Training in patients undergoing Upper Abdominal Surgery. Materials and Methods: On Day 1, maximal inspiratory pressure (PI Max) was measured by a Hand held pressure manometer before intervention. Threshold Inspiratory Muscle Training device was administered on Day 1, and continued for one week two sessions per day. Post treatment maximum inspiratory pressure. (PImax) was measured. Each session lasted 15 minutes, including breaks.
Conclusion: The study concluded that Threshold inspiratory muscle training device shows improvement in Maximal Inspiratory Pressure in upper abdominal surgery patient.

[†]Professor
**Corresponding author: E-mail: vishnudiwakarpt@gmail.com;*

Keywords: Threshold Inspiratory Muscle Training (IMT); Maximal Inspiratory Pressure (PI Max); Upper abdominal surgeries; Endurance; Inspiratory muscle strength.

1. INTRODUCTION

Abdominal surgery refers to any operation that involves an incision into the abdomen. In upper abdominal surgeries the incision is made in the midline extending from xiphoid process of the sternum and ending immediately above the umbilicus. Postoperative pulmonary complications (PPCs) following abdominal surgeries were first described by Pasteur in 1908 that remain an important cause of postoperative morbidity, patient discomfort, increase in length of hospital stay(LOS), increased use of hospital resources and overall hospital costs [1,2,3]. PPCs are defined as any pulmonary abnormality that occurs in the post-operative period and causes identifiable diseases or dysfunction that is clinically significant and has a negative impact on the clinical course. Once occur PPCs can prolong hospital stay for 1-2 weeks [4]. These PPCs include a telectasis, pneumonia, exacerbations of chronic pulmonary disorders, and respiratory failure requiring mechanical ventilation [5,6]. Upper abdominal procedures are associated with a 20-40% incidence of PPCs while lower abdominal surgery carries an incidence of 2-5% [5,6,7].

After abdominal surgery, because of direct or indirect trauma to the diaphragm, results in the decrease in maximum static respiratory pressures (MRPs), name lythe maximum inspiratory pressure (PImax) and maximum expiratory pressure (PEmax), which reflect the strength of the respiratory muscles [8,9]. Various kinds of physiotherapy treatments are given in the post operative period to avoid the PPcs, such as Deep Breathing exercises, thoracic expansion exercises, early postoperative mobilization, incentive spirometry. Respiratory muscle training device improve the capacity for strength, endurance, and exercise of respiratory muscles. Device is typically handheld devices with a spring load that is obstructed at varying intensities. As a result, the purpose of this study is to evaluate the Threshold Inspiratory Muscle Training's Effect in patients undergoing Upper Abdominal Surgery.

2. ABOUT EQUIPMENT

1. Hand-held pressure manometer (PImax) - The most extensively used measure of respiratory muscle strength is the Maximal Inspiratory Pressure (MIP). Residual Volume is used to calculate MIP (RV). It is performed with low-cost, portable equipment; it is simple and quick to complete; and it is non-toxic.
2. Threshold inspiratory muscle training device - The inspiratory muscles are strengthened and endurance is improved with Inspiratory Muscle Training (IMT). Pressure resistive IMT devices are typically handheld devices with a spring load that is obstructed by varying intensities. The resistive load slider can change the intensity of these lights (varying from low to high). This device has a valve at the end that is closed by the positive pressure of a spring and can be adjusted in resistance by 2 cm H2O increments. The Threshold IMT includes a one-way spring-loaded valve that closes during inspiration and requires participants to inhale deeply enough to open the valve and allow air to flow through. For inspiratory muscle training, this device maintains constant pressure [10].

3. PATIENT INFORMATION

Patient is 42-year male with complains of abdominal pain associated with fever, vomiting, loss of appetite, tenderness on right hypochondria. With the following complaints, he visited a local practitioner where primary assessment was done and USG was suggested. Patient reported a history of tobacco chewing from past 20 years. He was also diagnosed for diabetes mellitus recently. USG report findings suggested large hepatic abscess. Patient was advised for surgery and he came to our hospital AVBRH for further medical management.

On admission to the hospital, as a result of deteriorating general condition of the patient emergency exploratory laparotomy was planned on the next day. The surgery was planned under general anaesthesia. Exploratory laparotomy for drainage of liver abscess was performed on 16/10/21, and patient was shifted to ICU.

Fig. 1. Hand HeldPressure Manometer device (PIMax)

Fig. 2. Threshold IMT device

4. CLINICAL FINDINGS

On assessment during post-operative state.

Patient was drowsy and disoriented. On inspection, inter costal drains were present on 1st day. pallor was absent.

4.1 CVS Examination

Heart rate was 114 beats/min. Blood pressure was 110/60 mm Hg.

4.2 Respiratory Examination

Respiratory rate was 14 breaths/min, with regular rhythm. patient had abdomino-thoracic pattern. Auscultation revealed basal crackles and decreased entry in lower lobe. On chest expansion on axillary level was found to be decreased by 1cm, on xiphoid level it was decreased by 2cm.

