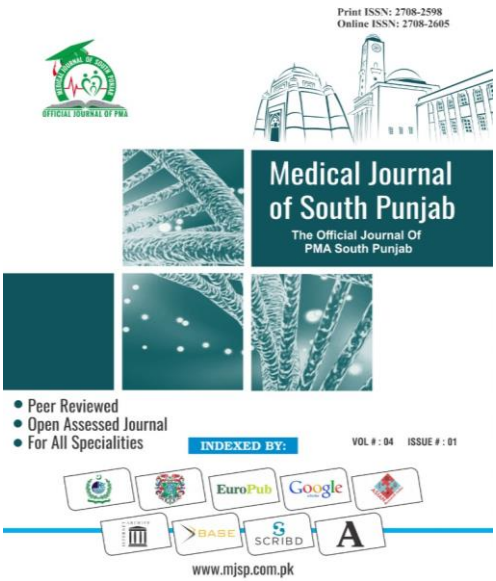
ISSN (E): 2708-2601
ISSN (P): 2708-2598

Medical Journal of South Punjab
Article DOI:10.61581/MJSP.VOL04/02/03
Volume 4, Issue 2, 2023



Comparing Incentive Spirometry with the Acapella Device for Physiotherapy after Thoracoscopic Lung Resection Surgery

Publication History

Received: Sep, 13 2023 Revised: Sep 14, 2023
Accepted: Sep 23, 2023 Published: Dec 30, 2023

Authors and Affiliation:

Saffa Nadeem[1*], Hafiz Ahmed Raza Khan[2], Mahnoor Fatima[3], Yousaf Saeed[4], Jawaria Laghari[5], Muhammad Yahya[6]

[1,5] Ch. Pervaiz Ellahi Institute of Cardiology, Multan, Pakistan

[2,4]Social Security Hospital Sheikhupura, Pakistan

[3]Bahawal Victoria Hospital, Bahawalpur, Pakistan

[6]CMH Multan institute of medical sciences Multan, Pakistan

[*]**Corresponding Author Email:** drsaffanadeem@gmail.com

Conflict of Interest:

Author(s) declared no conflict of interest.

Acknowledgment:

No Funding received.

Citation: Nadeem S, Khan HAR, Fatima M, Saeed Y, Laghari J, Yahya M. Comparing Incentive Spirometry with the Acapella Device for Physiotherapy after Thoracoscopic Lung Resection Surgery. Medical Journal of South Punjab. 2023 Dec 30; 4(2):14-22.

Please scan me to access online.

An official publication of
Medteach Private Limited, Multan, Pakistan.
Email: farman@mjsp.com.pk, Website: https://mjsp.com.pk/index.php/mjsp

Medical Journal of South Punjab
Volume 4, Issue 2, 2023; pp: 14-22
Original Article

Comparing Incentive Spirometry with the Acapella Device for Physiotherapy after Thoracoscopic Lung Resection Surgery

Saffa Nadeem[1*], Hafiz Ahmed Raza Khan[2], Mahnoor Fatima[3], Yousaf Saeed[4], Jawaria Laghari[5], Muhammad Yahya[6]

[1,5] Ch. Pervaiz Ellahi Institute of Cardiology, Multan, Pakistan
[2,4]Social Security Hospital Sheikhupura, Pakistan
[3]Bahawal Victoria Hospital, Bahawalpur, Pakistan
[6]CMH Multan institute of medical sciences Multan, Pakistan
[*]Corresponding Author Email: drsaffanadeem@gmail.com

ABSTRACT

Objective: *The objective of this study was to conduct a comparative analysis of the effectiveness of incentive spirometry, the Acapella device, and a combination of both in physiotherapy for patients undergoing thoracoscopic pulmonary resection surgery.*

