



## A STUDY ON EFFECT OF INSPIRATORY MUSCLE TRAINING IN UPPER ABDOMINAL SURGERY PATIENTS

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### ABSTRACT

To investigate the effect of the Inspiratory Muscle Training in improving the maximum inspiratory pressure (P<sub>I</sub>max) in upper abdominal surgery patients, 30 patients were selected by convenient sampling method, divided into two groups. P<sub>I</sub>max of both the groups was measured thrice throughout the treatment protocol. Experimental Group received treatment with IMT threshold device, followed by thoracic expansion exercises emphasizing on the basal expansion exercises. Conventional Group received only the thoracic expansion exercises. IMT device increases the inspiratory muscle strength post operatively. Comparing the values of P<sub>I</sub>max in both the groups. IMT given by threshold device associated with the thoracic expansion exercises will improve the P<sub>I</sub>max in upper abdominal surgery patients.

**KEYWORDS:** *Post operative pulmonary complications, Maximum inspiratory pressure, Maximum expiratory pressure, Threshold device, Thoracic expansion exercises.*



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## 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<sup>12,3</sup> 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<sup>4,6,7</sup>. PPCs have been defined as any pulmonary abnormality that occurs in the post operative period and produces identifiable diseases or dysfunction which is clinically significant and adversely affects the clinical course. Once occur PPCs can prolong hospital stay for 1-2 weeks<sup>11</sup>. These PPCs include atelectasis, pneumonia, exacerbations of chronic pulmonary disorders, and respiratory failure requiring mechanical ventilation<sup>7, 8, 9, 10,11</sup>. The incidence of complications is inversely related to the distance of the surgical incision from the diaphragm. Thus, the complication rate is significantly higher for thoracic and upper abdominal surgery than for lower abdominal procedures<sup>4,7,8,11</sup>. That is the reason why upper abdominal procedures are associated with a 20-40% incidence of PPCs while lower abdominal surgery carries an incidence of 2-5%<sup>1,2,3,9,10,11</sup>. Abdominal surgeries influences respiratory pattern but effects on respiratory muscles are not well described measurements of respiratory movements<sup>3</sup>. After upper abdominal surgeries all patients have decreased lung volumes and adopt a rapid shallow pattern of breathing<sup>[10]</sup> this may happen because, surgical procedures can affect the respiratory muscles by a number of pathophysiological mechanisms including thoracoabdominal mechanics, reflexes, neuromechanical coupling, and loss of muscular integrity<sup>3,4</sup>. Although the respiratory muscles specially the diaphragm is the vital of life, abdominal muscle contribute 20% of the work of breathing<sup>2, 3, 4</sup>. 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<sub>max</sub>) and maximum expiratory pressure (PE<sub>max</sub>), which reflect the strength of the respiratory muscles<sup>11,19,21</sup>. This decrease is sustained for 48 hours after surgery and may persist for a week, gradually returning to normal PI<sub>max</sub>. PI<sub>max</sub> is calculated by the negative pressure manometer<sup>26</sup>. 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, spirometry, inspiratory muscle training (IMT)<sup>9,1</sup>. There are number of studies conducted on preoperative IMT<sup>14,15</sup>. IMT is mostly used for prehabilitation. IMT aims to increase inspiratory muscle strength and endurance by applying a resistive load to the inspiratory muscles specially diaphragm, in order to achieve a training effect. Various methods are suggested for inspiratory muscle training, these are inspiratory threshold pressure loading, isocapnic/normocapnic hyperpnoea, and inspiratory resistive flow loading<sup>12</sup>. Specific effects of inspiratory muscle training such as an increase in PI<sub>max</sub>, were

