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The Effect of Breathing Exercise and Incentive Spirometry versus Breathing Exercise and EzPAP® on Flow Rates and Chest Expansion in Post Abdominal Surgery Patients: A Randomized Controlled Trial

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ABSTRACT

Induction of general anesthesia impairs gas exchange in the lungs, persists postoperatively, and may contribute to significant post-operative morbidity and health care cost. Post-operative complications range from 17% to 88%. Various reasons leading to these complications are incisional pain, accumulation of secretion, reduced chest expansion. The purpose of this study was to compare combination of breathing exercise and inspiratory spirometry v/s breathing exercise & EzPAP® & breathing exercise. The total number of subjects included in the study were forty, twenty (20) in each group. The subjects were randomly assigned to each group. Subjects in both the groups were treated for five days post operatively. The outcome measures used in the study were peak expiratory flow rate (PEFR), chest expansion, and pulse oximetry. Statistical analysis was done by using Wilcoxon sign ranked test for pre and post values of SpO2, PEFR & chest expansion for data which was not normally distributed. Mann Whitney U test was used to compare data between groups. Peak expiratory flow rates improved in both groups after treatment. Chest expansion improved on fifth post op day in both the groups. Pulse oximetry values improved in both groups, but in experimental group it was significant.

Keywords: Abdominal Surgery, Anesthesia, Saturation, Incentive spirometry, breathing exercise.

INTRODUCTION

Post Pulmonary complications are prevalent in abdominal surgical patients. It has been reported that post pulmonary complications in upper abdominal surgery range from 17% to 88%. Post pulmonary complication includes atelectasis, pneumonia, and respiratory failure.[1] Post pulmonary complications are common in post abdominal surgery patients because of incision pain, accumulation of secretion, reduced air entry on auscultation, reduced chest expansion.

Abdominal surgeries are mostly performed under general anesthesia which impairs respiratory muscle function.[3] Respiratory muscle function impairment leads to reduced vital capacity and FRC.

Pain at surgical site in post upper abdominal surgical patients results in shallow, monotonous breathing which may decrease ventilation to dependent lung regions and may develop atelectasis.[2]

Because of anesthesia respiratory system is depressed which affect cough reflex. Also due to reduced lung volume, incision pain, recumbence muco-ciliary escalator is affected leading to accumulation of secretion.

Physiotherapy has a mainstay in management of post-surgical complications. In the management of surgical patient's physiotherapy techniques commonly used includes preoperative education, deep breathing exercise, incentive spirometry, positive expiratory pressure (PEP device), continuous positive airway pressure (CPAP), early positioning and mobilization and less commonly intermittent positive pressure breathing.[4]

Incentive spirometry works on frequent maximum inspiratory effort and is used for the prevention and treatment of respiratory complications in post–surgery wards(5). It promotes deep breathing and sustained inspiration which leads to collateral ventilation.[6] It is goal-oriented feedback mechanism.[7]

Similarly, EzPAP®, is a positive pressure device which amplifies an input of either air or oxygen approximately four times greater using co-anda effect.[8] EzPAP® is an option for treating and preventing atelectasis when incentive spirometry won't maintain a patient's airway. The EzPAP® positive pressure airway system delivers CPAP using flow from an oxygen flow meter via a mouthpiece or facemask. EzPAP® is disposable device that does not have a significant economic cost. It allows patient to breath normally through the mouthpiece or mask.[9]

The aim of our study was to compare the effects of breathing exercise & EzPAP combined versus combination of breathing exercise & incentive spirometry.
There is paucity of data which compares incentive spirometer and breathing exercises with EzPAP® and breathing exercises to know its effect on flow rates and chest expansion. The purpose of the study was to compare and find effectiveness between both treatment options.

MATERIALS AND METHODS

Study design was comparative interventional study. Sampling was convenient. The study was conducted at NMMC hospital, Vashi & Terna multi-speciality hospital & research center. Nerul, Navi Mumbai. Both Control & experimental group consisted of Twenty (20) subjects.