Methods *A total of 268 patients participated in this study and were randomly assigned to either the incentive spirometry group or the Acapella device group. Lung function parameters, including FEV1 and FVC, were measured. The patients' comfort levels were evaluated using a visual analogue scale, and pain assessment was performed using a 0-10 scale. The primary outcome measure was FEV1 on the third day postoperatively. Additionally, the total analgesia required was recorded. Statistical analysis involved the use of Mann-Whitney U test, independent t-test, Chi-square test, or Fischer exact test. A significance level of $p \leq 0.005$ was adopted.*

Results: *In a preference test where participants were asked to evaluate both devices, the majority (94%) favored the Acapella device significantly ($p < 0.001$). Pain levels showed no significant difference between the two groups at various postoperative time points. Furthermore, the total morphine dose used in the incentive spirometer group (202.55±28.54mg) was comparable to that in the Acapella group (206.93±22.64mg) ($p=0.166$).*

Conclusion: *The study concluded that there was no significant difference between the Acapella device and incentive spirometry concerning overall lung function improvement following thoracoscopic surgery for pulmonary resection.*

Keywords: Acapella Device, Incentive Spirometry, Thoracoscopic Surgery, Lung Resection.

1. INTRODUCTION

In patients undergoing thoracic surgery, airway clearance hinders a great problem in terms of postoperative care, as it becomes difficult to remove airway secretions effectively due to postoperative pain. This phenomenon can lead to the development of several complications like, pneumonia, atelectasis and death[1]. Very commonly adapted method for airway clearance is respiratory physiotherapy in which chest walls are vibrated by performing percussion manually[2]. Drawbacks of this technique are that it requires intense labor, it is operator dependent and it takes too much time[3]. Further it may also be painful or discomforting for some patients when performed immediately after thoracic surgery[4]. As a result of these outcomes alternative methods to provide chest wall vibrations and methods for oscillations have been devised and are in practice in several settings which are thought to improve the process of airway clearance and overall lung function[5]. But there is lack of research regarding the use of vibratory positive expiratory pressure with the help of Acapella device for the sake of airway clearance postoperatively in lung resection surgery. A counterweighted plug, a metal strip and a magnet are different parts of Acapella device. The metal strip is attached to a lever. Oscillations in the airflow are produced by the break and reform phenomenon which is induced by a magnetic pull from the plug as it alternatively blocks the passage of the airway with the help of the device[6].

In order to maintain expiratory flow volume above 15 l.min l for 3 seconds, acapella device is available in blue form while for those who readily maintain their expiratory flow above or equal to 15 l.min l for 3 seconds are advised green type of Acapella device[7]. This study is based upon the hypothesis that Acapella device is superior to other devices in terms of efficacy for enhancement of pulmonary function and provision of comfort postoperatively in thoracoscopic surgery for lung resection. The study suggests comparable effectiveness of the Acapella Device and incentive spirometry post thoracoscopic lung resection surgery. Tailoring rehabilitation approaches based on patient preferences can enhance engagement and adherence. Educating patients on device options enables informed decisions. This evidence promotes efficient resource allocation in healthcare. Integrating preferred devices can improve patient experience, potentially boosting compliance and satisfaction. Future research can focus on refining postoperative physiotherapy devices, advancing patient-centric care in thoracoscopic surgery rehabilitation.

2. METHODOLOGY

Study was performed in Department of Intensive Care Unit, Nishtar Hospital Multan from 1st October 2018 to 30th September 2021. A total of 268 patients were enrolled in this study after getting an informed consent from each patient. Ethical approval was taken from Hospital's

Ethics Committee. Sample size was calculated from the reference study by Y. J. Cho et al[8]. Patients aged between 20 and 70 years were included in the study, ensuring a specific age range for the participants, undergoing lung resection surgery using the video-assisted thoracoscopic procedure were included, specifying the surgical technique, patients undergoing resection of less than two lobes of the lung were included, specifying the extent of lung resection, patients who underwent tracheal extubation in the operation theatre and were immediately admitted to the intensive care unit postoperatively were included, patients postoperatively administered with intravenous (IV) patient-controlled analgesia (PCA) were included, specifying the method of pain management.

