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Original Research Article

Effect of ACBT and TENS on Pulmonary Function and Pain Perception in Abdominal Surgeries: A Randomized Control Trial

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ABSTRACT

Background: Pulmonary complication and pain are the major problems in the patients undergoing abdominal surgeries. Surgery and general anesthesia directly affects the respiratory system. Surgeries alter postoperative pulmonary function and are associated with pain after surgery. Purpose: The purpose of this study aimed to assess the Pulmonary Function (FVC, $FEV_{1,}$ and FVC/FEV_1) and Pain Perception in Abdominal Surgeries.
Methods: A RCT of 40 participants who underwent abdominal surgeries with age group of 20-65 years are included in the study. On 1st, 7th and 14th day pulmonary function test ($FEV_{1,}$ FVC and FEV1/FVC ratio), chest expansion and pain perception by NRS was evaluated. Group A received ACBT and Group B received ACBT along with TENS for the period of 2 weeks.
Results: The result showed that there was highly significant difference in pain perception and FVC, very significant difference in chest expansion and there was no significant difference in FEV_1 and FEV_1/FVC ratio of the PFT values after 2 weeks of intervention.
Conclusion: The study concluded that ACBT improves the lung function in abdominal surgeries but there is more significant improvement in pulmonary function when ACBT is given along with TENS.

Keywords: ACBT, TENS, Abdominal surgeries, Pain perception and PFT.

INTRODUCTION

Pulmonary complications and pain are the major problems in the patients undergoing abdominal surgeries. These procedures are associated with relatively high rates of pulmonary and cardiac complications. Pulmonary complications are more common than the cardiac complication, which is associated with longer length of stay in the hospital. [1] Preoperative and postoperative respiratory therapy helps to prevent or reverse complication and improve airway clearance. The risk and severity of complications can be reduced by the use of therapeutic maneuvers that increase lung volume. [2]

Worldwide 56 (29%) of 192 WHO member states undergoes abdominal surgeries every year. Because of this epidemiological transition, surgery will assume an increasing role in public health. [3] Surgery has become an integral part of global health care, with an estimated 234 million operations performed yearly. However, little is known about the actual worldwide volume and availability of surgical care since only anecdotal evidence exists. Despite of the improvement in the surgical technology and perioperative care, complication rates are still high ranging from 30% to 50%.[4] Surgery and general anesthesia directly affects the respiratory

system. Surgeries alter postoperative pulmonary function, as observed by impairment of lungs volume such as total lung capacity, vital capacity and tidal volume. It also reduces the efficiency of efforts to cough for as long as one week and also fall in a oxygen arterial pressure and in oxygen-hemoglobin saturation. [5] Following major operations, the vital capacity diminishes by 50% - 60% and functional residual capacity by 30% for few days to weeks. [6]

Pulmonary complications (PPCs), which are defined as pulmonary abnormalities occurring in the postoperative period producing clinically significant, identifiable disease or dysfunction that adversely affects the clinical course. [7] PPCs continue to be an important risk of major abdominal surgery lasting 3 hours or more which accounts approximately 25% of postoperative deaths occurring within 6 days of surgery. In USA, postoperative pulmonary complications ranges from 10% to 88% and its incidence depend on the procedure and postoperative risk factors. [8] PPC presents high rate of morbidity, mortality and prolonged hospital stay predominantly in abdominal, cardiac and thoracic surgeries. Its incidence varies according to the previous diagnosis of the candidates for surgery; the type of surgery. For all these reasons, the incidence rates vary dramatically, ranging from 2 to 40%. Postoperative pulmonary complications have been reported to occur in 5-10 % of the general patient population and in 4-22 % of patient's undergone abdominal surgery. [9] The basic mechanism of PPCs is a lack of lung inflation that occurs because of a change in breathing to a shallow, monotonous breathing pattern without periodic sighs, prolonged recumbent positioning and temporary diaphragmatic dysfunction. Mucociliary clearance which is impaired postoperatively along with the decreased cough effectiveness, increases risks associated with retained pulmonary secretions, anaesthesia, opioid analgesia and postoperative pain which also seem to contribute to this ventilation pattern which contributes to the PPCs. [10,11] According to some authors, surgery lasting for more than 210 minutes is a risk factor for postoperative pulmonary complications. [12]

