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Short Term Effects of Combination of ACBT, Chest Mobility Exercises and Tens on Chest Expansion, PEFR and Pain Perception Postabdominal Surgeries: RCT

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ABSTRACT

Background and objectives: Abdominal surgery involves a surgical repair, resection or reconstruction of organs inside the abdominal cavity. Postoperative pulmonary complications are common after abdominal surgeries. Pulmonary function tests, such as FVC, FEV1 and peak expiratory flow rate, are all reduced significantly after surgery, especially if the patient has pain. This purpose of the study is to determine the short term effects of combination of ACBT, Chest mobility exercises and TENS on pulmonary variables and pain on patients who had recent abdominal surgery.
Methods: The study was conducted on 40 stable patients who underwent major abdominal surgery of age above 25 years and were selected as per inclusion and exclusion criteria. They were randomly divided into experimental group1 (n=20) and control group2 (n=20). Group1 received combination of ACBT, chest mobility exercises and TENS while Group2 received breathing exercises and sham current, for 5 consecutive days. Pre and post differences in chest expansion, PEFR, and NPRS were assessed.
Results: Analysis of pre and post values of group 1 was done using Wilcoxon signed rank test which showed significant difference (P value < 0.05) for chest expansion, PEFR and NPRS. Between group analysis was done using Mann Whitney U test which showed significant difference (P value < 0.05) for all the three outcome variables.
Conclusion: It can be concluded from the present study that the combination of ACBT, Chest mobility exercises and TENS is effective in improving chest expansion, PEFR and reducing pain significantly in a short period.

Key words: Abdominal surgery, Postoperative pulmonary complications, ACBT, chest mobility exercises, TENS, Chest expansion, PEFR and NPRS.

INTRODUCTION

Abdominal surgery involves a surgical repair, resection or reconstruction of organs inside the abdominal cavity.[1] Abdominal surgeries can be either open, laparoscopic or robotic. Traditionally, during open abdominal surgery, the surgeon operates through an incision given over the abdominal wall or laparotomy, which is subsequently sutured or stappled.[1, 2]The common reasons for abdominal surgery are: - To remove diseased tissue/organ (ectomy) eg- gastrectomy, for repair (rhaphy/plasty) eg- herniorrhaphy, hernioplasty, to produce artificial opening (otomy/ostomy) eg- colostomy, ileostomy or for inspection (scopy) .[3]

Various Incisions are:

(A) Vertical incision: (1. Midline incision, 2. Paramedian incision), (B) Transverse incision: (1. Marryland muscle cutting incision, 2. Pfannenstiel incisions), (C) Oblique incision: (1. Kocher's subcostal incision, 2. McBurney's grid iron incision and 3. Rutherford Morrison oblique muscle cutting incision), (D) Thoracoabdominal incision: (Right or left thoraco-abdominal incisions). These surgeries carry a risk of complications which may be General, Specific complications of individual operation or time related like immediate, early or late post- operative complications. Postoperative complications include:

Haemorrhage, Wound infection, burst abdomen, incisional hernia. Cardiovascular complications-Arrhythmias, cardiac arrest, myocardial infarction or deep vein thrombosis, Pulmonary complications-Atelectasis, hypoxia, consolidation, pneumonia, pneumothorax, pleural effusion, bronchospasm, pulmonary oedema, pulmonary embolism, ARDS or respiratory failure. Gastrointestinal complications-Paralytic ileus, constipation, Urinary complications-Acute retention, acute renal failure or urinary tract infections, Cerebral complications and Pressure sores.[4,5,6]

