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# Post-Laparotomy Pulmonary Complications in Blow Bottle versus Interdigital Breathing Technique: A Quasi-Experimental Study

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## ABSTRACT

***Objective:*** To analyze the impact of interdigital versus blow-bottle breathing exercises on spirometry, pulse oximetry and respiratory rate in post-laparotomy patients.
***Study Design:*** Quasi-experimental study.
***Place and Duration of Study:*** Riphah College of Rehabilitation Sciences, Riphah International University and Capital Hospital, Islamabad, Pakistan, from Apr to Aug 2018.
***Methodology:*** This quasi experimental study recruited 27 post laparotomy patients, male and female, aged between 25-45 years. Along with conventional treatment for both groups, Group-A (n=14) received interdigital breathing exercises and Group-B (n=13) was given blow-bottle breathing therapy. Effect on spirometry, pulse oximetry tests and respiratory rate on Day 1, 3 and 6 were recorded.
***Results:*** On 6th Day post-laparotomy, interdigital group (Group A) showed significantly higher median and mean ranks for oxygen saturation (OS) ($p$<0.001), rate of peek expiratory flow ($p$=0.000), forced expiratory volume (1 second) ($p$=0.018), forced vital capacity (p<0.001) and lower respiratory rate (p<0.001). Blow bottle breathing therapy revealed significantly higher mean for forced vital capacity ($p$=0.017), but was lower for Oxygen saturation ($p$<0.001) and respiratory rate ($p$<0.001).
***Conclusion:*** Our findings lead us to conclude that interdigital technique provides more benefit to post-laparotomy patient compared to blow bottle technique in effective management of pulmonary complications.

**Keywords:** Blow bottle, Breathing, Interdigital, Laparotomy, Spirometry.

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## INTRODUCTION

Laparotomy is a diagnostic and therapeutic intervention for intraabdominal pathologies.[1] While surgeries with minimal access have reduced the need for laparotomies, elective laparotomies are still needed for procedures like pancreaticoduodenectomy, transplantation and emergency conditions.[2] Complications such as fever, vomiting and nausea, commonly occur after emergency laparotomy, but rarely, more serious complications such as chronic obstructive pulmonary disease (COPD) associated with chest and wound injuries, burst abdomen, fistulas, sepsis, hemorrhage, thromboembolism, visceral injuries and even death.[3,4] In spite of advances in the surgical field, thoracic and abdominal surgical procedures affect both the cardiovascular and the respiratory system with different chest physiotherapy techniques showing variable effectiveness in improving the functioning of both systems,[5] with interventions like earlier mobilization, huffing, deep breathing, spirometry and process of coughing.[6] While laparotomy is associated with a high incidence of pulmonary complications, up to 30.2% in literature,[7] leading to lengthy hospitalization and morbidity, increasing treatment costs and mortality,[8] thus, making positive expiratory pressure (PEP) of 10-20 cm of H2O essential at middle expiratory level for the prevention of airway collapse.[9] It is well known that postoperative changes in pulmonary function occur with altered function of diaphragm and other chest muscle, resulting in decreased Forced Vital Capacity (FVC) and decreased Forced Expiratory Volume in 1 sec (FEV1). The reduced Inspiratory Capacity, Functional Residual Capacity (FRC), and Vital Capacity (VC), make effective cough production difficult for the patient.[10]

Keeping in view the high prevalence of postoperative pulmonary complications (PPC), dearth of quality research and lack of evidence of effectiveness of different devices in Pakistani context , the current study design was planned to

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analyze the impact of interdigital versus blow bottle breathing exercises on various parameters such as spirometry, pulse oximetry and respiratory rate, in terms of FVC, FEV1, peek expiratory rate of flow (PEFR), oxygen saturation (OS), rate of respiration (RR) and pulse rate (PR), to help clinicians in selecting better rehabilitation therapy.

## METHODOLOGY

The quasi-experimental study was carried out at Riphah College of Rehabilitation Sciences, Riphah International University and Capital Hospital, Islamabad, Pakistan, from April to August 2018 after approval from the Ethics Review Committee (Number RIPHAH lRCRS/RECILetter-00313, dated 20th March 2018).

**Inclusion Criteria:** Post-laparotomy patients with pulmonary complications, of either gender, aged 25-45 years, and being managed as indoors department patients, were included.

**Exclusion Criteria:** Patients who were vitally unstable, having complicated post-laparotomy complications such as delirium, were excluded.

