

**[ORIGINAL ARTICLE]****Effectiveness of Pre-operative Inspiratory Muscle Training on Post-Operative Recovery in patients undergone Abdominal Surgery- A Systematic Review.****Ms. Deepali Bhagwan Bamble<sup>1</sup>, Dr. Archana Nagargoje (PT)<sup>2</sup>**<sup>1</sup>Under Graduate Student, <sup>2</sup>Assistant Professor, Department of Cardiovascular and Respiratory Sciences Physiotherapy, D.V.V.P.F.'S College of Physiotherapy, Ahmednagar.**ABSTRACT :**

**Background:** As there is effect of General Anaesthesia on respiratory muscles which also reduces mucociliary escalator activity for 72 hours that leads to accumulation of mucus in alveola, and it further leads to atelectasis. To reduce all these complications, strength of respiratory muscle must be good. In this study we are mainly focusing on effect of pre-operative inspiratory muscle training improving the post-operative recovery to prevent complications in patients with abdominal surgery. The aim of the study is the effectiveness of pre-operative inspiratory muscle training on post-operative recovery in patient's undergone abdominal surgery.

**Subjects and Method:** Pre-operative exercises are beneficial for the patients under gone abdominal surgery to avoid post-operative pulmonary complications and get faster recovery. Hence, the purpose of the present systemic review is to provide an overview of the recent literature on the role of effectiveness of pre-operative inspiratory muscle training on post-operative recovery in patients undergone abdominal surgery. Articles published on an online electronic database were included. We included studies that were published in English. This systematic review included seven articles which were Randomised controlled trials, controlled trials, prospective study.

**Result:** 7 articles were reviewed out of which 6 articles shown the positive response on research question and 1 article did not showed much impact.

**Conclusion:** The studies show that preoperative inspiratory muscle training will improve post-operative recovery.

**Keyword:** Abdominal surgery, inspiratory muscle training, preoperative, post-operative, pulmonary complications.

**Introduction:**

Patients undergoing major surgery suffer postoperative respiratory complications with significant postoperative morbidity & mortality.<sup>(1-2)</sup> Complications include atelectasis, pneumonia, and adult respiratory distress syndrome. Nearly one quarter of deaths occurring within 6 days of surgery are related to postoperative pulmonary complications.<sup>(3)</sup> In patients undergoing abdominal surgery, changes in lung function are seen as being inevitable.<sup>(4)</sup> The incidence of postoperative pulmonary complications after abdominal surgery

is reported to be 6–76%, with the incidence following upper abdominal operations as high as 60–75%.<sup>(5-9)</sup> The postoperative period of abdominal surgery is associated with respiratory muscle dysfunction and impaired physical capacity, which, in turn, are associated with the development of postoperative pulmonary complications.<sup>(10-11)</sup> A leading cause of postoperative pulmonary complications is inadequate inspiratory effort leading to inadequate expectoration of sputum. Furthermore, a high respiratory demand leads to inspiratory muscle fatigue and exacerbates collapse of alveoli. Anaesthesia, the trauma of surgery, and

\*Corresponding author

**Ms. Deepali Bhagwan Bamble**

Email : bambleddeepali12@gmail.com

Under Graduate Student, Department of Cardiovascular and Respiratory Sciences Physiotherapy, D.V.V.P.F.'S College of Physiotherapy, Ahmednagar.

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the conditions inherent to the postoperative period (such as incisions, drains, and catheters) have an impact on the respiratory mechanics and mobility of patients.<sup>(4,5)</sup> The first postoperative days are associated with limited upright mobilization, fatigue, and restrictive ventilatory defects, among other functional disorders.<sup>(18-19)</sup> Patients develop predictable pulmonary changes that include altered respiratory mechanics, reduced lung volumes, respiratory muscle dysfunction and alterations in oxygenation status. These changes may be transient and self-resolving or may predispose patients to the development of more substantial complications. Postoperative pulmonary complications (PPCs) have been defined as ‘...a pulmonary abnormality that produces identifiable disease or dysfunction that is clinically significant and adversely affects the clinical course’.<sup>(12)</sup> Some evidence suggests that adequate preoperative respiratory muscle strength and the ability to generate sufficient lung volumes may be protective against the development of Postoperative Pulmonary Complications.<sup>(13-14)</sup> Hence, preoperative training of the inspiratory muscles is one of several rehabilitation interventions currently coming under increasing investigation. Inspiratory muscle training (IMT) is a technique that targets the muscles of inspiration and aims to increase inspiratory muscle strength and endurance by applying an increased load to inspiration.<sup>(15)</sup> Inspiratory muscle training (IMT) has been used as a nonpharmacologic intervention for respiratory symptoms since the 1980s. The purpose of IMT is to improve inspiratory muscle strength and endurance.<sup>(16)</sup> About 35% of patients experience postoperative complications after major abdominal surgery, including 9% postoperative pulmonary complications. Physical therapy appears to be effective as postoperative treatment<sup>9–13</sup> and may lower the incidence of postoperative pulmonary complications when given preoperatively.<sup>(17)</sup> showed preoperative physical therapy to be effective in high-risk patients who underwent a coronary artery bypass procedure. The question is whether preoperative physical therapy prevents the postoperative pulmonary complications that occur in high-risk patients after other types of surgery, such as abdominal surgery.