Studies have shown Postoperative pulmonary complications (PPC) to be more common than cardiac complications, and the commonest was respiratory failure.[5] Incidence of PPCs in an Indian state study was 30.2%.[7] Mortality rate is increased in both the short and long term in patients who developed PPCS.[5] Morbidity is also increased by PPCs which is marked by postoperative hypoxemia.[8] Also the patients who suffered from combined pulmonary and cardiac complications had a longer stay.[9] Length of hospital stay (LOS) has shown to be prolonged by 13-17 days.[5] Surgical duration, anaesthesia and nociception can cause respiratory impairment, exacerbate muco-ciliary clearance depression and suppress the cough reflex leading to secretion retention and reduced lung volumes, thus contributing to atelectasis and infection.[10]

Previous studies show that a Major abdominal surgery can cause reduction in FRC and VC, attributed to diaphragmatic dysfunction, decreased chest wall compliance and cause pain during inspiration.[11] PFTs like FVC, FEV 1 and PEFR, are all reduced significantly after surgery, especially if the patient has pain.[5]

Along with the medical management, physiotherapy has a valuable role in prevention of PPCs as well as their treatment.[3] Chest physiotherapy has been an important component in the prevention and amelioration of PPCs following abdominal surgery and has been regularly utilized in both pre and postoperative care.[12]Active cycle of breathing technique (ACBT) comprises of repeated cycles of 3 ventilatory phases; Breathing control (BC), Thoracic expansion exercises (TEE) and Forced expiratory technique (FET). Effective in mobilizing and clearing the excess bronchial secretions and to improve lung function. It neither causes nor increases hypoxemia or increases airflow obstruction.[13,14] Chest mobility exercises combine active movements of the trunk or extremities with deep breathing. They are designed to maintain or improve mobility of the chest wall, trunk, and shoulder girdles.[15] These help to increase chest wall mobility, flexibility, and thoracic compliance and helps in performing effective muscle contraction and also increases tidal volume, reduces respiratory rate, dyspnea and facilitate relaxation.[16]

Transcutaneous electrical nerve stimulation (TENS) is the application of low frequency current in the form of pulsed rectangular currents through surface electrodes on the patient's skin to reduce pain. Its effect and use depend upon gate control theory and pain modulation.[17] It is a non-pharmacological, safe and non-invasive pain-relieving method.[18] TENS has been used after various procedures, including cardiac surgeries, abdominal surgeries, cesarean section, total knee arthroplasty, thoracotomy, etc.[19]

Maria W. Lamvel, et al (2016) conducted a RCT on patients with recent abdominal

surgeries for evaluating effect of ACBT and TENS on pulmonary function and pain perception and concluded that combined intervention of ACBT and TENS for 2 weeks had highly significant effect in experimental group because of TENS which reduces pain perception.[21] Dharmesh Parmar et Al (2015) studied the immediate effect of chest mobilization on chest expansion on COPD patients and concluded that chest wall mobilization significantly improved chest expansion.[24] Sukhyanti kerai et al (2014) concluded that TENS is effective in reducing post-operative pain following various surgeries. The success with use of TENS depends on appropriate selection of parameters and electrodes are to be placed around the surgical incision.[25]

Despite of the modern surgical methods there are many problems arising postoperatively during the hospital stay i.e PPCs, pain and others, for which physiotherapy treatment has been proven safe and effective. Individual studies have been done on effectiveness of individual effects of ACBT and chest mobility exercises in improving chest expansion, ventilation and pulmonary function and also on effectiveness of TENS on reducing postoperative pain. There are no studies which evaluate the combined effect of these three techniques. Also, from the previous studies the short-term effects of these techniques are not clear, so the present study is needed to evaluate the short- term effects of the combination of these techniques.

The objective of the study is to determine if the combination protocol (ACBT, Chest mobility exercise and TENS) improves chest expansion, peak expiratory flow rate (PEFR) and postoperative pain in a short- term period in patients with recent major abdominal surgery.

MATERIALS AND METHODS

Randomized control trial was conducted in Surgery Department, GG Hospital, Jamnagar. Ethical clearance was obtained from Ethical Committee of M.P Shah Medical college, Jamnagar.