As described by Webber and Pryor, Active cycle of breathing technique (ACBT) comprises of repeated cycles of three ventilatory phases; Breathing control, Thoracic expansion exercises and Forced expiratory technique. [13] ACBT has shown to be effective in mobilizing and clearing the excess bronchial secretions and to improve lung function. It neither causes nor increases hypoxemia or increases airflow obstruction. [14] The ACBT is a flexible method of treatment which can be adapted for the use in any patient, young or old, medical or surgical, where there is a problem of excess bronchial secretions and it can be used with or without an assistant. Despite of modern surgery and anesthesia, patients continue to associate surgery with severe postoperative pain for which they will receive inadequate analgesia transcutaneous electrical nerve stimulation (TENS) is widely used worldwide to relieve a wide range of painful conditions. [15] A program of TENS is reported to be a non-invasive, non-addictive method of relieving postoperative pain. The conventional mode is most frequently used in the postoperative pain. [16] The postoperative period is frequently associated with clinically important abnormalities of pulmonary function. Following surgery of the abdominal or thoracic cavities, postoperative changes are invariable and severe with recovery of function delayed for days or weeks. [17] Therefore the present study has been taken up to evaluate the combined effect of ACBT and TENS for the pulmonary function and pain perception in abdominal surgeries.

MATERIALS AND METHODS

A Randomized control trial of 40 participant (25 male and 15 female) using simple random sampling was done. Participants who underwent laparotomy

with the age group of 20-65 years were included according to inclusion and exclusion criteria. The intervention was given once in a day, 6 days in a week for a period of 2 weeks. 3-4 cycles of ACBT and TENS around the suture line for 10-15 minutes was given. Each treatment session lasted for 15-30 minutes including rest period. Both interventions were given once in a day (12 sessions) for 2 weeks.

The inclusion criteria for this study were both male and female participants, age between 20 to 65 years, those willing to participate in this study, individuals who underwent laparotomy. And exclusion criteria for the study were participants who were haemodynamically unstable, chronic debilitating conditions, rib fractures, thoracic vertebra fracture, acute pleuritic chest pain and laparoscopic surgeries.