As there is effect of General Anaesthesia on respiratory muscles which also reduces mucocilliary escalator activity for 72 hours that

leads to accumulation of mucus in alveola, and it further leads to atelectasis.<sup>(18,19)</sup>

To reduce all these complications, strength of respiratory muscle must be good.

In this study we are mainly focusing on effect of pre-operative inspiratory muscle training improving the post-operative recovery to prevent complications in patients with abdominal surgery.

### **Material and Methodology:**

**Study design:** Systematic review

**Search strategy:** Articles published on abdominal surgery were included. The search strategy used were medical subject terms and text words for randomized controlled trails, abdominal surgery, inspiratory muscle training and pre & post-operative patients with abdominalsurgery. A search of all published literature is conducted using PubMed (NCBI), ScienceDirect (Elsevier), Google Scholar, Pedro, ResearchGate. The following search keywords were used to identify articles within the title: “preoperative inspiratory muscle training”, “abdominal surgery” and “post-operative complications”. Randomized control trials studies were evaluated for the study.

**Selection criteria:** Articles included were the (a) Articles considering inspiratory muscle training in preoperative patients. (b) Randomized control trails on Pulmonary function, preoperative and post-operative abdominal surgery and effect of inspiratory muscle training on it. (c) Articles which were on randomized control trails study and systematic review studies (d) Articles published in English language only. The exclusion criteria were, Articles published in language other than English language.

**Data Extraction:** A systemic review will be undertaken. Studies included in this review were published in English from past 10 years full articles from all over the world and which focused effect of preoperative inspiratory muscle training in post-operative recovery patients with abdominal surgery. All steps in the selection and extraction processes (i.e., the study selection, data extraction, and risk of bias evaluation) will be assessed independently by two reviewers. The titles and abstracts of all retrieved references will be screened. The full texts of relevant publications will be reviewed and will included if they met the inclusion criteria. The data from the included studies will be extracted using a piloted data extraction form, which included information on the study population, design, interventions, comparison,

outcome measures, and results.

**Data analysis:** Various electronic databases will be searched by the investigator and guide. The titles and abstracts of all the retrieved results will be then screened for eligibility. The first screening process is aimed at narrowing down the volume of the

articles by rejecting the studies that are not relevant or appropriate according to the previously stated criteria. Duplicates will be removed. Full text versions of all relevant articles will be evaluated by both.

