

Effect of Acapella on Lung Function in Patients Post-Operative Cardiac Surgery: Experimental Study

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Abstract:

Background: Cardiac surgery (sternotomy with cardiopulmonary bypass) commonly impairs lung function and raises the risk of post-operative pulmonary complications. The Acapella device, which combines airway oscillation with expiratory resistance, may help but is understudied in this population.

Objective: To assess whether one week of Acapella use improves pulmonary function after cardiac surgery.

Methods: A single-arm pre-post pilot study of 15 post-cardiac surgery patients, with spirometry (FVC, FEV1, FEV1/FVC, PEFR) measured on Day 1 and Day 7 of Acapella use. Paired t-tests compared pre- and post-values.

Results: All parameters improved significantly by Day 7 — FVC, FEV1, PEFR, and MEFR showed strong gains ($p < .001$ – $.001$), while FEV1/FVC also improved, though more modestly ($p = .007$).

Conclusion: One week of Acapella use was linked to broad improvements in lung function post-cardiac surgery. Given the small, uncontrolled sample, larger controlled trials are needed before recommending it as standard practice.

Keywords: Forced expiratory volume in first second (FEV1), Forced vital capacity (FVC), Peak expiratory flow rate (PEFR,) American Thoracic Society (ATS), Body Mass index (BMI)

Introduction:

By altering the movement of the chest wall, causing inflammation, and occasionally damaging the phrenic nerve, cardiac surgery, particularly sternotomy and cardiopulmonary bypass, severely strains the lungs, impairing breathing and the lungs' capacity to expel mucus. Because of this, pulmonary problems following surgery are prevalent, with atelectasis (partial lung collapse, typically in the lower left lung) being the most common issue. Patients with atelectasis are more likely to experience impaired oxygen exchange and respiratory failure, as well as a significantly greater decline in lung function (FVC and FEV1). Easy-to-use breathing techniques are beneficial for early recovery since anaesthesia, diaphragm weakness, changes in the chest wall, fluid surrounding the lungs, and pain from the incision all contribute to this collapse. The Acapella gadget is a straightforward handheld device that helps clean and release mucus and reopen compressed lung regions by combining vibration and resistance during exhalation. It improves lung function and mucus clearance more effectively than normal physiotherapy alone, according

to earlier study, and it also works well for other lung disorders. However, not enough research has examined Acapella specifically following heart surgery, particularly examining its impact on lung function, oxygen levels, and dyspnea. This study attempts to fill that knowledge gap.

MATERIAL AND METHODOLOGY:

Participation: Study was conducted in Department of Cardiovascular & Thoracic surgery in a Tertiary Care Teaching Hospital for which duration of the study was 1 year with patient diagnosed with cardiac surgery was taken where sample size was 15 patients. Institutional Ethical Committee approval was taken before the commencement of the study Screening of patients was conducted in accordance with the specified inclusion and exclusion criteria. Inclusion criteria: - Age 20 yrs to 60 Both male and female Patients undergoing uncomplicated cardiac surgery Patient with stable hemodynamic Participants willing to give consent. Exclusion criteria- Subject with pre diagnosed respiratory pathology Subject already diagnosed with any neuromuscular disease which directly affects the lung functions. Rib fracture

Intervention: - Acaeplla + Conventional Physiotherapy (Diaphragmatic Breathing Exercise (10 repetition & 2 set per day from POD1 To POD 7)

Incentive Spirometry (10 repetition & 2 set per day from POD1 ToPOD7)

Early Mobilization (2 set per day from POD1 To POD 7)

Ankle Toe Movement (10 repetition & 2 set From POD1 To POD7)

OUTCOME MEASURE: -

According to 2019 ATS guidelines, spirometry was used to quantify pulmonary function (FEV1, FVC, FEV1/FVC, and PEFR). Prior to the test, the patient's anthropometrics, smoking history, and demographics were noted, and BMI was computed. With a nose clip in place and ongoing therapist coaching to guaranty maximum effort, each move included maximal inspiration, forced expiration to a flow plateau or FET of six seconds, and a last quick full inspiration. The best-effort manoeuvre was employed for analysis after three attempts.