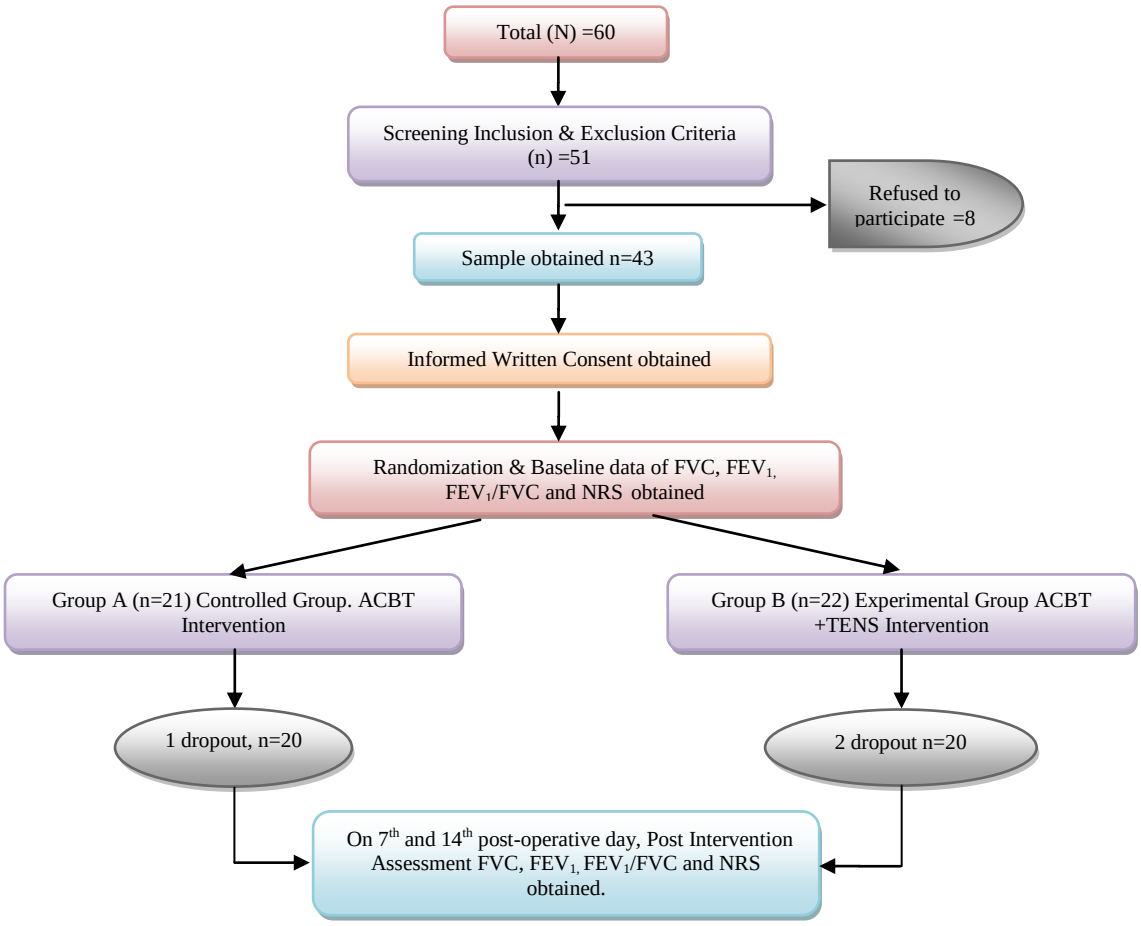


Figure 1: Flow Chart representing the procedure of selection of participants

OUTCOME MEASURES

Chest Expansion Measurement: Chest expansion is the difference between maximum inspiration and maximum expiration. The normal chest expands symmetrically during deep inhalation. Chest expansion was measured with inch tape method at different level of the chest which measures symmetry and extent of expansion. It was performed at three levels, for three lobes of the lungs from top to bottom. The levels of measurements are at axilla (for upper lobe expansion), at the 4th intercostals (for middle lobe expansion) and at the Xiphoid process (for lower lobe expansion).

Pulmonary Function Test: Forced Expiratory Volume in One Second (FEV_1), Forced Vital Capacity (FVC) and FEV_1/FVC Ratio. This specific measurement computed by the instrument called spirometry (RMS HELIOS 401).

Pain perception: It was measured using Numerical rating scale (NRS)

The study received approval from Institutional Ethical Committee of Pravara Institute of Medical Sciences.

DATA ANALYSIS AND RESULTS

Statistical analysis was carried out utilizing the trial version of Graph Pad Instat software and $p<0.05$ is considered as level of significance. Student's Paired' test and Unpaired' test was applied to analyze the data.

Pain perception: It was calculated pre and post after the intervention in both the groups (Table & Graph no.1). The mean difference for pain perception in group A and group B after intervention was 7.650±0.9333 and 5.300±0.9787.

Chest Expansion: Chest expansion was measured at three levels in both the groups (Table & Graph no.1).

The difference between post values of both the groups (Group A and group B) at axillary level was 0.65±0.13cms; at 4th intercostals was 0.425±0.067cms and at xiphoid process was 0.025±0.67cms respectively.

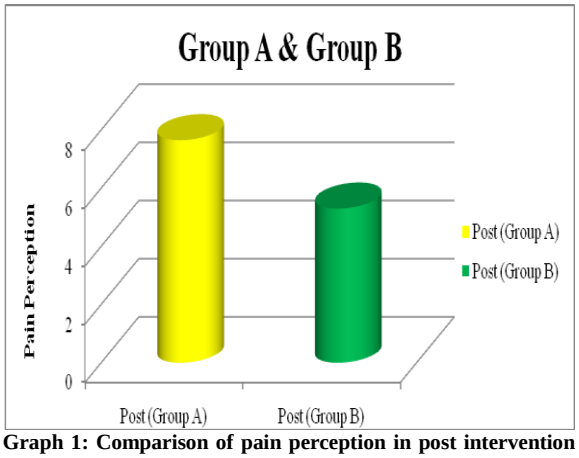
Forced Expiratory Volume In One Second (FEV_1) : In group A, mean difference between D1 and D14 was 0.41 ± 0.151 liters and in group B mean difference between D1 and D14 was 0.46±0.05 liters.

Forced vital capacity (FVC): In group A, mean difference between D1 and D14 was 0.31 ± 0.09 liters and in group B mean difference between the D1 and D14 was 0.31±0.08 liters.

FEV1/FVC Ratio: In Group A, mean difference between D1 and D14 was 3.68±1.40 liters and in group B mean difference between the D1 and D14 was 7.50±4.74 liters.