found in five, statistically valid studies in which training intensity was carefully studied<sup>14</sup>. The ability to generate inspiratory pressure can be increased by the formation of a pressure threshold. This threshold can be produced by a spring loaded valve in IMT threshold device, which increases resistance improving the respiratory function and increases the blood flow redistribution to the muscles. The increment in inspiratory muscular strength increases the lung capacity in order to offset the increased respiratory load. However, exact mechanisms of IMT are not clear, such as the mechanisms through which this kind of training improves the performance in the maximal incremental exercise, as well as the devices which result in more efficiency. Among the most commonly used devices for IMT is Threshold device<sup>12,13</sup>. Number of studies with varying quality are available in regards of the preoperative IMT showing reduced incidence of the post operative pulmonary complications. But, very few are on post operative IMT treatment. This study was conducted in patients with upper abdominal surgery to find out the answer whether postoperative inspiratory muscle training, associated with thoracic expansion exercises is as effective as, or, better than only thoracic expansion exercises.

## MATERIALS AND METHODS

Sample of 30 subjects between the age group 20-60 years, both males and females who have undergone upper abdominal surgery between 15/7/2015 to 30/12/2015 at Dr. D. Y. Patil hospital, were included in this study. Patients with any of the pulmonary condition, cardiac condition, rib fracture, were excluded. IMT threshold device for inspiratory muscle training and negative pressure manometer were used for the treatment and measurement of the outcome respectively. These patients were informed about the goals of the study and its related procedures and signed an informed consent form. The study was approved by the institution ethical committee.

### Procedure

Those subjects fulfilling the exclusion and inclusion criteria were randomly assigned to both the groups, Group 1, (IMT and thoracic expansion exercises) n=15, and Group 2 (thoracic expansion exercises) n=15. Respiratory evaluation was performed two days prior to surgery. Preoperative day two, post operative day one and post treatment PI<sub>max</sub> measurement was taken of all subjects. The subjects were instructed and trained about the equipment and procedure to avoid any learning effect during the study. For the experimental group 1, inspiratory muscle training with threshold device, using a nasal clip followed by thoracic expansion exercises were given preoperative two days, and from post operative day second to two weeks, three sets of five repetitions with two minutes rest after each set, three times a day and five days per week. On post operative day one, only deep breathing exercises and splinted coughing were taught. The load used was 20% of the PI<sub>max</sub> measured, rhythm and pauses were determined for each patient. This was followed by thoracic expansion exercises emphasizing on the basal expansion exercises, three sets of five repetitions with

three seconds of inspiratory hold and two minutes rest after each set. For the conventional group 2, PI max was taken preoperatively, post operative day one and at the end of two weeks. Preoperatively thoracic expansion exercises emphasizing on the basal expansion exercises, three sets of five repetitions with three seconds inspiratory hold and two minutes rest after each

session were given. Manual proprioceptive facilitation was given during the exercises. On post operative day second only deep breathing exercises and splinted coughing were taught to the patients. From day second thoracic expansion exercises were continued for two weeks



**Figure 1**  
**IMT Thresholds Device**

## RESULTS

Independent sample test was performed using Statistical Package for Social Sciences (SPSS) version 20, the test showed P value of pre operative PI max greater than 0.05 so not significant statistically, Hence both the groups were comparable. So applied multivariate test, Repeated Measure Anova for the outcome measures. The test showed significant  $P = 0.000 (< 0.05)$  for the value of PImax within the groups that is factor 1 and was also significant  $P = 0.000 (< 0.05)$  for Factor\*1 that is between the groups. These results indicate that PI max value is statistically significant in both the groups when compared to each other. It was found that the mean PI max value was significantly reduced in the post operative reading in both the groups. The mean PI max value of post treatment was significantly higher than the mean PI max value of the pretreatment in both the groups. The comparison between the groups showed that the PImax values of

experimental group reached significantly higher than the PI max values of the conventional group. The study found the significant difference in the mean value and standard deviation of the PImax reading preoperative day 2, post operative day 1 and post treatment. Mean value and standard deviation of group 1, Preoperative day 2,  $293.35 \pm 28.55$ , post operative day 1,  $46.22 \pm 28.52$  and post treatment  $71.59 \pm 31.03$ . Mean value and standard deviation of group 2, on Preoperative day 2,  $106.03 \pm 15.59$ , post operative day 1,  $52.56 \pm 20.47$  and post treatment  $68.02 \pm 19.19$ . It was observed that the post operative PImax value was significantly reduced than preoperative, post treatment PImax value is increased in the conventional group, so it could be said that thoracic expansion exercises may emphasize on the improvement of the respiratory muscle strength. There was significant decrease in post operative PImax value than the preoperative, which was markedly increased post treatment in experimental group.