Appropriate Study Instruments:

Pulmonary Function Test: - Helios 401 (RMS Pulmonary function test) spirometer with software, Mouthpiece, Nose Clip, Handheld Probe, Weighing Machine, and Stadiometer

Acapella: Protex Acapella Respiratory Device (REF 21 -1531

Statistical Analysis: -

Pre- and post-intervention (Day 1 vs. Day 7) pulmonary function parameters were compared using a paired samples t-test in SPSS, with each patient (n = 15) serving as their own control and significance set at $p < 0.05$ (two-tailed, $df = 14$).

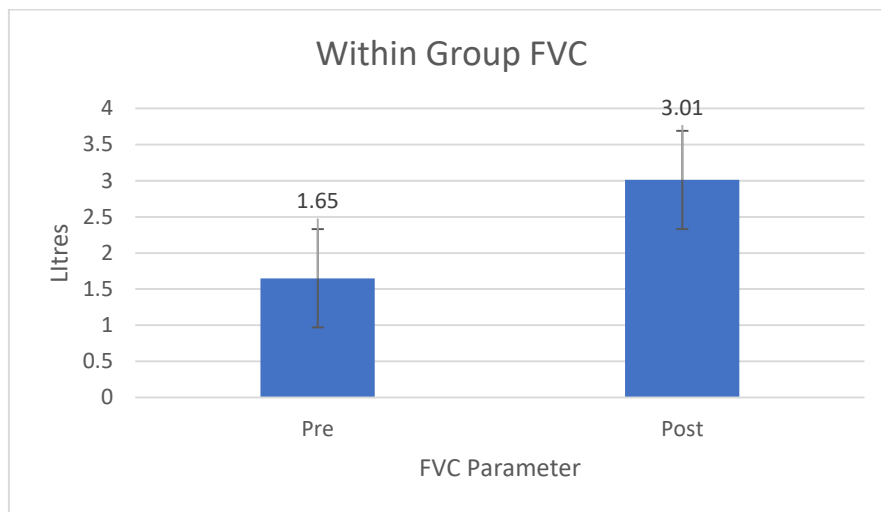
Result:

In brief, this pilot study examined the lung function of 15 patients undergoing cardiac surgery on Day 1 immediately post-operation, and again on Day 7 after one week of Acapella device use. By Day 7, every lung function measure had improved, and these increases were statistically significant, not by chance. Patients had higher peak and mid-range breathing speeds (PEFR and MEFR), could exhale more total air (FVC), and exhaled air more quickly in the first second (FEV1). The change in the airway narrowing measure (FEV1/FVC ratio) was the smallest and most inconsistent of the patients but showed improvement.

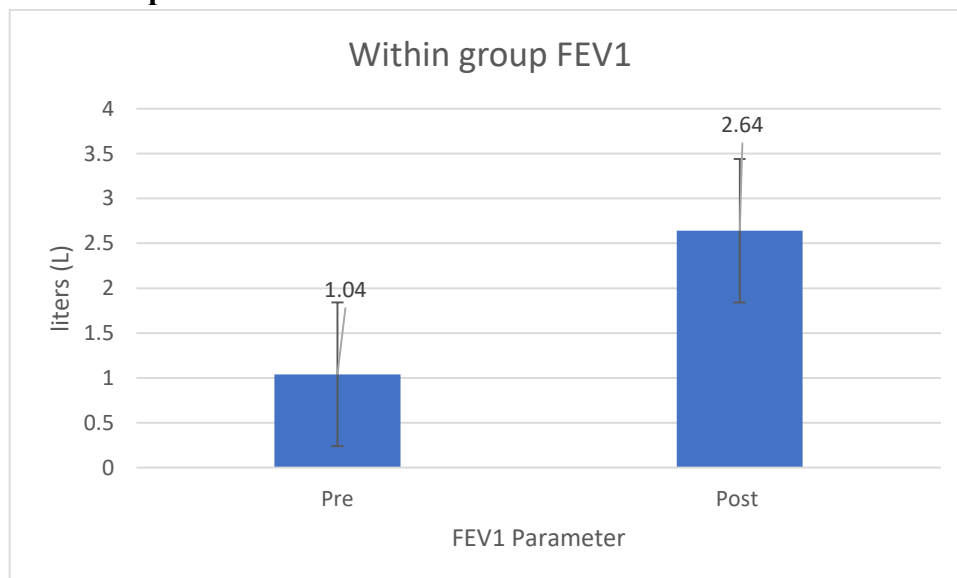
Overall, the results suggest that lung function improved substantially after heart surgery after a week for study