The present study was conducted on total of 45 patients who underwent major abdominal surgery were selected according to the selection criteria. But 5 subjects dropped out of the study due to early discharge from the ward, thus remaining 40 subjects were randomly divided into two groups, where group A is the experimental group and group B is the control group. Both male and female patients aged above 25 years having recent upper or lower abdominal surgeries who were referred for physiotherapy were included in the study. Only patients who were willing to participate and who were able to comprehend and follow commands got selected for the study. Patients who underwent laparoscopic surgery, Haemodynamically unstable patients or patients having Rib or Thoracic vertebrae fracture, Infected incisional wound, Chest wall pain, Osteoporosis, Psychiatric illness, Peripheral vascular diseases or Neuromuscular diseases were excluded from the study.

Materials used include: Consent form, Peak flow meter, Measure tape, NPRS Scale, TENS machine, Chair, Pillow, Sterillium, Case Record form

INTERVENTION:

Intervention of group A included- ACBT, chest mobility exercises and TENS, while group B received diaphragmatic exercises and sham current.

ACBT Protocol included a cycle of Breathing control, Thoracic expansion exercise and FET

For Breathing control the patient performed relaxed abdominal breathing keeping his/her hand on the abdomen to feel the movement. 	For Thoracic expansion exercises the patient performed deep inspiration followed by a 3 second hold and then relaxed expiration. 3 to 4 repetitions and then pausing for a few seconds or again having breathing control.	Forced expiratory technique (FET)was performed which included, one or two huffs. Followed by pause for breathing control after one or two huffs. 

2)Chest mobility exercises - included the following:

To mobilize upper chest and shoulders: The patient being in chair sitting/high-sitting position performed bilateral shoulder flexion during inspiration and then bend forward at hips during expiration. To stretch pectorals: The patient clasped both the hands behind head, he/she was asked to horizontally abduct the arms during deep inspiration and to bring elbows together and bend forward during expiration. Trunk extension in sitting position: The patient clasped his/her both hands behind the head and was asked to slowly leaned back as like looking at the celling. The patient exhaled and returned to upright position, as shown in figure below. All these exercises were repeated 5 times each per session.

3)TENS PROTOCOL:

Placement: Electrodes were placed parallel to and at each end of incision about 2 to 3 cms away from incision. Parameters: Frequency - 80 to 120 hz, Pulse - short duration, Intensity - as tolerated by patient, Time - 10 minutes.

GROUP B intervention included diaphragmatic breathing and Sham current which was given as a placebo, as the parameters of this kind of current are not specific like other currents and does not hold any significant effect.

OUTCOME MEASURES:

The outcomes were assessed by another Physiotherapist during whole study for blinding purpose,

CHEST EXPANISON:

The patient's chest was exposed only when it was not objected by the patient. With non-stretchable inch-tape the chest expansion was measured at three levels, i.e. Axillary, 4th Inter-costal Space, Xiphoid process, as shown in figure below. Difference between inspiration and expiration was noted.

PEAK EXPIRATORY FLOW RATE (PEFR):

Measured using Peak-Flow-Master by Cipla. The cursor was set to zero mark initially. Patient held the peak flow meter horizontal in front of the mouth. Taking a deep breath in and closing the lips firmly around the mouthpiece making sure that there is no leakage of air through the lips. Patient was made to breathe out as hard and as fast as possible and number indicated by the cursor was noted. The cursor was returned to zero and this sequence was repeated 2 more times. The highest or best reading of all three measurements was recorded.

3)NUMERICAL PAIN RATING SCALE (NPRS):

The numerical pain rating scale measures the intensity of pain. It consists of an 11-point scale from 0 – 10, where 0 means no pain and 10 means most intense pain imaginable. Patients verbally selected a value from 0 - 10 that correlated to the pain experienced by them. The NPRS has a good sensitivity and

also its valid for measuring postoperative pain.

