

Case study

Effect of threshold inspiratory muscle training device on inspiratory muscle strength in upper abdominal surgery patient: A case report

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 (PI_{max}) 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. (PI_{max}) 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.

KEY WORDS: Threshold Inspiratory muscle training (IMT), Maximal inspiratory pressure (PI Max), Upper abdominal surgeries, Endurance, Inspiratory muscle strength.

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. Post operative 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 weeks¹¹. These PPCs include atelectasis, pneumonia, exacerbations of chronic pulmonary disorders, and respiratory failure requiring mechanical

ventilation (4,5). Upper abdominal procedures are associated with a 20-40% incidence of PPCs while lower abdominal surgery carries an incidence of 2-5% (4,5,6).

After abdominal surgery, because of direct or indirect trauma to the diaphragm, results in the decrease in maximum static respiratory pressures (MRPs), namely the maximum inspiratory pressure (PI_{max}) and maximum expiratory pressure (PE_{max}), which reflect the strength of the respiratory muscles (7,8). Various kinds of physiotherapy treatments are given in the postoperative 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.

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.

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.

CVS examination:- Heart rate was 114 beats/min. Blood pressure was 110/60 mm Hg.

Respiratory examination :- Respiratory rate was 14 breaths/min ,with regular rythm. 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

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

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 revealed increase in total serum bilirubin, SGOT, SGPT levels which clearly indicates liver infection

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.

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

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

The intervention was administered twice a day for one week. After one week, participants were reviewed using the same outcome measure to determine the effects of the intervention on training.

RESULT

Table 1- PRE – POST COMPARISON OF PIMAX

PIMax	
PRE INTERVENTION	POST INTERVENTION
50 mm Hg	60 mm Hg

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) (9). 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(10).

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, oesophagectomy, open bariatric surgery.(11,12) 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 (13).

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.

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' (14).

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 other muscles (15).

CONCLUSION

In the present study, the maximal inspiratory pressure (PI Max) 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.

REFERENCES

1. Celli B. Respiratory muscle strength after upper abdominal surgery. *Thorax*. 1993 Jul 1;48(7):683-4
2. Siafakas NM, Mitrouska I, 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 incision and prevention. *BMJ*. 1968 Feb 17;1(5589):401-6.
4. Sršen D, Perko Z, Pogorelič Z, Mimica Ž. Effect of surgical incision on pain and respiratory function after abdominal surgery: a randomized clinical trial. *Hepato-gastroenterology*. 2007 Jan 1;54(80):2216-20.
5. 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*. 1983 Apr;127(4):431-6.
6. Das arijit kumar, Effect of Routine Physiotherapy Vs early mobilization in preventing postoperative pulmonary complications in subjects with specific risk factors: A randomized controlled Study. *Physiotherapy and Occupational Therapy Journal*, Sept 2010,3
7. 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.
8. 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.
9. Canet J, Mazo V. Postoperative pulmonary complications. *Minerva Anestesiol* 2010; 76: 138-43.
10. 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.
11. Hulzebos EH, van Meeteren NL, van den Buijs BJ, de Bie RA, De La Riviere AB, Helder 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.
12. 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.

13. 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.

14. Pardy RL, Leith DE. Ventilatory muscle training. In: Roussos C, Macklem PT, eds. *The Thorax*. New York, Marcel Dekker, Inc., 1995; pp. 1353–1371.

15. McConnell AK. *Respiratory Muscle Training: Theory and Practice*. Edinburgh, Churchill Livingstone/ Elsevier, 2013.

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