1. Comparison of FVC parameter

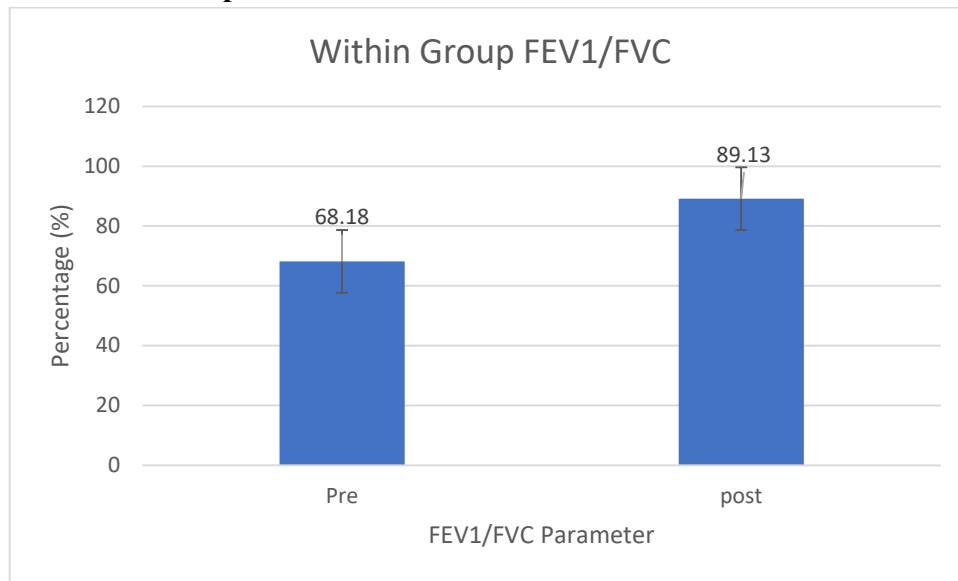
COMPONENT	PRE	POST	DIFFERENCE	P VALUE
FVC	1.65	3.01	1.36	<0.05
FEV1	1.04	2.64	1.6	<0.05
FEV1/FVC	68.18	89.13	20.95	<0.007
PEFR	2.81	5.81	3	<0.01
MEFR	1.34	3.35	2.01	<0.05