PIMax levels revealed, patient had inspiratory muscle weakness due to exploratory laparotomy (upper abdominal surgery).

Pain history: - Patient had history of pain at site of incision. On visual analog survey (VAS) scale, grade 3 at rest and grade 4 on activity. Pain was aggravated on limb mobility and relived during rest.

5. DIAGNOSTIC FINDINGS

The patient had undergone investigations of blood analysis, liver function and kidney function tests. Blood analysis indicates that there is an indication of increase in total leukocyte count. Liver function test reveled increase in total serum bilirubin, SGOT,SGPT levels which clearly indicates liver infection.

6. PHYSIOTHERAPY INTERVENTION

The patient's PIMax (Maximum Inspiratory Pressure) was measured with a Hand Held Pressure Manometer. The Threshold inspiratory muscle training device was used to provide inspiratory muscle training.

For measuring endurance, a 2-minute walk test was performed to measure the functional capacity. Distance covered by patient was measured.

The goal is to improve the strength of inspiratory muscle and improve the endurance of the patient.

Before the intervention, the patient was given information and benefits about the threshold inspiratory muscle training equipment.

On Day 1, maximal inspiratory pressure (PI Max) was measured by a Hand held pressure manometer before intervention. Threshold Inspiratory Muscle Training device was administered on Day 1, and continued for one

week two sessions per day, Each session lasted 15 minutes, including breaks.

After one week, patient were reviewed using the same outcome measure to determine the effects of the intervention on training.

7. PROCEDURE

7.1 2-minute Walk Test

A 50-foot (15.2-meter) out-and-back course was used for the 2MWT.

The patient was told to walk as quickly as possible until they were told to stop. he was also told not to be concerned if he needed to slow down or take a break, but that if he did, he should resume walking as soon as they were ready. "You're doing great; you have 1 minute remaining," he was told after 1 minute had passed. At 2 minutes, the patient came to a halt and the distance he had covered was recorded. During the test, the patient did not require the assistance of a person or a gait aid. The distance travelled by the patient prior to treatment was 65 metres .patient had reduced functional capacity. Test was also performed after the intervention of one week to evaluate improvement [11].

7.2 Threshold Inspiratory Muscle Training (IMT)

Prior to the treatment, patient and his caregivers were educated about the treatment protocol and the importance of physiotherapy and early rehabilitation a proper informed consent was taken from the patient.

The patient was instructed to close their lips over the mouthpiece and inhale deeply, then continue to inhale and exhale without taking the device out of their mouth. Typically, the participants begin training with a light load, about one-third of their maximum capacity the PImax and gradually increases the tension by adjusting a screw until the desired result is achieved. The training load is increased to 30% of the current PImax.

The intervention was administered twice a day for one week.

8. RESULTS AND DISCUSSION

Post-operative drugs such as anaesthetics and analgesic also affect upper airway and accessory muscle function, increasing the risk of Post-operative Pulmonary Complications (PPC) [12]. Respiratory muscle training devices increase the strength, endurance and ability for exercise of respiratory muscles. IMT devices with Pressure Threshold are typically spring-loaded handheld devices that is obstructed at varying intensities. As a result, the goal of this research is to see how Threshold Inspiratory Patients undergoing Upper Abdominal Surgery are affected by muscle training. In addition, post-operative pain can limit respiratory movements, which can also be impaired by reflex inhibition of respiratory muscle activity, especially the diaphragm [13].

Pre- and post-operative inspiratory muscle training was carried out. Pre-operative IMT has been undertaken prior to coronary artery by-pass graft surgery (CABG), abdominal surgery, esophagectomy, open bariatric surgery [4,14]. Post-operative treatment has followed open bariatric surgery and cardiac surgery, whereas pre- and post-operative treatment has been undertaken in patients undergoing CABG surgery and Pneumonectomy [15].

Individuals must generate enough negative pressure to overcome a threshold load and therefore start inspiration in order to perform inspiratory pressure threshold loading. Threshold loading allows for variable loading at a definable intensity by supplying flow independent resistance to inspiration. This form of loading was accomplished with the use of a spring-loaded poppet valve and a continual negative pressure system. Maximal force generation, maximal velocity, maximal rate of shortening, maximal power output, and inspiratory muscle endurance are all improved by training with inspiratory pressure threshold loading.

Table 1. Pre and post treatment analysis

Outcome measures	Pre-treatment	Post- treatment
PIMax	50 mm Hg	60 mm Hg
VAS	8	2
2- minute walk test distance	65 meters	90 meters

Among the skeletal muscles, the breathing muscles are distinctive. in that they are active all of the time. There are three training principles that are well established for skeletal muscles namely 'overload', 'specificity ' and 'reversibility' [16].

Romer & McConnell studied on specificity and reversibility of inspiratory muscle training which stated that respiratory muscles respond to these principles in the same manner as of the muscles [17].