Sr. No	Authors	Title	Year	Inclusion Criteria	Place	Outcome Measure	Key Findings
1.	Xiaoqing Ge; Wenjie Wang; Lu Hou; Kunpeng Yang; Xianen Fa.	Inspiratory muscle training is associated with decreased postoperative pulmonary complications: Evidence from randomized trials.	2018	Randomized controlled trials evaluating inspiratory muscle training before cardiothoracic or upper abdominal surgery. Thirteen randomized controlled trials were included in the meta-analysis for a total of 784 patients	Departments of Thoracic Surgery, and c Cardiac Surgery, The Second Affiliated Hospital of Zhengzhou University, Zhengzhou, Henan Province, China; and b Second Clinical College of Lanzhou University, Lanzhou, Gansu Province, China.	Primary outcomes. We pooled the data of PPCs in the meta-analysis- Twelve trials totalling 741 patients provided data on PPCs.13-19,21-25 Compared with standard care, IMT was associated with a significant decrease in PPCs	Preoperative inspiratory muscle training resulted in significantly improved maximum inspiratory pressure and was associated with decreased postoperative pulmonary complications.
2.	JJ Dronkers; RH Naber; CM Dronkers-Landman; NLU van Meeteren D	Preoperative therapeutic programme for elderly patients scheduled for elective abdominal oncological surgery: a randomized controlled pilot study	Nov 19 2014	colon surgery (waiting period minimally two weeks and first surgical intervention for this pathology), age 60 years, and adequate cognitive functioning (a good understanding and accurate execution of instructions)	A VeldmanGelders eVallei Hospital, Department of Physiotherapy, Department Physical Activity and Health, TNO Quality of Life, Leiden, The Netherland	Parameters of feasibility, preoperative functional capacity and postoperative course	The intensive therapeutic exercise programme was feasible and improved the respiratory function of patients due to undergo elective abdominal surgery compared with home-based exercise advice.
3.	Silvia Maria de Toledo Piza Soares1, Luciana Bertoldi Nucci2, Marcela Maria de Carvalho da Silva3 and Thaís Colombini Campacci3	Pulmonary function and physical performance outcomes with preoperative physical therapy in upper abdominal surgery: a randomized controlled trial	Nov 5, 2014	elective open abdominal surgery (defined as opening of the peritoneal cavity), waiting period of at least 2 weeks, no prior surgical intervention for oesophageal, gastric, or biliary tract resection,	Tertiary public hospital and private university, São Paulo state, Brazil	Pulmonary function outcome variables were inspiratory and expiratory strength, respiratory muscle endurance and spirometry, and physical performance	Preoperative physical therapy improved pulmonary function and physical performance in the pre- and postoperative periods among

				age $\geq$ 40 years, and acceptable physical condition (permitting pulmonary function and walk tests).		outcome variables were the functional independence measure and 6-minute walk test distance. Any postoperative pulmonary complications were recorded.	patients undergoing upper abdominal surgery
4.	Jaap Dronkers, Andre' Veldman, Ellen Hoberg, Cees van der Waal	Prevention of pulmonary complications after upper abdominal surgery by preoperative intensive inspiratory muscle training: a randomized controlled pilot study	Dec 20, 201	elective surgery for aneurysm of the abdominal aorta with a scheduled delay until surgery of at least two weeks, and at least one of the following risk factors: age 465 years, smoking less than two months before surgery, chronic obstructive pulmonary disease (COPD), and overweight (body mass index (BMI) 427 kg/m <sup>2</sup> ).20–22	GelderseVallei Hospital Ede, the Netherlands.	Effectiveness outcome variables were atelectasis, inspiratory muscle strength and vital capacity, and feasibility outcome variables were adverse effects and patient satisfaction with inspiratory muscle training.	Preoperative inspiratory muscle training is well tolerated and appreciated and seems to reduce the incidence of atelectasis in patients scheduled for elective abdominal aortic aneurysm surgery. In
5.	Marcela CangussuBarbalho-Moulim; Gustavo Peixoto Soares Miguel; Eli Maria Pazzianotto Forti; IV Fla'vio do Amaral Campos; II Dirceu Costa.	Effects of preoperative inspiratory muscle training in obese women undergoing open bariatric surgery: respiratory muscle strength, lung volumes, and diaphragmatic excursion	2011	Thirty-two obese women undergoing elective open bariatric surgery were randomly assigned to receive preoperative inspiratory muscle training (inspiratory muscle training group) or usual care (control group).	Meridional Hospital, Cariacica/ES, Brazil. Federal University of Saˆo Carlos (UFSCar) – Saˆo Carlos/SP, Brazil. IIMeridional Hospital, Cariacica/ES, Brazil. III Nove de Julho University (UNINOVE), Saˆo Paulo/SP, Brazil. IV Methodist University of Piracicaba (UNIMEP), Piracicaba/SP, Brazil.	The respiratory muscle strength was determined by the maximal static respiratory pressure measured during the forced inspiration and expiration: maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP). The measurement was carried out using an aneroid manometer (WikaH,Brazil), calibrated in centimetres H <sub>2</sub> O ( $\leq$ 300 cm H <sub>2</sub> O) and equipped with a 2-mm hole to relieve the oral pressure.	that the preoperative inspiratory muscle training increased the inspiratory muscle strength (maximal inspiratory pressure) and attenuated the negative postoperative effects of open bariatric surgery in obese women for this variable, though not influencing the lung volumes and the diaphragmatic excursion.