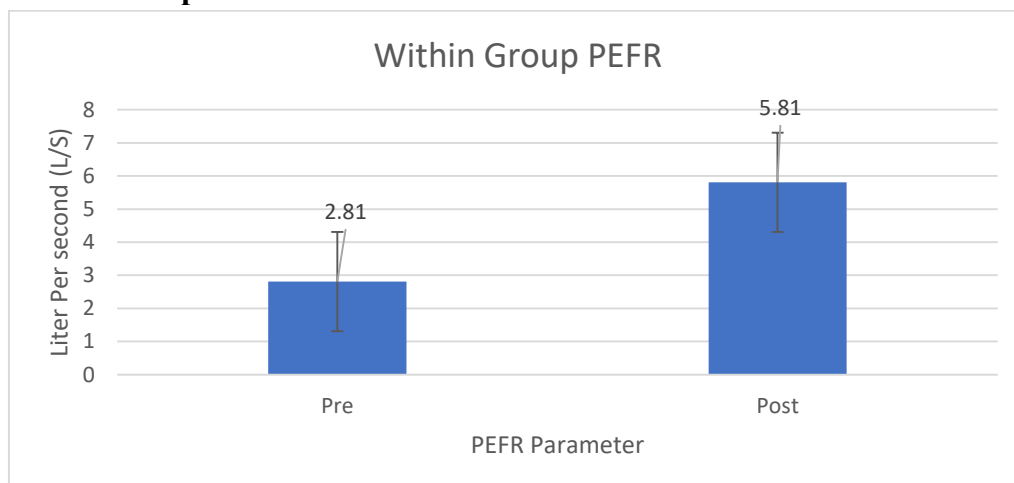
2. Comparison of FEV1 parameter



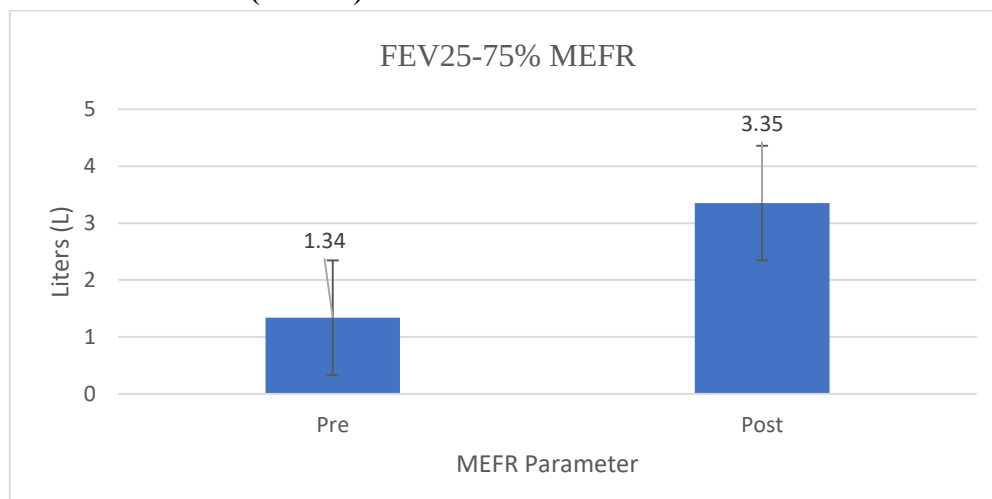
3. Comparison of FEV1/FVC parameter



4. Comparison of PEFR parameter



5. Comparison of FEV25-75%(MEFR)



Discussion:

All Measured parameters of lung function (FVC, FEV1, FEV1/FVC ratio, PEFR, and MEFr) were improved after one week of using the Acapella device in this pilot study of 15 patients. The fact that the improvement was seen across all of these measures and not just one indicates that the Acapella is improving the lungs overall, not just one particular aspect.

These results are in agreement with previous studies. A study over eight weeks showed that the Acapella device improved FEV1 and FVC in COPD patients more than a similar device called the Lung Flute. Similarly, in another study using COPD patients, lung function improved in only five days with Acapella and biofeedback, as with the one-week period used here.

A similar trial showed that peak breathing speed (PEFR) increased in the Acapella group by 155% compared to 64% in patients who did not use it and lung volumes improved by day 6 especially in heart surgery patients. These findings are also consistent with the significant improvement in PEFR in our study. The basic idea is that by blowing out against the resistance of the device the airways are opened and mucus cleared. Previous studies have shown that this device generally makes breathing better than similar devices.

One thing to note is that the improvement in the FEV1/FVC ratio shown here was greater than what is often reported in other trials. Previous study revealed that this particular ratio didn't change much even when FEV1 and FVC did improve.

Limitation: -

Due to the single-arm pre-post design without a control or comparison group, the small sample size (n=15), the lack of reported normality testing of the difference scores, and the abnormally large SD for FEV1/FVC (25.47) relative to its mean (which is worth flagging for outlier review), improvement cannot be distinguished from natural post-operative recovery, standard chest physiotherapy, mobilization or pain control occurring over the same week

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