STATISTICAL ANALYSIS

The Statistical analysis was done using SPSS software version 20 for windows software. Mean was calculated as measures of central tendency. Standard deviation was calculated as measure of dispersion. Level of significance was kept at 5% with confidence interval (CI) at 95% (P value <0.05). Out of 45 patients, 5 patients were drop outs so only 40 patients were included in statistical analysis such that 20 patients were in experimental group and 20 patients in control group. For within group analysis in both groups after 5 days intervention for Chest expansion at 3 levels, PEFR and NPRS, analysis was done using Wilcoxon Signed Rank test. For Between group comparison for all outcome measures was done using Mann Whitney U test.

RESULTS

Table 1: Demographic characteristics of all subjects

Group	N	Gender		Age(years)	Body Mass Index(kg/m^2)
Group A(Experimental)	20	Male	13	43.75 ± 14.9	24.7 ± 4.82
		Female	7		
Group B(Control)	20	Male	17	51.45±16.33	22.54 ± 3.57
		Female	3		

All data are expressed as Mean ± SD, N= number of subjects

Table 2: Within group analysis of Group A

Outcome measures	Pre Mean ± SD	Post Mean ± SD	Z value	P value
Chest expansion at axillary level	2.32 ± 0.63	2.75 ± 0.5	-3.494	0.000
Chest expansion at 4th intercostal level	1.82 ± 0.63	2.45 ± 0.53	-3.729	0.000
Chest expansion at xiphoid process	1.6 ± 0.6	2.3 ± 0.57	-3.946	0.000
PEFR	88.5 ± 23.9	95 ± 23.7	-3.962	0.000
NPRS	5.55 ± 0.75	2.28 ± 0.76	-4.010	0.000

Interpretation: Wilcoxon signed ranks test was applied to compare the pre and post values of all outcome measures of group A. All the variables have P value 0.000 which shows that there is significant difference between pre and post values.

Table 3: Within group analysis of Group B

Outcome measures	Pre Mean ± SD	Post Mean ± SD	Z value	P value
Chest expansion at axillary level	2.27 ± 0.49	2.35 ± 0.46	-1.732	0.83
Chest expansion at 4th intercostal level	1.95 ± 0.68	2.07 ± 0.56	-2.236	0.25
Chest expansion at xiphoid process	1.57 ± 0.65	1.7 ± 0.61	-1.890	0.59
PEFR	88.5 ± 23.9	95 ± 23.7	-3.357	0.01
NPRS	5.55 ± 0.75	2.28 ± 0.76	-3.993	0.000

Interpretation: Wilcoxon signed rank test was applied to compare the pre and post values. Chest expansion at 4th Inter-costal level, PEFR and NPRS have P value less than 0.05 which shows that there is significant difference between pre and post values. While Chest expansion at Axillary level and at Xiphoid process level have P values greater than 0.05 which show that the difference is not significant.

Table 4: Between group analysis

Outcome measures	Z value	P value
Chest expansion difference at axillary level	-3.536	0.000
Chest expansion difference at 4th intercostal level	-4.281	0.000
Chest expansion difference at xiphoid process	-4.540	0.000
Peak expiratory flow rate difference	-5.481	0.000
Numeric Pain Rating Scale difference	-5.209	0.000

Interpretation: Mann Whitney U test was applied for between group analysis. P values for all the variables is less than 0.05, this shows that there is significant difference between the outcomes of both groups.

Thus, the results prove that null hypothesis was rejected and experimental hypothesis was accepted i.e, there is significant short term effect of combination of ACBT, chest mobility exercise and TENS on chest expansion, peak expiratory flow rate and pain perception in patients who underwent Abdominal surgery.

DISCUSSION

The purpose of the study was to find out the short term effect of combination of ACBT, Chest mobility exercise and TENS on chest expansion, PEFR and pain perception among patients who had Abdominal surgeries. The result of study demonstrated that there was a statistically significant difference in pre and post values of chest expansion, PEFR and NPRS after a five day intervention in GROUP A and show that Group A showed more improvement among all the outcome variables than the Group B.