After taking informed consent, conventional treatment was provided to all enrolled patients, according to hospital protocol, which included incentive spirometer 3-4 times a Day, percussion 2 times a Day, mobilizing patient on 2nd post-operative Day and limb physio on zero and 1st post-operative Day. Total sample size of 30 post-laparotomy patients, meeting selection criteria, was randomly allocated into Group-A and Group-B using lottery method. Group A was provided Interdigital breathing exercises and Group B was given physiotherapy using Blow Bottle technique. Initially, there was an equal number of 15 patients in each group, however, one patient from Group A and two from Group B dropped out of the study, leaving behind 14 in Group A and 13 in Group B, with total of 27 (Figure).

Digital spirometer was used for the assessment of FVC, FEV1, PEFR. Pulse Oximeter including probe was used for assessment of oxygen saturation and digital monitor for assessing respiratory and pulse rates was used for data collection along with recording basic demographic characteristics on data collection sheet. Blow Bottles comprise of two 1 Liter plastic bottles attached with a tube made of plastic through the bottle openings, and patient would blow water from one to the other bottle requiring 18-36 mm of H2O pressure.

Data was entered, coded and statistically analyzed using Statistical Package for the social sciences (SPSS) version 25.00. Descriptive statistics were utilized with frequency and percentage calculated for gender, Mean±SD for age, and median interquartile range (IQR) for the test variables. Non-parametric Mann-Whitney U test and Friedman Test were utilized to analyze the between groups and within group difference respectively. Pearson's r was used to measure the effect size. The *p*-value of ≤0.05 was considered significant.

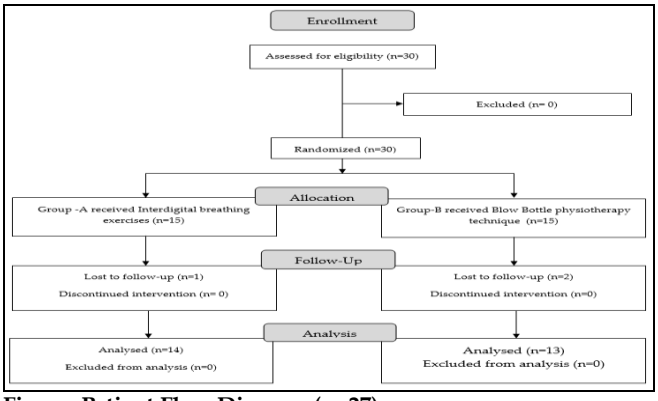


**Figure: Patient Flow Diagram (n=27)**

## RESULTS

This study included random allocation of patients into two groups with n=27 with Group A (Interdigital breathing) =14 and Group B (Blow Bottle) =13. Group A had a mean age of 36.21±7.52 years and 36.08±6.08 years in Group B. The male population in Group A was 9(64.3%) and 7(53.8%) in Group B, while the female population was 5(37.7%) in Group A and 6 (46.2%) in Group B.

With $p<0.05$ considered significant, current study results revealed no significant difference between Group A and Group B with $p>0.05$ for FCV, FEV1and PEFR (Table-I).

No significant difference emerged between Group A and Group B variables of OS, RR and PR at base line and post-intervention with $p>0.05$ (Table II).

Significance of applied interventions within group at 3 different intervals i.e., at Day 1, Day 3 and Day 6 (Table III) were assessed which revealed that within the Group A, significant improvement was noted with maximum median (IQR) at Day 6 for FCV, FEV1, PEFR, OS and RR with $p<0.001$ ($p=0.008$, $p=0.018$, $p<0.001$ and $p<0.001$, respectively). However, no significant difference in PR was noted with $p=0.607$. Within Group B, the difference in median (IQR) at Day