**Figure 2**  
**Measurement Of Maximum Inspiratory Pressure (Pimax)**



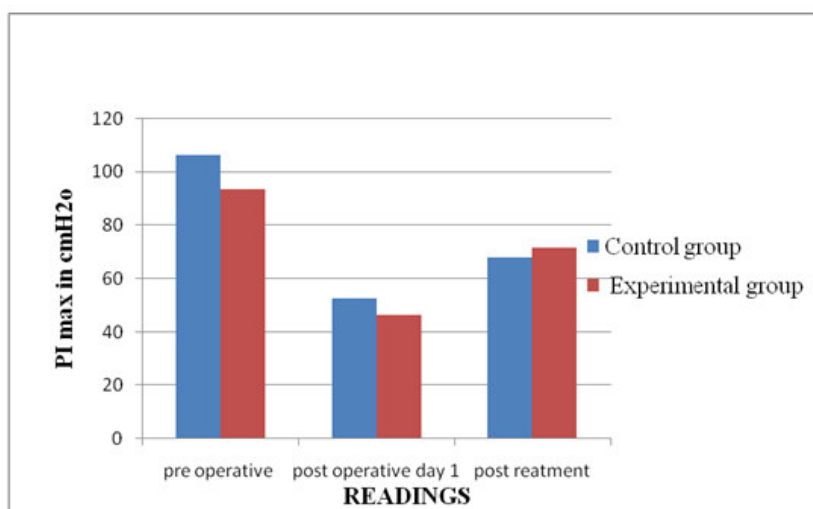
**Figure 3**  
*Treatment With IMT Threshold Device*



**Figure 4**  
*Thoracic Expansion Exercises*

**Table 1**  
*Group Wise Distribution of PI max*

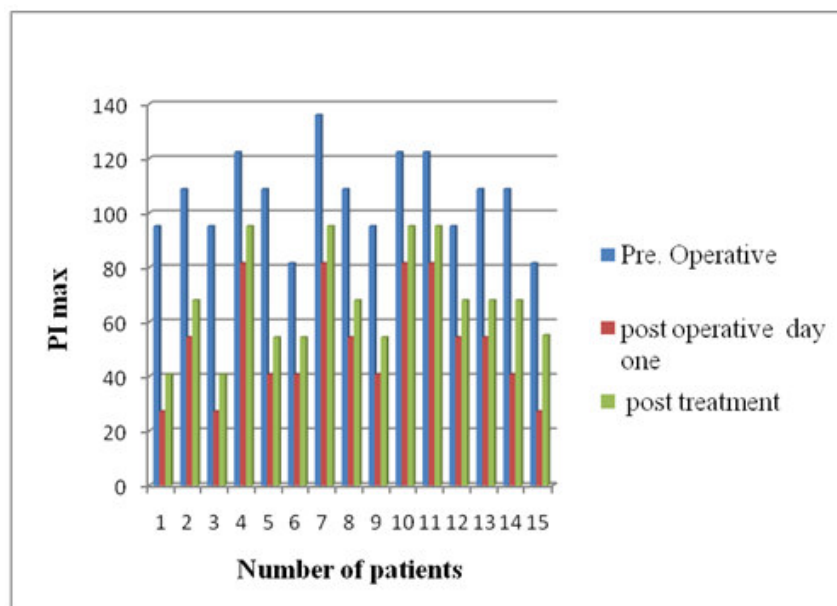
	PI max of conventional Group (cmH2o) N=15	PI max of experimental Group (cmH2o) N=15
pre operative	106.03± 15.59	93.35± 28.55
post operative day 1	52.566± 20.47	46.22± 28.52
post treatment	68.02± 19.19	71.59± 31.03



