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Review Article

Physiotherapy Section

Effectiveness of Respiratory and Abdominal Strength Exercises in Postoperative Patients with Abdominal Surgeries: A Narrative Review

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ABSTRACT

Abdominal surgeries are performed to diagnose and/or to treat different medical conditions by opening the abdominal cavity through large incision in the abdominal wall. Weakness of abdominal muscles, pulmonary complications and incisional pain are more common after abdominal surgeries. There has been significant research on managing such complications by using variety of physiotherapy interventions. This review intended to narrate the available literature on the effects of respiratory exercise and abdominal muscle strength training on pain and abdominal muscle strength after major abdominal surgeries. A systematic search of online databases was conducted and based on the reference lists of selected articles, further studies were identified. Twelve articles that met the inclusion criteria were analysed. Many of the previous studies concluded that respiratory exercise and abdominal muscle strength training after open abdominal surgeries improve abdominal muscle strength and decrease pain. Respiratory functions were also reported to be improved. But recent evidence regarding such effectiveness is insufficient and these aspects need to be explored in future.

Keywords: Abdominal muscles, Laparotomy, Pain, Physical therapy

INTRODUCTION

With an estimated 234 million surgeries being performed yearly, it can be said that surgery has become an integral part of global healthcare. As per the report of The World Bank in 2002, it was reported that approximately 11% of entire global disease burden, i.e., 164 million disability-adjusted life years, are attributed to surgically treatable conditions [1]. Abdominal surgery refers to any surgical operation on abdominal organs performed for treatment of a variety of reasons, including infection, obstruction, tumours or inflammatory bowel disease [2]. Postoperative Pulmonary Complications (PPCs) are common in patients undergoing abdominal surgery and are responsible for the increased morbidity and mortality as well as length of hospital stay and health related cost of care [3,4].

Atelectasis, pneumonia, acute respiratory failure, trachea-bronchitis, wheezing, and prolonged mechanical ventilation are the most commonly observed PPCs [5]. It is known that the decrease in lung volumes and capacities, abnormal respiratory pattern, abnormal gas exchange, and pulmonary defense in patients undergoing open abdominal surgeries start with anaesthetic induction and perpetuate in the postoperative period, contributing to the occurrence of these PPCs [6,7]. The incidence of PPCs in these subjects is related to the existence of preoperative risk factors such as advanced age, smoking, malnutrition, obesity, lung diseases, and clinical diseases. Surgical and anaesthetic factors such as the time of surgery, type of surgery, and the effects of anaesthetic drugs on the respiratory system also contribute to the development of PPCs [8].

Physiotherapy treatment for patients after open abdominal surgery consists of a variety of interventions intended to improve cardiopulmonary and/or physical function and reduces the incidence of PPCs. These interventions may include lung expansion exercises, secretion clearance techniques, limb exercises, progressive mobilisation programs, and other techniques. It has been reported that postsurgical physiotherapy interventions after open abdominal surgeries reduce the incidence of PPC [8]. More recently, the focus on strategies to reduce and improve postoperative health-related quality of life has shifted to include pre rehabilitation. It may be described as the process of improving the functional capacity of the individual prior to a planned intervention, commonly surgery, to enable the individual to withstand the anticipated cardiovascular, respiratory, neuromuscular or musculoskeletal stressors [9].

Various systematic reviews and meta-analyses have been conducted focusing on the effects of respiratory therapy [2], incentive spirometry [10], preoperative inspiratory muscle training [11], preoperative exercise therapy [12], positive expiratory pressure breathing [13] and chest physiotherapy [14] on PPCs. While these studies have provided a valuable contribution to the literature, they have limited scope with respect to effectiveness of respiratory exercise and abdominal strength training program on pain and abdominal muscle strength. In order to justify the use of abdominal muscle strengthening exercises along with the regular respiratory exercise in postoperative patients with open abdominal surgeries, one need to be confident that the efficacy of these interventions is worthwhile with minimal chances of harm. Therefore, this review assesses the available literature to determine whether use of this intervention is justified.

LITERATURE SEARCH

Full texts of the articles were included for narrative review if their purpose(s) included the use of respiratory exercise and/or abdominal muscle strengthening for preventing abdominal pain and/or improving abdominal strength. Articles were excluded from the review if they fell into one of the following categories: 1) commentaries, cost analyses, surveys, patient monographs, letters, and guidelines; 2) the use of respiratory exercises for other purposes, such as for inspiratory muscle training and bronchodilator administration, or as a monitoring tool; and 3) use of respiratory exercises in non surgical populations.