Sample size was based on the literature data, in the study report, the intra group comparison of Group A & Group B of PEFR's mean ± SD values were 115.3 ±40.6 and 140.3± 40.8 respectively in pre-test study. Considering the maximum variation value as 40.8, minimum power value as 80%, level of significance 5% the estimated sample size was forty (40).

Software for Statistical analysis used was SAS 9.1.3. The total duration of study was Eight months. We included subjects between 18-65 years of age, Post-operative upper abdominal surgery, Included: laparotomy, Cholecystectomy, Hepatec-tomy, Pancreatectomy, Gastrectomy, Enterectomy & ability to sign consent.

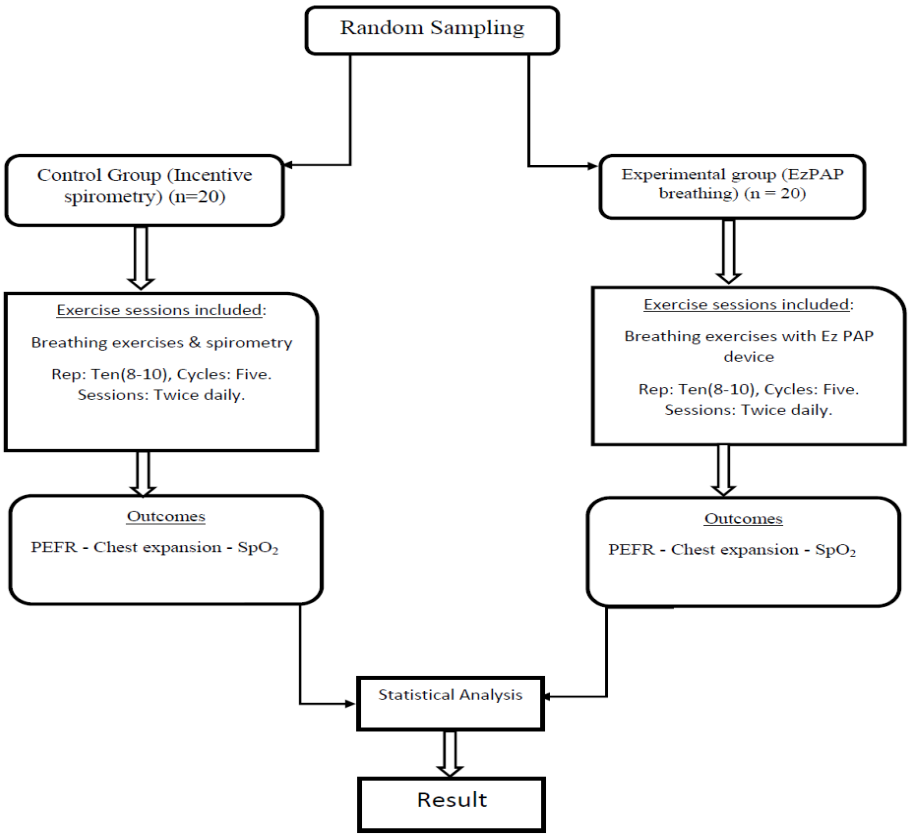
We excluded patients whose anticipated post-operative hospital stay of less than three days, Body mass index > Thirty, Inability to follow verbal instruction, Patients with pre-existing pulmonary complication, Patients operated for laparoscopic surgery.