Table 1: Comparison of pain perception in post intervention in both the groups

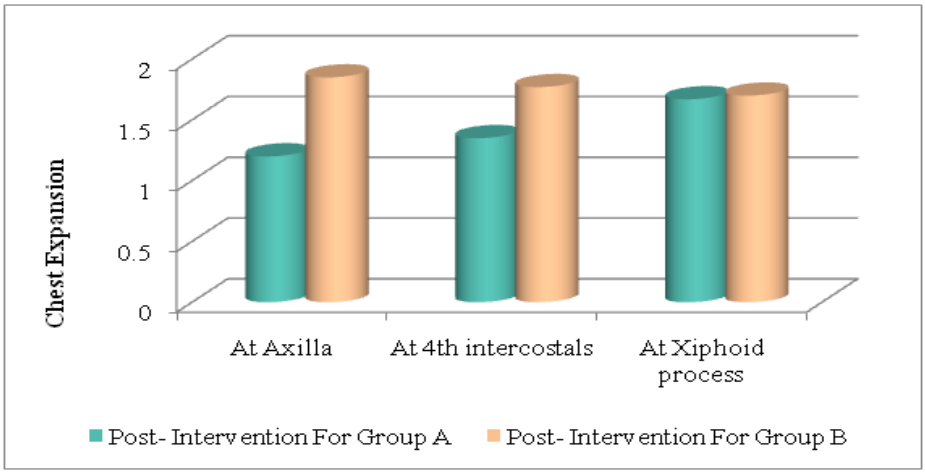
	Group A	Group B	p-value
Mean	7.65	5.30	P=0.83,p>0.05
SD	0.93	0.97	



Graph 1: Comparison of pain perception in post intervention in both the groups

Table 2: Chest expansion measurement Group A & Group B (Post intervention)

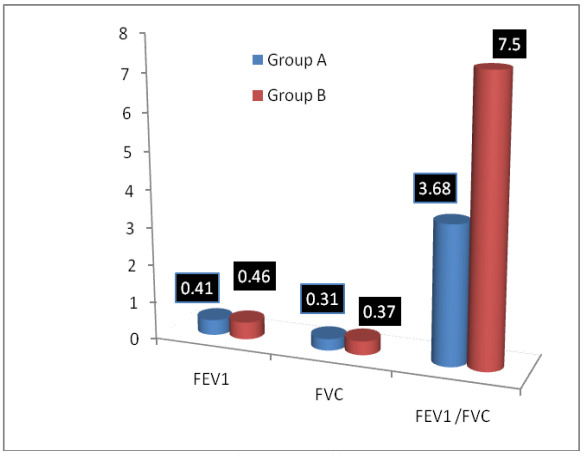
Levels of chest expansion	Group	Pre-Intervention	Post-Intervention	Mean Difference	t-value	p-value
At Axillary level	Group A	0.82±0.29	1.20±0.29	0.45±0.03	13.07	0.164 ,p>0.05
	Group B	1.40±0.50	1.85±0.43	0.45±0.03	13.07	0.0001 ,p<0.05
At 4th Intercostals	Group A	0.92±0.406	1.35±0.43	0.42±0.05	7.76	0.0001, p<0.05
	Group B	1.35±0.108	1.77±0.111	0.42±0.04	10.37	0.0001 ,p<0.05
At Xiphoid process	Group A	1.10±0.416	1.67±0.46	0.57±0.06	8.75	0.001 ,p<0.05
	Group B	1.15±0.56	1.700±0.57	0.55±0.11	4.59	0.0002 ,p<0.05



Graph 2: Chest expansion measurement Group A & Group B (Post intervention)

Table 3:- PFT parameters of both the group in liters

PFT	Group	D1	D7	D14	Mean difference	t-value	P value
FEV1	Group A	1.138±0.26	1.277 ±0.24	1.55 ±0.41	0.41 ± 0.151	3.592	0.001,p<0.05
	Group B	1.007±0.46	1.17 ±0.41	1.46±0.41	0.46±0.05	3.592	0.001,p<0.05
FVC	Group A	1.79±0.30	1.94 ±0.32	2.11 ±0.27	0.31 ± 0.09	2.717	0.013,p<0.05
	Group B	1.79±0.29	1.96 ±0.32	2.14±0.37	0.37±0.08	2.256	0.036,p<0.05
FEV1/FVC	Group A	96.85±3.14	95.96±3.41	93.16 ±3.40	3.68±1.40	4.892	0.0001,p<0.05
	Group B	97.26±3.24	93.25±5.76	89.76±5.10	7.50±4.74	8.244	0.0001p<0.05



Graph 3: Comparison of mean difference between both the group.

DISCUSSION

The result obtained in this study indicated that, there was highly significant difference in pain perception and FVC, very significant difference in chest expansion and there was no significant difference in FEV_1 and FEV_1/FVC ratio of the PFT values after 2 weeks of intervention.