Patients with a BMI less than 15 Kg/m^2 or more than 30 Kg/m^2, with a baseline FEV1 less than 30% of the predicted value were excluded, specifying a criterion related to lung function, suffering from a respiratory infection within the last 3 months and those with specific baseline arterial blood gas parameters (partial arterial pressure of CO2 less than 50mmHg and partial pressure of oxygen less than 70mmHg), who underwent tracheal intubation, were unconscious, or had certain neuromuscular ailments were excluded from the study. Patients were distributed into two group randomly, either group who were given standard care or the group who were given standard care and Acapella device therapy in combination. Preoperatively baseline investigation performed on each patient involved, measurement of FEV1 (forced expiratory volume in 1 second), FVC (forced vital capacity) and ABG (arterial blood gases) analysis i.e. pulmonary function tests.

Standard procedure of video assisted thoracoscopic surgery was performed and all protocols for anesthesia were properly followed. Postoperatively patient controlled anesthesia PCA consisted of fentanyl (10 to 20mg per ml) and morphine (0.4 to 0.7 mg per ml) with continuous infusion. Incentive spirometery technique was applied in the patients of the control group. Green Acapella device was implied in this study because patients with reduced pulmonary function were already excluded in preoperative care. In Acapella group along with Acapella device standard care was also provided after every two hours with the help of incentive spirometery. Use of Acapella device was repeated 2 hourly. FEV1 and FVC were measured with the help of a portable spirometer. These measurements were taken preoperatively, one hour after surgery, sic hour after surgery, at first postoperative day and also at 2^{nd} and 3^{rd} postoperative day. PaO_2 to FIO_2 ratio was also calculated preoperatively, immediately after surgery, at six hours postoperatively and at 1^{st} postoperative day.

Visual analogue scale was implied for the assessment of comfort of the patient. It was explained as, comfortable=1, uncomfortable but tolerable=2, painfully uncomfortable but still agreeing to continue the treatment=3, severe painful

but tolerable=4 and severe pain not tolerable=5. Inquiry about preference between Acapella device and simple incentive spirometery was made. Assessment of pain was made by using another visual analogue scale which consisted of a scale from 0 to 10 where 0 represented no pain and 10 represented worst possible pain. This assessment was performed at 0 hour, 6 hours postoperative, 1st, 2nd and 3rd postoperative day. Equivalent morphine administered intravenously was used to evaluate the requirement of additional analgesia in total. Primary outcome was the value of FEV1 on the 3rd day postoperatively. Data thus collected was analyzed statistically by using computer software SPSS version 23. Comparison between the control and case groups was done by using Mann-Whitney U test, independent t-test Chi square test or Fischer exact test. P value of less than or equal to 0.005 was considered as significant.

3. RESULTS

Both the groups were comparable in terms of age, BMI, smoking history, comorbidities, pathology, extent of the surgery, operating time and anesthesia time (p>0.05). Table-I

The comfort level was high in the group using Acapella as compared to the groups which was using incentive spirometer (p<0.001). When all the participants were asked to test both the devices and give their preference, majority of the people in both the groups (a total of 94%) suggested Acapella (p<0.001). The pain level was not significantly different between both the groups at 1st postoperative hour, 6th postoperative hour, 1st postoperative day, 2nd postoperative day and 3rd postoperative day (p-value 0.557, 0.943, 0.916, 0.639 and 0.917, respectively). The total dose of morphine used in incentive spirometer group (202.55±28.54mg) was not significantly different from the dose (206.93±22.64mg) used in the Acapella group (p=0.166). Table-II