The patient underwent exploratory laparotomy in this case (upper abdominal surgery). A post-operative clinical assessment was performed, and PIMax levels revealed reduced inspiratory capacity or inspiratory muscle weakness. A 2-minute walk test was performed to assess endurance, which revealed decreased functional capacity. Following a clinical evaluation, a plan was developed to improve the strength and endurance of the respiratory muscles. As a result, an intervention for a device known as the threshold inspiratory muscle training device was planned. The intervention lasted one week. After a week of training, the patient's PIMax levels improved,2- minute walk test was also performed post-treatment the total distance covered by patient was increased and there was an overall improvement in strength and endurance.

9. CONCLUSION

In the present study, the maximal inspiratory pressure (PIMax) was improved in upper abdominal surgery patients after one week of Threshold inspiratory muscle training. Inspiratory Muscle Training using the IMT threshold device can be added to the physiotherapy treatment regimen of patients following upper abdominal procedures to prevent postoperative pulmonary problems.

CONSENT

A proper informed consent was taken from the patient.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Celli B. Respiratory muscle strength after upper abdominal surgery. Thorax. 1993 Jul 1;48(7):683-4.
2. Siafakas NM, Mitrouskal, Bouros D, Georgopoulos D. Surgery and the respiratory muscles. Thorax. 1999 May 1;54(5):458-65.
3. Wu A, Drummond GB. Respiratory muscle activity and respiratory obstruction after abdominal anticipation and prevention. BMJ. 1968Feb17; 1(5589):401-6.
4. Hulzebos EH, van Meeteren NL, van den Buijs BJ, de Bie RA, De La Riviere AB, Helders PJ. Feasibility of preoperative inspiratory muscle training in patients undergoing coronary artery bypass surgery with a high risk of postoperative pulmonary complications: a randomized controlled pilot study. Clinical Rehabilitation. 2006 Nov;20(11):949-59.
5. Sršen D, Perko Z, Pogorelić Z, Mimica Ž. Effect of surgical incision on pain and respiratory function after abdominal surgery: a randomized clinicaltrial. Hepato-gastroenterology. 2007Jan1;54(80):2216-20.
6. Ford GT, Whitelaw WA, Rosenal TW, Cruse PJ, Guenter CA. Diaphragm function after upper abdominal surgery in humans 1–3. American Review of Respiratory Disease. 1983Apr;127(4):431-6.
7. Das Arijit Kumar. Effect of routine physiotherapy vs early mobilization in preventing postoperative pulmonary complications in subjects with specific risk factors: A randomized conventional led Study**.** Physiotherapy and Occupational Therapy Journal; Sept 2010,3
8. Özyürek S, Malkoç M, Günerli A, Koca U, Egeli T. Inpatient inspiratory muscle training after upper abdominal surgery. European Respiratory Journal. 2014 Sep 1;44(Suppl 58):P3663.
9. Casali CC, Pereira AP, Martinez JA, deSouza HC, Gastaldi AC. Effects of inspiratory muscletraining on muscular and pulmonary function after bariatric

surgery in obese patients. Obesity Surgery. 2011Sep1;21(9):1389-94.
10. Canet J, Mazo V. Postoperative pulmonary complications. Minerva Anestesiol. 2010;76:138-43.
11. Sharma RR, Axelsson H, Oberg A, Jansson E, Clergue F, Johansson G, Reiz S. Diaphragmatic activity after laparoscopic cholecystectomy. Anesthesiology: The Journal of the American Society of Anesthesiologists. 1999 Aug 1; 91(2):406-13.
12. Carolyn Kisner, Lynn Allen Colby. Therapeutic Exercise. Edition- 5, chapter-25,page no- 85.
13. Brooks D, Parsons J, Tran D, Jeng B, Gorczyca B, Newton J, Lo V, Dear C, Silaj E, Hawn T. The two-minute walk test as a measure of functional capacity in cardiac surgery patients. Arch Phys Med Rehabil. 2004;85:1525–30.
14. Casali CC, Pereira AP, Martinez JA, de Souza HC, Gastaldi AC. Effects of inspiratory muscle training on muscular and pulmonary function after bariatric surgery in obese patients. Obesity Surgery. 2011 Sep 1;21(9):1389-94.
15. Weiner P, Man A, Weiner M, Rabner M, Waizman J, Magadle R, Zamir D, Greiff Y. The effect of incentive spirometry and inspiratory muscle training on pulmonary function after lung resection. The Journal of Thoracic and Cardiovascular Surgery. 1997 Mar 1;113(3):552-7.
16. Pardy RL, Leith DE. Ventilatory muscle training. In: Roussos C, Macklem PT, eds. The Thorax. New York, Marcel Dekker, Inc., 1995;1353–1371.
17. McConnell AK. Respiratory muscle training: Theory and practice. Edinburgh, Churchill Livingstone/ Elsevier; 2013.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/77000