**Figure 5**  
*PI max in both the Groups*



## Group 2



## Group 1

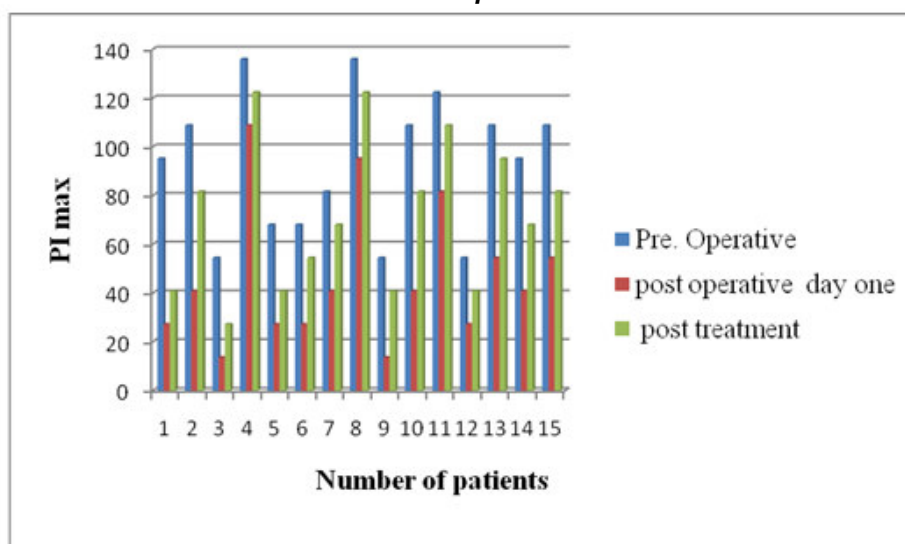


Figure 6

## DISCUSSION

This study was conducted to evaluate the effect of inspiratory muscle training in post operative individuals undergoing upper abdominal surgeries. Morphologically all the subjects were not similar. The results showed that IMT improved the strength of the respiratory muscle of experimental group was significantly more than the conventional group and accounted an early recovery, and the alternative hypothesis is proved that is the inspiratory muscle training along with the thoracic expansion exercises has significant effect on the upper abdominal surgery patients. In the present study it was found that there was significant decrease in the PI max in all the subjects in both the groups, this may occurred because Upper abdominal surgeries causes respiratory muscular dysfunction, which may last up to 48 h to 7 days, as there is alteration in, neural conventional, muscle integrity, reflex mechanisms, length tension relationships, and thoracoabdominal mechanics<sup>21</sup>. According previous studies, there may be significant

decrease in the value of PI max and measurements of muscular strength for both groups in the 2<sup>nd</sup> Post operative day<sup>21,22,23</sup>. However the post operative measurements on the first day after surgery may hindered by tiredness, post operative sedation, oxygen suppletion, nasogastric tube, and post operative complications<sup>18</sup>. In the study of Luiz Alberto Forgiarini Junior et al they found that there was a significant postoperative reduction in respiratory muscle strength in both the groups<sup>23</sup>. According to the author this reduction was due to postoperative pain, any history of pulmonary diseases may increases the mortality in patients submitted to upper abdominal surgery<sup>22</sup>. These results suggest that inspiratory muscles are more affected than expiratory muscles following upper abdominal surgeries. This may be explained because diaphragm function could be impaired by reflex paresis, and its inspiratory action reduced by the synergetic activity of abdominal muscles<sup>21</sup>. Kulkarni et al demonstrated that IMT before major abdominal surgery significantly improves maximum inspiratory pressure