Pain Perception

There was a highly significant difference between both the groups, which states that pain perception was reduced more in group B as compared to group A. The 'Gate control' theory suggests that pain was largely transmitted by small un-myelinated 'C' fibres which could be inhibited by activity of myelinated 'A' fibres. Stimulation of these larger 'A' fibres could close the spinal gating mechanism in the substantia gelatinosa and thus prevent painful peripheral stimuli from gaining access to higher cortical centres. The release of endorphins and activation of inhibitory reflex areas in the brain stem have been proposed as alternative mechanisms for the effect of transcutaneous stimulation. [18] Hymes *et al*. (1974) were the first to report the success of conventional TENS for acute pain resulting from surgery using sterile electrodes straddling the incision. Potentially, TENS could relieve pain and reduce concurrent opioid consumption and associated adverse events such as respiratory depression. A systematic review on acute pain, including postoperative pain, by Reeve, Menon and Corabian (1996) reported that 12 of 20 RCTs found that TENS was beneficial in postoperative pain.

Chest Expansion

Chest expansion was measured at three levels; axilla, at 4th intercostals and at Xiphoid process in both the groups which suggest that there was very significant difference at axilla and 4^{th} intercostal space but there was no significant difference at the xiphoid process. The difference between post values of both the groups (Group A and Group B) at axillary level was 0.65±0.13cms; at 4th intercostals was 0.425±0.067cms and at xiphoid process was 0.025±0.67cms respectively.

Breathing exercises produce a large and sustained increase in transpulmonary pressure which distends the lungs and reinflates the collapsed lung units, TEE re-expands the lung tissue and in mobilizing and clearing excess bronchial secretions is explained by the phenomenon of interdependence, which states that expanding forces exerted between adjacent alveoli. At high lung volumes the expanding forces between alveoli are greater than at tidal volume and assist in re-expansion of lung tissue. In FET, there is dynamic compression and collapse of the airways downstream (towards the mouth) of the equal pressure point. This is an important part of the clearance mechanism of either a huff or a cough. This exercise decreases the atelectatic area and increase ventilation. [13,14] So this exercise maintains expansion of lungs and prevents collapse due to which

chest expansion was improved more in group B. There is comparatively more increase in chest expansion in experimental group due to application of TENS. As TENS being the pain relieving modality it reduces the pain and helps in performing breathing exercises for effectively.

Suman Sheraz et.al, (July 2015) studied the blood gases and oxygen saturation response to active cycle of breathing techniques in COPD patients during phase 1 of cardiac rehabilitation on 100 patients, pre- test values of ABG, oxygen saturation, chest expansion, respiratory rate and heart ate of the participant will be taken. There was highly significant difference in PCO2 and oxygen saturation in experimental group as compared to control group and they concluded that ACBT is more effective than conventional physical therapy and there is significant increase in the chest expansion in experimental group after the treatment.

Forced Expiratory Volume in 1 second (FEV1) and Forced Vital Capacity (FVC): There was a highly significant difference in FVC values but there was no significant difference in FEV1 values.

FEV1 values in group A, mean difference between D1 and D14 was 0.41 ± 0.15 liters and in group B mean difference between D1 and D14 was 0.46±0.05 liters.

FVC values in group A, mean difference between D1 and D14 was 0.31 ± 0.09 liters and in group B mean difference between the D1 and D14 was 0.37±0.08 liters.

Sema Savci, Selvilay Sakinc et .al, studied the efficacy of incentive spirometer (IS) and active cycle of breathing techniques (ACBT) following coronary artery bypass graft (CABG) surgery. Sixty male patients (41-75 years) with CABG were included in the study. Thirty patients underwent ACBT and 30 patients underwent IS combined with mobilization. Patients were evaluated using pulmonary function tests, arterial blood gases, 6-minute walk test (6MWT), chest radiography, and a 10-cm visual analogue scale for pain perception. Fifth day post-operatively, pulmonary function variables were similarly but significantly decreased in both groups compared to pre-operative values (vital capacity decreased 15% and 18% in ACBT and IS, respectively, p=0.05). No significant difference was found in 6MWT distance obtained before and on the fifth day following CABG surgery within and between ACBT and IS groups (p>0.05). And they concluded that both treatments improved arterial oxygenation from the first day post-operatively. After a 5-day treatment, functional capacity was well preserved with the usage of ACBT or IS. Both physiotherapy methods had similar effects on the rate of atelectasis, pulmonary function, and pain perception.

FEV1/FVC Ratio: There was very significant difference within the group but there was no significant difference between the group. In Group A, mean difference between D1 and D14 was 3.68±1.40 liters and in group B mean difference between the D1 and D14 was 7.50±4.74 liters.

CONCLUSION

The present study shows that the use of ACBT had significant improvement on the chest expansion and pulmonary functions in both the group but the combined use of ACBT and TENS had highly significant effect in experimental group comparatively because of the use of TENS which reduces pain perception.

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