Search Strategy

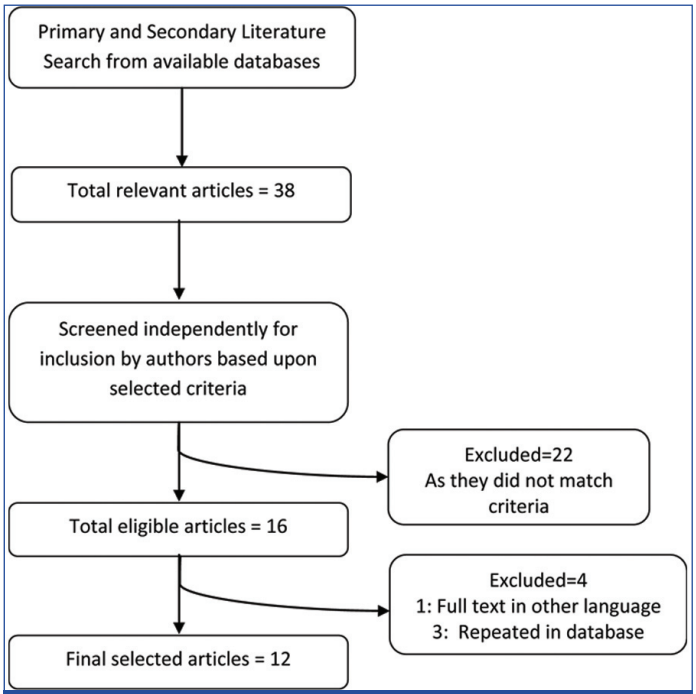
The search strategy included primary and secondary searches:

Primary search: Computerised databases (MEDLINE, CINAHL, PubMed, and Google Scholar) were searched from year 1990 to 2020. Key terms for the search included "respiratory therapy," "breathing exercises," "chest physical therapy," "respiratory exercise", "abdominal muscle strength", "open abdominal surgery", "open laparotomy", "abdominal pain" and "pulmonary complications."

Secondary search: Involved scanning all reference lists from the studies identified in the primary search. Both searches were limited to human studies that are performed in English.

One author screened all titles and abstracts of papers to identify relevant studies for inclusion. Both the authors reviewed relevant full texts which were found to be eligible in primary screening. Secondary search was done in the reference lists of the full texts and grey literature for other articles of relevance.

Selection process: The primary computer database search yielded 31 articles. The secondary search provided seven additional articles for a total of 38. Full texts of the articles were accepted (n=16) for narrative review if their purpose(s) included the use of respiratory exercise and/or abdominal muscle strengthening for preventing abdominal pain and/or improving abdominal strength. It was found that out of these 16 studies, three studies were repeated in two different databases and one full text was found to be in Korean language, so was excluded [Table/Fig-1].



[Table/Fig-1]: Selection process of the reviewed articles.

Variability of study designs, population covered, interventions applied, etc., was analysed and tabulated. Risk of bias assessment for randomised studies using the visualisation tool for risk of bias assessment in a systematic review (robvis), risk-of-bias tool for randomised trials (RoB2) and the risk of bias in non randomised studies of interventions (ROBINS-1) for observational studies was done [15].

Search Results

[Table/Fig-2] shows the summary of analysis of articles included in this narrative review [2,8,10-14,16-20]. The risk of bias for systematic reviews, non randomised studies and randomised trials are given in [Table/Fig-3-5] [2,8,10-14,16-20].

DISCUSSION

Efforts were focused on finding and discussing studies related to effects of respiratory exercise and abdominal strength training on pain and abdominal muscle strength for postoperative patients with abdominal surgeries. The following questions were formulated, and answers were sought during this process:

- Does respiratory exercise affect pain for postoperative patients with abdominal surgeries?
- Does abdominal strength training affect pain for postoperative patients with abdominal surgeries?
- Does respiratory exercise affect abdominal muscle strength for postoperative patients with abdominal surgeries?
- Does abdominal strength training affect abdominal muscle strength for postoperative patients with abdominal surgeries?

Respiratory exercises and pain: Pain is one of the most common postoperative complications limiting patients' functional ability and increased duration of hospitalisation. Respiratory exercises are reported to improve oxygen saturations of postoperative patients without increasing pain [17]. Exercises aimed at increase respiratory capacity following standard guidelines reduce incisional and postoperative pain [2,11]. A negative association between postoperative respiratory training and pain intensity and duration was reported in one of the previous studies [18]. Decline in respiratory muscle performance after surgery is associated with pain, drains and pneumoperitoneum. The current evidence suggests that physiotherapist-directed postoperative exercise decreases pain over usual care for patients following open surgeries, and physiotherapists may be able to help these patients if referrals are made in this direction [18].