Safety outcomes i.e. wound dehiscence, chest tube dislodgment, postoperative pneumonia, arrhythmias and transfusions required were not significantly different between both the groups (p-value 0.652, 0.555, 0.735, 0.314, and 0.513 respectively). There was also no significant difference in chest tube drainage, number of days of chest intubation and length of hospital stay between the two groups (p-value 0.214, 0.651 and 0.055, respectively). Table-III

Table-I
Baseline Characteristics

Variable	Incentive Spirometer (n=134)	Acapella (n=134)
Age, years	34.54±4.7	37.25±7.3
BMI	23.63±3.23	24.81±2.73
ASA-I/ASA-II	87/47	84/50
Tobacco History, n (%)		
Never smoked	67 (50)	63 (47)
Current smoker	34 (25.4)	29 (21.6)
Former smoker	33 (24.6)	42 (31.34)
HTN, n (%)	12 (8.95)	15 (11.19)

DM, n (%)	21 (15.67)	18 (13.43)
IHD, n (%)	9 (6.7)	6 (4.47)
COPD, n (%)	24 (17.9)	31 (23.13)
Asthma, n (%)	6 (4.47)	9 (6.7)
Previous TB, n (%)	25 (18.66)	17 (12.68)
Pathology, n (%)		
Adenocarcinoma	14 (10.45)	17 (12.68)
Bronchoalveolar Carcinoma	12 (8.95)	14 (10.45)
Squamous cell carcinoma	9 (6.7)	7 (5.22)
Metastasis	21 (15.67)	23 (17.16)
Benign disease	34 (25.4)	27 (20.15)
Extent of surgery, n (%)		
Lobectomy	76 (56.72)	67 (50)
Segmentectomy	33 (24.6)	39 (29.10)
Metastatectomy	25 (18.66)	28 (20.89)
Operating time, min	145.27±16.72	138.95±13.59
Anesthesia time, min	163.9±22.4	167.26±19.22

Data is mentioned as mean± S.D otherwise mentioned otherwise; BMI=body mass index; ASA= American society of anesthesiologists

Table-II
Outcome variables

Variable	**Incentive Spirometer (n=134)**	**Acapella (n=134)**	**p-value**
Comfort score, median(IQR)	2(2-3)	2(1-2)	<0.001
Preference, n (%)			
Incentive spirometer	4 (2.9)	2 (1.5)	<0.001
Acapella	125 (93.28)	128 (95.52)	
Same	5 (3.73)	4 (2.9)	
Pain, median (IQR)			
1 hour post-op	5(4-6)	5(4-6)	0.557
6 hour post-op	4(4-5)	4(4-5)	0.943
POD 1	4(3-5)	4(3-5)	0.916
POD 2	3(3-4)	3(3-4)	0.639
POD 3	3(3-4)	3(3-4)	0.917
Total dose of morphine, mg	202.55± 28.54	206.93± 22.64	0.166

Data is mentioned as mean± S.D otherwise mentioned otherwise.

Table-III
Safety Outcome

Variable	Incentive Spirometer (n=134)	Acapella (n=134)	p-value
Wound dehiscence, n (%)	2 (1.5)	3 (2.24)	0.652
Chest tube dislodgment, n (%)	7 (5.22)	5 (3.73)	0.555
Post-op pneumonia, n (%)	5 (3.73)	4 (2.9)	0.735
Arrhythmia, n (%)	3 (2.24)	1 (0.7)	0.314
Transfusion, n (%)	13 (9.7)	10 (7.46)	0.513
First 24h chest tube drainage, ml	369.86±169.13	397.69±195.36	0.214
Duration of chest tube, days	8.11±3.24	7.95±2.68	0.651
Post-op length of stay, days	6.77±1.44	6.34±2.09	0.055

Data is mentioned as mean± S.D otherwise mentioned otherwise.

4. DISCUSSION

In the discussion, the study's findings regarding the use of the Acapella device versus incentive spirometry in terms of pulmonary function and patient preference were thoroughly analyzed.