6.	SR Kulkarni, E Fletcher, AK McConnell, KR Poskitt1, MR Whyman	Pre-operative inspiratory muscle training preserves postoperative inspiratory muscle strength following major abdominal surgery – a randomised pilot study	26 July 2010	(i) over 18 years of age; and (ii) undergoing major abdominal general surgery (defined as deliberate breach of peritoneum), or major urological surgery, with ASA (American Society of Anaesthesiologis ts) grades I–IV requiring any length of hospital stay	Department of Vascular Surgery, Cheltenham General Hospital, Sandford Road, Cheltenham GL53 7AN, UK	Primary end- points were absolute and relative change in all respiratory variables following training before surgery and after surgery. Secondary outcome measures included length of stay of patients, time in HDU/ITU postoperativel y, time on a ventilator, respiratory rates and oxygen saturations from charts at a fixed time postoperativel y off oxygen, proven respiratory infection (positive sputum culture) and other pulmonary complications	Pre- operative specific IMT improves MIP pre- operatively and preserves it postoperativel y. Further studies are required to establish if this is associated with reduced pulmonary complicatio ns
7.	Hiroaki Nomori, M.D.; Ryutchirou Kobayashi, M.D.; GentarouFuyu no, M.D., Shojiroh Morinaga, M.D.; Hiroshi Yashima, R.P.T	Preoperative Respiratory Muscle Training- Assessment in Thoracic Surgery Patients with Special Reference to Postoperative Pulmonary Complications.	6JU NE,1 994	50 consecutive patients who underwent thoracic surgery between June 1992 and June 1993. There were 37 men and 13 women aged 24 to 73 years old (55 ± 13 [SO]). Their diseases were lung tumour in 31. mediastinal tumour in 6.	Salselkal Central Hospital, Tokyo, Japan.	maximum inspiratory (MIP) and maximum expiratory (MEP) mouth pressure before and after training in 50 patients undergoing thoracic surgery. For control purposes, MIP and MEP were	Preoperative respiratory muscle training may prevent postoperativel y pulmonary complicatio ns by increasing both inspiratory and expiratory muscle strength in
7.	Hiroaki Nomori, M.D.; Ryutchirou Kobayashi, M.D.; GentarouFuyu no, M.D., Shojiroh Morinaga, M.D.; Hiroshi	Preoperative Respiratory Muscle Training- Assessment in Thoracic Surgery Patients with Special Reference to Postoperative Pulmonary Complications.	6JU NE,1 994	50 consecutive patients who underwent thoracic surgery between June 1992 and June 1993. There were 37 men and 13 women aged 24 to 73 years old (55 ± 13 [SO]).	Salselkal Central Hospital, Tokyo, Japan.	maximum inspiratory (MIP) and maximum expiratory (MEP) mouth pressure before and after training in 50 patients undergoing	Preoperative respiratory muscle training may prevent postoperativel y pulmonary complicatio ns by increasing both

	Yashima, R.P.T		<p>Their diseases were lung tumour in 31. mediastinal tumour in 6. chronic empyema in 6, chest wall tumour in 2, giant bulla in 2, and oesophageal tumour in 3 patients. Mean body surface area (BSA) and body mass index (BMI) were <math>1.6 \pm 0.2 \text{ m}^2</math> and <math>21.3 \pm 3.0</math> (SO), respectively.</p>		<p>thoracic surgery. For control purposes, MIP and MEP were measured in 50 age- and sex-matched healthy subjects at two different times without training</p>	<p>inspiratory and expiratory muscle strength in patients undergoing thoracic surgery. Patients with respiratory muscle weakness have a higher risk of postoperative pulmonary complications.</p>
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**Discussion:**

This systematic review has summarised the current literature on effectiveness of pre-operative inspiratory muscle training on post-operative recovery in patients undergone abdominal surgery. There is consistent evidence that patients undergone abdominal surgery inspiratory muscle training in pre-operative period can improve post-operative recovery and lower the risk of pulmonary complications. Total 7 articles were viewed for the study out of which 6 supported the research question showing impact of pre-operative inspiratory muscle training on post of recovery there by reducing the risk of post-operative pulmonary complications. One article did not support the research question and the was having lower impact on post-op recovery which was conducted by JJ Dronkers et.al has shown that, the intensive training programme was feasible, with a high compliance and no adverse events. Respiratory muscle endurance increased in the preoperative period from 259-273 to 404 -349 J in the intervention group and differed significantly from that in the control group. Timed-Up-and-Go, chair rise time, LASA Physical Activity Questionnaire, Physical Work Capacity and Quality of Life (EORTC-C30) did not reveal significant differences between the two groups. There was no significant difference in postoperative complications and length of hospital stay between the two group.<sup>(21)</sup>