STUDY PROCEDURE

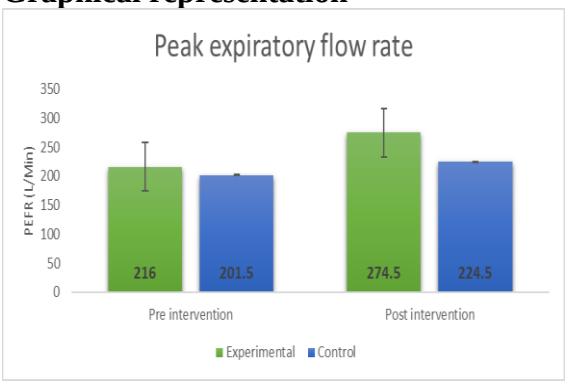
Permission was obtained from institutional scientific & institutional ethics committee. The procedure, possible benefits, risks and discomforts of participating of the study were explained to the subjects. They were made aware of their right to withdraw from study at any point of time before taking signed consent. Equipment's used included stethoscope to check air entry in lungs, Pulse Oximeters to measure oxygen saturation. Measuring tape for measuring chest expansion. Flow meter is used to check pre and post treatment peak

expiratory flow rates. Oxygen cylinder to connect to EZPAP device. Informed consent was taken from patients, they were explained about the procedure, possible benefits, risks and discomforts of participating in the study. They were made aware of their right to withdraw from study at any point of time.

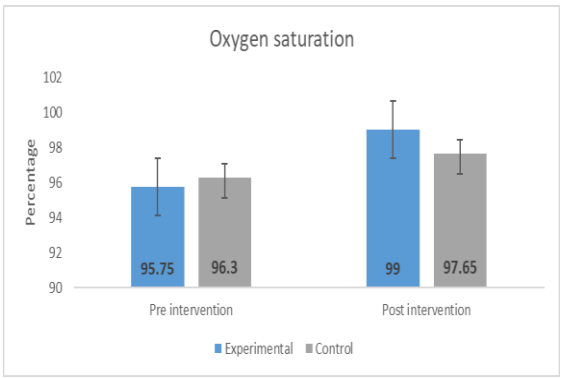
Statistical analysis was to compare the efficiency of both the techniques, normality of both the group data was checked. Normality was checked using Shapiro rank test. Data within normal distribution was compared with parametric tests. Data which is not normally distributed was compared with non-parametric test. For data within normal distribution the paired t test was used to compare pre and post values PEFR, Chest expansion and SPO_2 of same group, whereas unpaired t test was used to compare post treatment values of PEFR, Chest expansion, SPO_2 of control group and experimental group. Data processing was done with the help of data analysis software i.e. statistical package for social science 25 version.



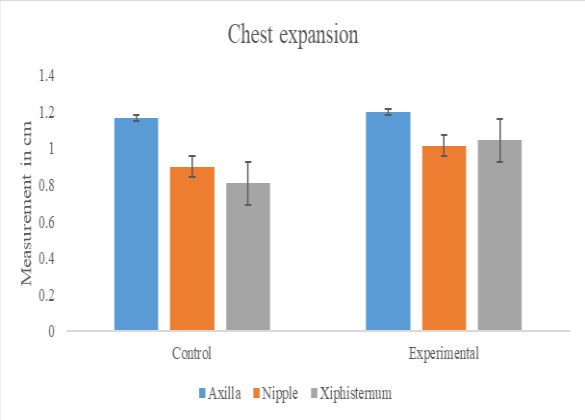
Graphical representation



a) Peak expiratory flow rate



b) Oxygen saturation



c) Chest expansion: Values post treatment.

RESULTS

1) PEFR, chest expansion- axillary level, nipple level, xiphisternal level, SPO2 increased significantly after treatment with incentive spirometer and breathing exercise.
2) PEFR, chest expansion- axillary level, nipple level, xiphisternal level, SPO2 increased significantly after treatment with EZPAP and breathing exercise.
3) On comparison of post treatment results of both the groups PEFR, chest expansion-at nipple and xiphisternal level, SPO2 showed more significant difference in experimental group (EzPAP and breathing exercise) values than in control group (incentive spirometer and breathing exercise) while there was no difference in chest expansion at axillary level.

DISCUSSION

The investigation was a randomised clinical trial conducted over six months to test the effectiveness of incentive spirometry and breathing exercises versus EzPAP and breathing exercises on subjects with post abdominal surgery. The results of this investigation indicated statistically significant improvement in PEFR, chest expansion at all levels, and SPO_2 for subjects of both groups.