Despite the study not demonstrating significant improvements in pulmonary function after surgery with the use of the Acapella device in comparison to incentive spirometry, patient feedback revealed a substantial preference for the Acapella device due to its perceived comfort and ease of use. This aligns with the observed preference for the Acapella device in previous studies. For instance, patients with bronchiectasis have reported successful sputum expectoration with oscillation devices and expiratory positive pressure, suggesting its potential effectiveness[9,10,11].

Interestingly, the mechanism of action of the Acapella device, resembling high-frequency oscillations of the chest wall, has been previously explored in a related study[13]. Although the use of the Acapella device after thoracic surgery has been studied minimally[8], this similarity in mechanism suggests its potential benefits. Further research is warranted to establish the Acapella device's role as a primary therapeutic tool in post-thoracic surgery care.

Comparisons between the Acapella device and other airway clearance techniques also underscore its preference and effectiveness, reinforcing the findings of this study[9,10,14]. Even in comparison with devices like flutter, the Acapella device emerged as a more comfortable option for patients, aligning with our study's patient preferences[15].

Moreover, findings from studies comparing the Acapella device to high-frequency chest wall compressions and conventional chest physiotherapy emphasize the greater comfort associated with the Acapella device[16]. Additionally, in one of the studies, Regular use of an Acapella device improves symptoms and quality of life in people with COPD who

produce sputum daily or most day[17],[18]. This concurs with our study's results, where patients expressed better comfort with the Acapella device compared to standard incentive spirometry[19].

Basically, the Acapella device produces high intensity vibrations and it creates positive expiratory pressure which significantly help in clearance of bronchial secretions[20]. These collective findings underscore the potential of the Acapella device as a patient-preferred option for postoperative respiratory care. Although no significant pulmonary function improvements were observed in our study, the emphasis on patient comfort and preference signifies the value of the Acapella device as an adjunct therapy warranting further investigations.

5. CONCLUSION

From the results of this study it can be concluded that even though both modalities of treatment used to improve the lung functions after lung resection surgery through thoracoscopic technique, overall preference was given to the Acapella device as compared to incentive spirometery as Acapella device is in terms of comfort score.

REFERENCES

1. Sengupta S. Post-operative pulmonary complications after thoracotomy. Indian J Anaesth. 2015;59(9):618.
2. Andersen KS, Skoffer B, Oestergaard LG, Van Tulder M, Petersen AK. The effects of respiratory physiotherapy after lung resection: Protocol for a systematic review. Int J Surg Protoc. 2017;4:1-5. doi:10.1016/j.isjp.2017.03.001.
3. Fernández-Carmona A, Olivencia-Peña L, Yuste-Ossorio ME, Peñas-Maldonado L. Ineffective cough and mechanical mucociliary clearance techniques. Med Intensiva (Engl Ed). 2018 Jan 6. doi:10.1016/j.medin.2017.05.003.
4. Warnock L, Gates A, van der Schans CP. Chest physiotherapy compared to no chest physiotherapy for cystic fibrosis. Cochrane Database Syst Rev. 2013 Jan 1;9. doi:10.1002/14651858.CD001401.
5. Naswa S, Tuteja R, Gupta VP, Aggarwal R, Moiz JA. Comparison of Acapella® Versus Active Cycle of Breathing Technique in Post-Operative Pulmonary Complications after Valve Replacement Surgeries. Indian J Physiother Occup Ther Int J. 2017 Apr;11(2):24-9. doi:10.5958/0973-5674.2017.00030.2.
6. Dos Santos AP, Guimarães RC, de Carvalho EM, Gastaldi AC. Mechanical behaviors of Flutter VRP1, Shaker, and Acapella devices. Respir Care. 2013 Feb 1;58(2):298-304. doi:10.4187/respcare.01685
7. Volsko TA, DiFiore JM, Chatburn RL. Performance comparison of two oscillating positive expiratory pressure devices: Acapella versus Flutter. Respir Care. 2003 Feb 1;48(2):124-30. doi:10.4187/respcare.01685.