In a research conducted by Xiaoqing Ge et.al has shown that thirteen randomized controlled trials were included in the meta-analysis for a total of 784

patients. Compared with the standard care group, the inspiratory muscle training group exhibited significantly decreased postoperative pulmonary complications (risk ratio, 0.59; 95% CI, 0.47-0.74). Trial sequential analysis indicated that the cumulative Z curve crossed both the conventional boundary and the trial sequential monitoring boundary for benefit. The length of hospital stay was reduced in the inspiratory muscle training group (mean difference, 1.15 days; 95% CI, 2.10 to 0.20), and the maximum inspiratory pressure was significantly improved at the end of the preoperative training (mean difference, 13.66; 95% CI, 3.88-23.44). The quality-of-life outcome was unavailable in most of the studies.<sup>(20)</sup>

Silvia Maria de Toledo Piza Soares et.al in a research shown that there were no between-group differences at randomization. In the preoperative period, patients in the intervention group had higher inspiratory strength and respiratory muscle endurance than controls (88 cmH2O versus 64 cmH2O and 28 cmH2O versus 23 cmH2O, respectively;  $P < 0.05$ ). On the seventh postoperative day, in addition to inspiratory force and respiratory muscle endurance, the intervention group showed better results than controls in the functional independence measure score (118 versus 95) and 6-minute walk test distance (368.5 m versus 223 m), all  $P < 0.05$ . Postoperative pulmonary complications occurred in 11 patients in the control group and five in the intervention group ( $P = 0.03$ ).<sup>(22)</sup>

Study conducted by Jaap Dronkers, et al has shown, despite randomization, patients in the intervention group were significantly older than the patients in the

control group. Eight patients in the control group and three in the intervention group developed atelectasis (The median duration of atelectasis was 0 days in the intervention group and 1.5 days in the control group) No adverse effects of preoperative inspiratory muscle training were observed and patients considered that inspiratory muscle training was a good preparation for surgery. Mean postoperative inspiratory pressure was 10% higher in the intervention group.<sup>(23)</sup>

Marcela CangussuBarbalho-Moulim, et.al has researched in a study that showed, after training, there was a significant increase only in the maximal inspiratory pressure in the inspiratory muscle training group. The maximal expiratory pressure, the lung volumes and the diaphragmatic excursion did not show any significant change with training. In the postoperative period there was a significant decrease in maximal inspiratory pressure in both the groups. However, there was a decrease of 28% in the inspiratory muscle training group, whereas it was 47% in the control group. The decrease in maximal expiratory pressure and in lung volumes in the postoperative period was similar between the groups. There was a significant reduction in the measures of diaphragmatic excursion in both the groups.<sup>(24)</sup>

In a research SR Kulkarni, et.al has shown, in groups A, B and C, MIP did not increase from baseline to pre-operative assessments. In group D, MIP increased from 51.5 cmH<sub>2</sub>O (median) pre-training to 68.5 cmH<sub>2</sub>O (median) post-training pre-operatively ( $P < 0.01$ ). Postoperatively, groups A, B and C showed a fall in MIP from baseline ( $P < 0.01$ ,  $P < 0.01$ ) and ( $P = 0.06$ , respectively). No such significant reduction in postoperative MIP was seen in group D ( $P = 0.36$ ).<sup>(25)</sup>

In last article of search of article by Hiroaki Nomori, et.al has shown that preoperative respiratory muscle training increased both MIP and MEP significantly while the control subjects showed no increase in these parameters. Eight patients who had postoperative pulmonary complications had significantly lower values, and did not show significant increases in either MIP or MEP even after the training, unlike the other patients, who were without postoperative pulmonary complications. On the other hand, there were also another six patients who had equally low MIP and MEPs before training, but who raised their

values with training and avoided the postoperative pulmonary complications.<sup>(26)</sup>

### Conclusion:

This systematic review has provided an overview of the recent literature on the role effectiveness of pre-operative inspiratory muscle training on post-operative recovery in patients undergone abdominal surgery.

The studies show that preoperative inspiratory muscle training will improve post-operative recovery. Future studies are required to design a structured protocol of exercises in preoperative period which will help in faster recovery of postoperative period and reduce the risk of pulmonary complications.

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