After abdominal surgeries there are various changes occurring in pulmonary function and respiratory mechanics which can cause PPC which leads to reduction in pulmonary parameters like FVC, $FEV_{1,}$ PEFR, FRC and VC. Also, the chest expansion reduces. The present study intervention included the ACBT which consists of breathing control, thoracic expansion exercises (TEE) and forced expiratory technique (FET). Thoracic expansion exercise includes a minimum 3 second breath-holding period which can result in collateral filling among the alveoli and improved ventilation and mobilized secretions.[26] This exercise decreases the atelectasis area and increase ventilation maintains expansion of lungs and prevents collapse due to which chest expansion is thought to be improved more in Group 1. The effectiveness is also due to factors like the breathing control can lead to sustained increase in transpulmonary pressure which helps to distend the lungs and re-inflate the collapsed lung segments, TEE-expands the lung tissue and helps in mobilizing and clearing excess bronchial secretions which is explained by the phenomenon of interdependence.[27] Maria W. Lamuvel et al.,(2016) had similar findings as they studied the combined effect of ACBT and TENS on 40 abdominal surgery patients and concluded that the use of ACBT and TENS showed improvement in chest expansion and pulmonary function test with reduction in post-operative pain.[21]

Findings of Sejal Shingavi et al., (2017) support the present study as they compared ACBT and autogenic drainage on 30 abdominal surgeries and observed their effect on chest expansion, PEFR and inspiratory capacity. They concluded that ACBT is more effective than Autogenic drainage.[13] A study by Pryor et al.,(1990) stated that, a decrease in Spo2 caused by chest percussion may be avoided by using the ACBT technique.[28] ACBT increased FVC, PEFR, arterial oxygenation and exercise performance was found by Bipin et al., (2012). [29]

In the present study chest mobility exercise were given to Group A which help to increase chest wall mobility, flexibility, thoracic compliance and also to improve biomechanics of chest movement and maximal relaxed recoiling of the chest wall leading to effective contraction of each intercostal muscle. Findings of Gopi Mehta et al., (2015) support the present study and concluded that the combined intervention of PNF and chest mobility exercises showed significant improvement in chest expansion and pulmonary functions.[30]

The Group A was given TENS and Group B was given sham current as placebo, where group A was found more effective than Group B after analysis. TENS works on pain gate theory and another mechanism proposed is the activation of descending inhibitory pathway, according to which different opioid receptors are activated through release of endogenous opioids by different frequencies of TENS. Application of high frequency TENS activates μ-opioid receptors. These opioid receptors in turn activate the PAG-RVM pathway.[25] Findings by Silva MB et al., (2012) who studied the effect of TENS on pain, nausea, and emesis in patients admitted to surgery for laparoscopic cholecystectomy

support this study.[31]

Findings of Mohammed Taher Ahmed (2010) support the present study as he concluded that TENS is beneficial for postoperative pain relief following inguinal hernia repair without side effects and its pain-reducing effect lasted for one month postoperatively.[32] Birgitta Platon et al.,(2018) compared the pain relieving effect and the time spent in the recovery unit after treatment with high frequency, high-intensity TENS or intravenous opioids in 93 gynecologic surgery patients and concluded that TENS and opioids are both effective for pain relief after gynecologic surgery but TENS seems to be preferable for first choice of treatment as the treatment is associated with shorter time spent in recovery.[33]

The limitations of the present study were Male:female ratio was not equal. Muscle weakness which might be present postoperatively was not assessed. Length of hospital stay after the intervention was not measured.

CONCLUSION

The present study concludes that the combination of ACBT, Chest mobility exercises and TENS is effective in improving chest expansion, PEFR and reducing pain significantly in a short period among patients who had recent abdominal surgeries.

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