8. Cho YJ, Ryu H, Lee J, Park IK, Kim YT, Lee YH, Lee H, Hong DM, Seo JH, Bahk JH, Jeon Y. A randomised controlled trial comparing incentive spirometry with the Acapella® device for physiotherapy after thoracoscopic lung resection surgery. Anaesthesia. 2014 Aug 1;69(8):891-8. doi:10.1111/anae.12750.
9. Naraparaju S, Vaishali K, Venkatesan P, Acharya V. A comparison of the Acapella and a threshold inspiratory muscle trainer for sputum clearance in bronchiectasis – a pilot study. Physiother Theory Pract. 2010;26(5):353-7. doi:10.3109/09593981003596616.
10. Patterson JE, Hewitt O, Kent L, Bradbury I, Elborn JS, Bradley JM. Acapella versus 'usual airway clearance' during acute exacerbation in bronchiectasis: a randomized crossover trial. Chron Respir Dis. 2007;4(2):67-74. doi:10.1177/147997230607548.
11. Figueiredo PH, Zin WA, Guimaraes FS. Flutter valve improves respiratory mechanics and sputum production in patients with bronchiectasis. Physiother Res Int. 2012;17(1):12-20. doi:10.1002/pri.507 12.
12. Chicayban LM, Zin WA, Guimaraes FS. Can the Flutter Valve improve respiratory mechanics and sputum production in mechanically ventilated patients? A randomized crossover trial. Heart Lung. 2011;40(6):545-53. doi:10.1016/j.hrtlng.2011.05.008
13. Park H, Park J, Woo SY, Yi YH, Kim K. Effect of high-frequency chest wall oscillation on pulmonary function after pulmonary lobectomy for non-small cell lung cancer. Crit Care Med. 2012;40(9):2583-9. doi:10.1097/CCM.0b013e318258fd6d
14. Patterson JE, Bradley JM, Hewitt O, Bradbury I, Elborn JS. Airway clearance in bronchiectasis: a randomized crossover trial of active cycle of breathing techniques versus Acapella. Respiration. 2005;72(3):239-42. doi:10.1159/000085363
15. Volsko TA, DiFiore JM, Chatburn RL. Performance comparison of two oscillating positive expiratory pressure devices: Acapella versus Flutter. Respir Care. 2003;48(2):124-30. doi:10.4187/respcare.01685
16. Clinkscale D, Spihlman K, Watts P, Rosenbluth D, Kollef MH. A randomized trial of conventional chest physical therapy versus high frequency chest wall compressions in intubated and non-intubated adults. Respir Care. 2012;57(2):221–8. doi:10.4187/respcare.01299
17. Saeed M Alghamdi, Abdullah S Alsulayyim . A randomised trial of Oscillatory positive pressure therapy in COPD patients. 2023 Feb;78(2):136-143 doi: 10.1136/thorax-2022-219077.
18. Pengfei LI, Yutian LA, Kun ZH, Jianhua SU, Guowei CH. Can

Perioperative Oscillating Positive Expiratory Pressure Practice Enhance Recovery in Lung Cancer Patients Undergoing Thorascopic Lobectomy?. Chinese Journal of Lung Cancer. 2018 Dec 20;21(12).

19. Cho YJ, Ryu H, Lee J, Park IK, Kim YT, Lee YH, Lee H, Hong DM, Seo JH, Bahk JH, Jeon Y. A randomised controlled trial comparing incentive spirometry with the Acapella® device for physiotherapy after thoracoscopic lung resection surgery. Anaesthesia. 2014 Aug 1;69(8):891-8. doi:10.1111/anae.1275

20. Fabricio,Valdicir C. A randomised control trial of schintigraphic assessment of aerosol pulmonary deposition with the acapella positive expiratory pressure device. 2014 Mar;59(3):328-33 doi: 10.4187/respcare.02291.