The studies which investigated effects of inspiratory muscle training in both the pre and postoperative phases were not included. Some of these studies reported improvements in maximal inspiratory pressure which were sustained for upto three months but, the clinical significance of these long-term effects in this population were unclear [11].

Abdominal strength training and pain: Pain associated with incision or in the peri-incisional region is thought to be affecting the course of recovery. The incision of an open laparotomy creates significant loss of strength in the abdominal muscles and the postoperative pain is reported by many to be impeding the patients' involvement in active physiotherapy interventions [8,12,18]. Abdominal muscle strength training is an integral part of postoperative rehabilitation and is reported to be associated with patient perceived pain relief by few studies [20,21]. The evidence of the probable mechanism for the role of abdominal strength training on pain relief is still unclear. The effects offered by abdominal muscle strength training were not reported to be extending beyond the first few days postoperatively and, thus, the study evaluated immediate postoperative training only [14].

Respiratory exercises and abdominal muscle strength: Respiratory exercises including various types of intervention strategies using supervised exercises seem to be safe and feasible and improve functional capacity in patients undergoing major elective abdominal surgeries [22]. Improvements in respiratory functions are supposed to be associated with increase in strength of primary respiratory muscles as well as secondary muscles including the abdominals which provide fulcrum for diaphragmatic excursion during respiration [14,16-18].

Though the effects of respiratory exercises have not been found to be directly associated with the strength of abdominal muscle, the improvements in abdominal muscle strength are significant following various intervention protocols adapted for these studies [9,11,13,14]. Only few studies including one review study has reported the probable association between the respiratory exercise and abdominal muscle strength [23,24].

Postoperative recovery after abdominal surgery largely depends upon the patients' ability to cope with impaired respiratory and

Study	Methods						Participants						Interventions		Outcomes
	Design	Multi/ Single center / Period	Sample size / Allocation	Concealment of allocation / Blinding	Withdrawal / Intention-to-treat analysis	Follow-up	Number	Male / Female	Age (mean)	Setting	Inclusion criteria	Exclusion criteria	Control group	Experimental group	
Pouwels S et al., 2014 [12]	A systematic review										The study design was-RCT. Participants were patients awaiting elective major abdominal surgery. The intervention consisted of a preoperative Physical Exercise Training programme (PEXT), defined as a regimen of physical activities for specific therapeutic goals to gain or increase musculoskeletal and/or cardiovascular and/or respiratory (muscle) function.				Improvement of preoperative physical fitness, length of hospital stay, and postoperative complications.
Mans CM et al., 2015 [11]	Systematic review with meta-analysis						295 participants from 8 studies		35 to 71 years in included studies		RCT and quasi randomised trial studies investigating a form of preoperative inspiratory muscle training, compared with sham or no inspiratory muscle training. Adult participants (16 years and over) awaiting elective open cardiac, thoracic, or upper abdominal surgery. Preoperative inspiratory muscle training could be achieved by isocapnic/normocapnic hyperpnoea, inspiratory resistive flow training, or threshold pressure loading.	Studies with combined preoperative inspiratory muscle training with other preoperative interventions, or continued inspiratory muscle training into the postoperative period			Rates of PPC (as defined by the individual studies), and postoperative length of stay.
Rothman JP et al., 2014 [13]	A systematic review						578 patients from 8 studies				Full text written publications in English language. RCTs, prospective, retrospective as well as case studies	Studies did not include postoperative patients and if the discipline was other than abdominal surgery, such as heart and spine surgery. Also, studies reported only by abstracts			Pain, seroma function, physical function, pulmonary function, stress and intra abdominal pressure