**Table I: Results for Level of FVC, FEV1, PEFR in Group A and B at Baseline and Post-Intervention, (n=27)**

| Parameters | Timing | | Study Group Median (IQR) | | *p*- value |
|---|---|---|---|---|---|
| | Day | Intervention | Group-A (n=14) | Group-B (n=13) | |
| Forced Vital Capacity (FVC) | 1 | Pre | 1.17(.80) | 1.6(.80) | 0.941 |
| | | Post | 1.62(.79) | 1.62(.62) | 0.607 |
| | 3 | Pre | 1.17(1.13) | 1.17(1.03) | 0.677 |
| | | Post | 1.85(1.51) | 1.85(1.26) | 0.387 |
| | 6 | Pre | 1.94(1.04) | 1.94(.85) | 0.961 |
| | | Post | 2.37(.94) | 1.87(.99) | 0.303 |
| Forced Expiratory volume in 1 second (FEV1) | 1 | Pre | 0.70(.16) | 0.72(.22) | 0.902 |
| | | Post | 0.96(.15) | 0.93(.66) | 0.863 |
| | 3 | Pre | 0.72(.24) | 0.55(.53) | 0.902 |
| | | Post | 0.86(.41) | 0.86(.80) | 0.391 |
| | 6 | Pre | 1.0(1.60) | 1.23(.93) | 0.589 |
| | | Post | 1.0(.75) | 0.86(.99) | 0.27 |
| Peak Expiratory Flow Rate (PEFR) | 1 | Pre | 0.80(.47) | 0.87(.75) | 0.876 |
| | | Post | 1.22(.80) | 1.22(2.11) | 0.211 |
| | 3 | Pre | 0.89(.61) | 0.82(1.0) | 0.903 |
| | | Post | 0.96(.59) | 0.96(2.45) | 0.204 |
| | 6 | Pre | 1.76(3.24) | 1.76(1.61) | 0.98 |
| | | Post | 1.76(.61) | 1.78(1.86) | 0.446 |

**Table-II: Results for Between Group Analysis for OS, RR, and PR for both Group A and Group B at Baseline and Post-Intervention, (n=27)**

| Parameters | Timing | | Study Group Median (IQR) | | p-value |
|---|---|---|---|---|---|
| | Day | Intervention | Group-A | Group-B | |
| Oxygen Saturation | 1 | Pre | 98(.00) | 98(.50) | 1 |
| | | Post | 97(1) | 97(.50) | 0.849 |
| | 3 | Pre | 98(2) | 99(1.50) | 0.349 |
| | | Post | 98(0) | 98(0) | 0.335 |
| | 6 | Pre | 99(.00) | 99(.00) | 0.937 |
| | | Post | 99(.00) | 99(.00) | 0.937 |
| Respiratory Rate | 1 | Pre | 26(6.0) | 26(6.0) | 0.881 |
| | | Post | 32(6.0) | 32(6.0) | 0.496 |
| | 3 | Pre | 26(6.0) | 26(4.0) | 0.341 |
| | | Post | 26(6.0) | 30(5.0) | 0.401 |
| | 6 | Pre | 23(4.0) | 26(3.0) | 0.136 |
| | | Post | 23(4.0) | 26(6.0) | 0.137 |
| Pulse Rate | 1 | Pre | 72(22) | 72(14) | 0.643 |
| | | Post | 88(20) | 71(30) | 0.118 |
| | 3 | Pre | 75(11) | 73(10) | 0.165 |
| | | Post | 74(11) | 73(11) | 0.235 |
| | 6 | Pre | 75(6.0) | 73(5.5) | 0.561 |
| | | Post | 72(1.0) | 72(2.0) | 0.96 |

6 compared to Day 1 was not significant with $p$=0.500, $p$=0.584, $p$=0.146 for FEV1, PEFR and PR respectively. However, median (IQR) at Day 6 for FVC, O2 saturation and RR was higher with $p$=0.017, $p$<0.001 and $p$<0.001 respectively. This shows significant improvement with interdigital breathing technique in post laparotomy patients.

## DISCUSSION

Chest physiotherapy is being used form as far back as the early 20th century to minimize lung functions compromised by complications, using non-invasive procedures such as mobilization, draining secretions using postural changes, cough initiation, breathing exercises, huffing, percussion, and vibrations. Although one study concluded that incentive spirometry was not useful in recovering lung function and for PPC,[10] patients are trained in controlling the pattern of breathing as well as incentive spirometry to have better control of breathing.[11]

There is a dearth of evidence in favor of PEP being comparatively better than physiotherapy

**Table-III: Results For Within Group Analysis (Group A and Group B) for FVC, FEV1, PEFR, OS, RR and PR from Day 1 to Day 3 and 6 of Treatment, (n=27)**