preoperatively and preserves it post operatively compared with no intervention, deep breathing exercise or incentive spirometry<sup>25</sup>. In the present study there was significant increase in the value of PI max in the experimental group, these values were near to the preoperative values. This result suggests us that inspiratory muscle training given along with thoracic expansion exercises enhances the respiratory muscle strength and indices the early recovery. Barbara Cristina Brocki concluded in their study that 2 weeks of postoperative IMT, compared with standard physiotherapy alone, did not enhance respiratory muscle strength but improved oxygenation in high risk following pulmonary resection on the suspicion of or confirmed lung cancer. Respiratory muscle strength recovered in both groups 2 weeks after surgery<sup>24</sup>. Özyürek S. (2014) in their study, Inpatient inspiratory muscle training after upper abdominal surgery, concluded that, IMT results in faster improvement of respiratory and peripheral muscle strength. It can be suggested that IMT should be used as a part of inpatient rehabilitation program after upper abdominal surgery<sup>19</sup>. The protocol of IMT employed in this research was based on previous published studies and it showed good efficiency. The effects of IMT were more evident on PI max returned to higher levels more rapidly in experimental group than the conventional group<sup>21</sup>. In the present study also I found that the efficient effect of inspiratory muscle training in experimental group rather than the conventional group who received only thoracic expansion exercises. The improvement of inspiratory muscle function after IMT has been described in different surgical populations and reduced post operative respiratory dysfunction, resulting in less post operative pulmonary complication<sup>18</sup>. There were differences in the post treatment PI max value within the groups, this may be because of the preoperative pulmonary status of the individual subject and also the morphologically each subject was different from another. In the conventional group also there was increase in the post treatment PI max value which was less significant than the experimental group. Several studies have reported beneficial effects of distinct physiotherapy techniques in preventing lung function impairment and respiratory complications in patients submitted to upper abdominal surgeries<sup>25</sup>. Different maneuvers like breathing exercises, maximal inspiration sustained, chest expansion exercises, and diaphragmatic mobilization have been employed in this setting. However, the superiority of a given technique is not specifically emphasized<sup>11, 22</sup>. It is possible that the exercises even without load, have contributed to improving the outcome measure of the conventional group<sup>18</sup>. As pulmonary complications are strongly

associated with impairments of the respiratory muscular strength, various factors contribute to the development of the postoperative complications<sup>10, 11, 18, 13</sup>. The surgical procedure itself, performed in the abdominal region, is one such factor. Studies have demonstrated that this type of approach contributes to the development of postoperative complications, which are more common than are those resulting from thoracic or cardiac surgery<sup>4, 5, 9, 11</sup>. IMT may be a valuable physiotherapeutic intervention for in the upper abdominal surgery patients during the early Post operative period<sup>22, 23</sup>. Although the breathing exercises can improve the respiratory muscle strength, I found use of IMT device to be effective in improving the respiratory muscle strength. Use of IMT can be advantageous in respect to improve the respiratory muscle strength, reduction of the postoperative anxiety in patients and improvement of the self confidence. Last but not the least; it enhances the endurance of the patients by improving the quality of life. Recent advances are available proving improvement of the preoperative respiratory strength. But this is possible only in planned surgeries offering time limit of at least four weeks, but for those patients who underwent unplanned upper abdominal surgeries IMT could be the option to improve the post operative respiratory strength reducing the post operative pulmonary complications. In hospital stay patient can use the IMT machine under supervision of the physiotherapist, it is beneficial for the patient as it offers the visual feedback by a moving valve and motivates the patients to do exercises, which may be difficult in doing the thoracic expansion exercises. As the improvement occurs load can be increased by tightening the threshold valve. It is easy to use the machine at home post discharge as no supervision is advice once the patient learnt about the machine.

## CONCLUSION

According to the investigators of the study we can conclude that, immediate post operative inspiratory muscle training with threshold device associated with thoracic expansion exercises is effective in improving the inspiratory muscle strength in patients with upper abdominal surgery. Inspiratory Muscle Training with the IMT threshold device can be added to the physiotherapy treatment protocol of the patients undergoing upper abdominal surgeries in order to prevent post operative pulmonary complications.

## CONFLICT OF INTEREST

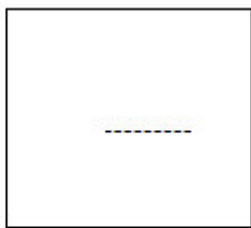
Conflict of interest declared none.

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