Grams ST et al., 2012 [14]	Systematic review with meta-analysis	NA / NA	NA / NA	NA / NA	NA / NA	NA	66 in meta analysis	NA / NA	NA	NA	RCT and Quasi randomised trial with surgery involving an incision above or extending above the umbilicus, other interventions in the abdominal cavity performed by conventional laparotomy or laparoscopy with age above 18 years; non obese; without heart, pulmonary and/or neuromuscular disease; who had not been on mechanical ventilation and/or in intensive care for more than 48 hours	NA	NA	NA	Respiratory muscle strength, spirometry diaphragm mobility and postoperative pulmonary complications
Örman J and Westerdahl E 2010 [16]	Systematic review	NA / NA	NA / NA	NA / NA	NA / NA	NA	NA	NA / NA	NA	NA	RCT evaluating the Positive Expiratory Pressure (PEP) technique performed with a mechanical devicein spontaneously breathing adultpatients afterabdominal orthoracic surgeryvia thoracotomy. Atleast one treatmentgroup in which the PEP technique was compared with other chest physiotherapy techniques or with no intervention.	Abstracts in conference proceedings or unpublished sources. If the study population had undergone thoracic surgery via sternotomy	NA	NA	NA
Pasquina P et al., 2006 [2]	A systematic review						4145 patients from 35 studies				Randomised trials of patients undergoing open abdominal surgery	Inadequate randomisation methods. Relevant trials had to compare any technique of prophylactic respiratory physiotherapy (active intervention) with no intervention or with another method of respiratory physiotherapy. Studies that tested therapeutic physiotherapy to treat pulmonary complications.			

Overend TJ et al. 2001 [10]	A systematic review										Inclusion criteria: 1. Articles included use of Incentive Spirometry (IS) for postoperative pulmonary complications 2. Human studies published in English until June 2000 and available on databases.	Articles were excluded if they fell into one of the following categories- 1. Reviews 2. Commentaries, cost-analyses, surveys, patient monographs, letters, and guidelines 3. The use of IS for other purposes, such as for inspiratory muscle training and bronchodilator administration, or as a monitoring tool 4. Use of IS in nonsurgical populations			A specially designed Critical Appraisal Form (CAF) which included information on study purpose, subject characteristics (i.e., age, surgery type, and inclusion/exclusion criteria), study design (i.e., type, sample size, treatment groups, randomization, treatment protocol, blinding, and statistical analysis), and results (i.e., dropouts, outcome measures, and statistical significance). Additional information was gathered on methodologic issues such as bias, contamination, and cointervention, as well as any other reliability or validity issues affecting the results and conclusions
Olsen M, 2000 [17]	A Review										RCT including minor and major surgeries				-
Elgaphar S and Soliman G 2015 [18]	Quasi experimental design	- Single centre study 21 days Total duration not mentioned	60 Randomisation table	NA NA	NA NA	First, second and third week	60	NA	50.13 for study group and 51.2 for control group	Postanaesthesia care unit of Menofiauni hospital, Egypt	All abdominal surgeries with age above 18, without heart, pulmonary and/or neuromuscular disease, who has not been on mechanical ventilator/intensive care for more than 48 h	Patient underwent video laproscopic surgeries	Route in physiotherapy	Route in physiotherapy with chest physiotherapy	FVC, FEV1, oxygen haemoglobin saturation, HR, SpO_2, dyspneoa
Possa SS et al. 2014 [19]	Retrospective study with historical control	Multi centre Six months	535		37		202	79 86		Private and tertiary care center of 497 beds in the state of São Paulo, Brazil	Adult patients (age ≥18 years) undergoing elective open upper abdominal surgery (UAS) and who received physical therapy in the postoperative period	Patients undergoing lower abdominal surgeries, laparoscopic surgeries, emergency surgeries, surgeries with associated chest manipulation, those who underwent more than one surgical procedure during hospitalisation and patients who did not adhere properly to the physical therapy treatment (performing physical therapy attendances	Preintervention period underwent a program of postoperative physical therapy treatment in which the therapeutic planning to be applied was determined by the professional providing patient care (non standard model)	Postintervention underwent a standardised program of physical therapy treatment which structured the model of patient care, focusing on the use of additional therapeutic resources (volumetric incentive spirometry and positive expiratory pressure in the airways),early sitting position and ambulation	Incidence of atelectasis was considered as the primary variable and the length of hospital stay as the secondary variable

Watters JM et al., 1993 [20]	Cross-sectional Comparative Study	Sinlge centre 2 years	40				26 14	36±9 young and 77±5 older	Ottawa civic centre	Patients who were 50 years of age or younger or 70 years of age or older, of either sex, in good general health, dwelling in a community, and capable of giving informed consent and cooperating in the study were recruited from among consecutive patients admitted for major elective non vascular abdominal surgery	Pregnant, had arthritis, stroke, or neuromuscular disorder that might affect grip strength, or were taking corticosteroids.					Total Body Water (TBW), Maximal voluntary handgrip, respiratory muscle strength, and visual analog pain	
Mackay MR et al., 2005 [8]	Randomised control trial	Single centre	56	Radomised table with concealed allocation	Concealed allocation	6	NA	69 for control group and 63 for intervention group	Westmead hospital	Manipulation of the viscera via a single upper, or combined upper and lower, midline open abdominal incision, and be classified as at high risk of developing PPC	Patients undergoing repairs of abdominal aortic aneurysms.	Early mobilisation-only group	Early mobilisation-plus-deep breathing and coughing group			Mobility duration, frequency and intensity of breathing, incidence of clinically significant PPC, fever, length of stay, and restoration of mobility	
		Five years				Yes	NA										NA