Peak expiratory flow rates improved in both groups after treatment. The experimental group showed significant improvement as compared to the control group. An incentive spirometer improved peak expiratory flow rate. This is probably due to improvement in diaphragmatic excursion postoperatively, which improved lung volume. Incentive spirometry encourages deep breathing, which leads to collateral ventilation and an improvement in lung volume.[5] The experimental group outperformed the control group. This could be because the EzPAP device amplifies airflow four times and provides greater flow and volume with less effort as compared to the incentive spirometer. Also, positive pressure is provided on expiration, which helps in re-expansion of collapsed alveoli and increases lung volume. [9] In incentive spirometry and EzPAP, breath control is involved and thus the flow rates, which themselves are volume dependent and effort-dependent, are improved. The improvement in peak flow rate in this study is similar to a previous study by Wange et al which compared incentive spirometry versus ACBT on chest expansion and flow rates in post abdominal surgery patients[10].

Thoracic excursion measurements showed significant improvement on the fifth post-operative day. Chest expansion at all levels showed improvement in both groups. However, chest expansion was comparatively better in the experimental group. In the experimental group, high lung volume was provided with EzPAP. At high lung volumes, the expanding forces between the alveoli are greater than at tidal volume and may assist in the re-expansion of lung tissue. [11] Lung tissue re-expansion improves overall lung compliance. This in turn helps in the improvement of thoracic compliance. Whereas, in the control group, deep breathing exercises and incentive spirometry improved respiratory muscle efficiency, thereby improving chest expansion. [10] However Chest expansion at axillary level showed no difference. This is probably because the pain and muscle guarding were not significant in these areas. In most patients, the incision was at the umbilical level. The improvement in thoracic excursion in this study is similar to that which has been shown in previous

studies investigating the use of the EzPAP positive pressure device by respiratory physiotherapists [14].

Arterial oxygen saturation improved after treatment in both groups due to resolving respiratory conditions, but improvement was greater in the experimental group. In the control group, this may be due to deep breathing exercises that allow air to flow via collateral channels, and air behind secretion may assist in mobilising them. Also, three-second holds at full inspiration decrease the collapse of lung tissue and improve gaseous exchange. In the experimental group, this improvement is because of deep breathing exercises and EzPAP therapy, which gives positive end expiratory pressure, which prevents the collapse of alveoli, improving gaseous exchange. It can also be due to increased inspired oxygen concentration, which will lead to a gradual increase in alveolar oxygen in poorly ventilated alveoli as more of the nitrogen is replaced by the added oxygen. [12]

The present study also supports the finding of a retrospective analysis of the use of the EzPAP positive pressure device by respiratory physiotherapist, S. Elliot, who evaluated the clinical use and outcomes of the EzPAP positive pressure device [13]. The results observed in this study have shown that deep breathing exercises and incentive spirometer versus deep breathing exercises and EzPAP are effective for improving lung function in the immediate post-operative period following abdominal surgery, and the experimental group shows a more significant increase than the control group. This is noted with the significant improvement in PEFR, thoracic excursion measurement, and arterial oxygenation. Few limitations of our study are Baseline for SPO_2 observed was within normal ranges after surgery in population of this study so; effects of EZPAP on patients with low arterial oxygenation were not tested. Radiographic investigations eliciting exact diaphragm excursion would have been more conclusive.

This study has shown that EzPAP can improve flow rates and chest expansion more effectively as compared to incentive spirometer. Hence we conclude that combination of EzPAP and breathing exercises have better effects as compared to combination of spirometer and breathing exercises.

Images showing devices used

Peak flow meter Device code: ISO 23747	
PULSE OXIMETER-Device code: ISO 13485 FDA IEC NO- 0516928902	
Incentive spirometer(Flow based)	

EzPAP DEVICE- Device code: US 6253766D441070 US	
OXYGEN CYLINDER	
EzPAP device with oxygen cylinder connected	

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Conflict of Interest: None

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Ethical Approval: Approved

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