| Parameters | Day | Group-A Interdigital Breathing | *p*-value | Group-B (Blow Bottle) | *p*-value |
|---|---|---|---|---|---|
| | | Median (IQR) | | Median (IQR) | |
| FVC | 1 | 1.62(1.8) | | 1.62(0.62) | |
| | 3 | 1.89(1.4) | *p*<0.001 | 1.85(1.26) | 0.017 |
| | 6 | 2.53(0.94) | | 1.87(0.99) | |
| FEV1 | 1 | 0.96(0.11) | | 0.93(0.67) | |
| | 3 | 0.87(0.25) | 0.008 | 0.86(0.8) | 0.500 |
| | 6 | 1.28(0.75) | | 0.86(0.99) | |
| PEFR | 1 | 1.22(0.8) | | 1.22(2.11) | |
| | 3 | 0.96(0.5) | 0.018 | 0.96(0.44) | 0.584 |
| | 6 | 1.76(0.6) | | 1.78(1.86) | |
| Oxygen saturation | 1 | 97(1) | | 97(0) | |
| | 3 | 98(0) | *p*<0.001 | 98(0) | *p*<0.001 |
| | 6 | 99(0) | | 99(0) | |
| RR | 1 | 32(6) | | 32(6) | |
| | 3 | 26(6) | *p*<0.001 | 30(5) | *p*<0.001 |
| | 6 | 23(4) | | 26(6) | |
| PR | 1 | 88(20) | | 71(30) | |
| | 3 | 74(12) | 0.607 | 73(11) | 0.146 |
| | 6 | 72(4) | | 72(4) | |

breathing techniques, even though a number of simple PEP breathing devices are in use like Blow-bottle with water seal resistance, PEP mask with resistors and Blow glove having a glove attached to long tube,[12,13] which then, utilizing Hagen–Poiseuille Law, a raised trans-luminal pressure in airway is generated during expiration, using PEP, such devices are flow-regulated by exhalation utilizing a mouthpiece or mask, as shown by a study which concluded that tubing PEP with 4 mm diameter oxygen tube behaved like PEP regulated device, capable of providing therapeutic PEP of 10-20 cm of water, however the authors recommended further in-vivo trials.[14]

While many studies have advocated for physiotherapy of respiratory exercises as being beneficial, there is dearth of high-powered research, due to which conclusions cannot be clearly drawn,[15-17] indicating need for research, particularly in Pakistani context. Concurrently, the use of locally made PEP devices like Blow Bottle was more prevalent compared to commercial devices for PPC especially for clearing secretions, prevention and treatment of collapse of alveoli and shortness of breath,[18] although one review noted that there was no significant difference regarding scoring of atelectasis between blow bottle technique and bi-daily physiotherapy regime including breathing exercises and postural drainage.[19] While one author noted that presently no single physiotherapy treatment is declared as having higher effectiveness than the other,[20] our study revealed significant improvement in the interdigital therapy group in parameters of FCV, FEV1, PEFR, OS and RR while in the blow bottle breathing group, the values of FEV1, PEFR, and PR did not show significant improvement at 6 Days post-operatively. In another study,[21] involving post-caesarean cases with exercises including deep breathing, inter-digital techniques and coughing techniques in test group compared to routine postnatal care in control group revealed significant improvement ($p$<0.001) in pulmonary function, supporting the results of the current study. While one author could not find any significant evidence in favor of blow bottle usage compared to conventional cardio-respiratory physiotherapy done post operatively,[19] another group of researchers in their study to prevent atelectasis, noted pulmonary complications in 30% of those given intermittent positive pressure breathing, 15% with incentive spirometer use and just 8% with blow bottle use.[22] With regards to incentive spirometry, one randomized control trial in adults, with median age of 35 years and higher male preponderance in test and control groups, pulmonary function with FVC was noted following exploratory laparotomy by incentive spirometer did not reveal significant association between FVC of test and control group, hence incentive spirometry was not recommended to be added to the care regimen.[23] Similarly, another researcher also did not find any

evidence favoring use of incentive spirometry either in prevention of PPC or for recovery of pulmonary function.[18] Interestingly, one study in which blow bottle use, by sitting and blowing bubbles in bottle having 10 cm water via a tube 20 times for 10 times daily was compared with simple sitting and taking 20 deep breaths 10 times daily, was used in treatment of cases of pneumonia revealed no difference in peek expiratory flow, VC and FEV1, however blow bottle use shortened overall hospital stay 20, suggesting some positive application of addition to treatment regimen.

## LIMITATIONS OF STUDY

Access to advanced equipment for respiratory assessment and treatment was restricted due to funding constraints. Cultural or language barriers affected patient participation and understanding of interventions. Limited prior research specific to the Pakistani population also made it challenging to establish appropriate baseline data or compare outcomes. Additionally, we faced difficulties in long-term follow-up of patients due to logistical issues in the local healthcare system. These limitations could potentially impact the study's overall conclusions and applicability to general population.

## CONCLUSION

We conclude that inter-digital technique provides more benefit to the post laparotomy patient compared to blow bottle technique to manage postoperative pulmonary complications.

**Conflic of Interest:** None.

**Authors' Contribution**

Following authors have made substantial contributions to the manuscript as under:

HA & NF: Data acquisition, data analysis, critical review, approval of the final version to be published.

SS & GS: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

HA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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