[Table/Fig-2]: Summary characteristics of studies [2,8,10-14,16-20].

Review	Study eligibility criteria	Identification and selection of studies	Data collection and study appraisal	Synthesis of findings
Grams ST et al., 2012 [14]	Unclear	Low	Low	Low
Örman J and Westerdahl E, 2010 [16]	Low	Unclear	Low	Low
Mans CM et al., 2015 [11]	Low	Low	Low	Low
Olsen M 2000 [17]	High	High	Unclear	Unclear
Overend TJ et al., 2001 [10]	Low	Unclear	Low	Unclear
Pasquina P et al., 2006 [2]	Unclear	Low	Low	Unclear
Pouwels S et al., 2014 [12]	Low	Unclear	Unclear	Unclear
Rothman JP et al., 2014 [13]	Low	Low	Unclear	Low

[Table/Fig-3]: Risk of bias assessment for systematic reviews [2,10-14,16,17].

abdominal muscle functions. Various studies have demonstrated the relationship between postoperative outcomes and measures of physical fitness including cardiorespiratory and muscle strength functions [25]. It has been reported in a previous study that conventional physiotherapy along with additional resources such as incentive spirometry, early ambulation and expiratory positive airway pressure can help in reducing atelectasis as a postoperative complication and also reduces hospital stay in abdominal surgery patients [19].

Present review supports findings of previous studies and additionally emphasises the role of postoperative physiotherapy including conventional as well as advanced resources for prevention of complications and emphasises its importance in improving respiratory and physical functioning.

Abdominal strength training and abdominal muscle strength: Abdominal wall paresis is considered one of the most common postoperative complications which is causing limitation in participation and performance of Activities of Daily Living (ADLs) for patients [12]. Incentive spirometry along with abdominal strengthening and inspiratory muscle training has been shown to have improvements in the abdominal muscle strength [16,26-29].

Preoperative and postoperative abdominal muscle training are reported to induce less reduction in inspiratory muscle strength after laparotomy which decrease rate of Postoperative Pulmonary Complications (PPC) [28].

Limitation(s)

As the number of studies including the topics under discussion is very less and specific interventions as well as outcome measures used are highly variable among all studies, it is difficult to comment on the strength of evidence reviewed in this study. Lack of available evidence is the main reason for considering future research on the effects of respiratory exercises and abdominal muscle strength training for preventions of postoperative complications, such as pain and abdominal weakness, in patients of open abdominal surgeries.

CONCLUSION(S)

The available literature suggests insufficient evidence of association or effects of the respiratory training and abdominal strengthening on pain in strength for postoperative patients with abdominal surgeries. It is evidently striking that there is no study available from India. This suggests that the effectiveness of respiratory exercise and abdominal strength training programme on pain and abdominal muscle strength in postoperative patients with abdominal surgeries is undervalued and underexplored and there is need to explore these aspects in the context of Indian population.

Study	Bias due to confounding	Bias in selection of participants	Bias in measurement of interventions	Bias due to departures from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of reported results
Elgaphar S and Soliman G 2015 [18]	High	Unclear	Low	Unclear	Low	Low	Unclear
Possa SS et al., 2014 [19]	High	Low	Low	Unclear	Low	Low	Unclear
Watters JM et al., 1993 [20]	High	Low	Unclear	Low	Low	Low	Unclear

[Table/Fig-4]: Risk of bias assessment for non randomised intervention studies [18-20].

Study	Random sequence generation (Selection bias)	Allocation concealment (Selection bias)	Blinding of participants and personnel (Performance bias)	Blinding of outcome assessment (Detection bias)	Incomplete outcome data (Attrition bias)	Selective reporting (Reporting bias)	Other bias (e.g., Conflict of interest)
Mackay MR et al., 2005 [8]	Low	Low	Unclear	Unclear	Low	Low	Unclear

[Table/Fig-5]: Risk of bias assessment for randomised trials [8].

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