

Original Research Article

## Effect of Lung Flute Device versus Autogenic Drainage in Pulmonary Tuberculosis- A Comparative Study

Dr. Sadaf Shaikh<sup>1</sup>, Dr. Vishnu Vardhan G.D<sup>2</sup>

<sup>1</sup>MPT in Cardio-Respiratory Physiotherapy, Dr. A. P. J. Abdul Kalam College of Physiotherapy

<sup>2</sup>Associate Professor, Dr. A. P. J. Abdul Kalam College of Physiotherapy

Corresponding Author: Dr. Sadaf Shaikh

### ABSTRACT

**Background and Objective:** Pulmonary Tuberculosis (TB) is one of the top 10 causes of death worldwide. It is one of the oldest diseases known to man and remains one of the most widespread diseases in the world. Restrictive conditions like TB alter pulmonary components, as observed by impairment of lung volumes such as total lung capacity, vital capacity and tidal volume. It also aids in accumulation of the secretions in the airways giving rise to further complications and affecting the Quality of life of the person. Therefore, the present study aims to assess the effect of Lung Flute Device and Autogenic Drainage Technique on Pulmonary functions in Tuberculosis.

**Materials and Methods:** A prospective cross-sectional comparative study was done with 30 participants diagnosed with Tuberculosis in the age group of 18-65. On Day 1 and Day 5 the Pulmonary function test (FVC, FEV<sub>1</sub>, FEV<sub>1</sub>/FVC ratio and PEFr) was performed. Group A participants received Lung Flute Device and Group B participants received Autogenic Drainage Technique. Intervention was given twice a day, 3 days a week for 2 weeks and each session last for 15-30 minutes. Data was analyzed using 'Paired' and 'Unpaired' t test.

**Results:** There was highly significant difference ( $p < 0.0001$ ) in FVC, FEV<sub>1</sub> and PEFr in both the groups but Group A showed slightly more improvement where Lung Flute Device was given as an intervention and there was no significant difference in FEV<sub>1</sub>/FVC ratio in both the groups in PFT values after 2 weeks of intervention.

**Conclusion:** The study concluded that the Lung Flute Device and Autogenic Drainage both improves the lung function in Pulmonary Tuberculosis but the small innovative Lung Flute Device shows more significant improvement in pulmonary functions compared to Autogenic Drainage. Therefore, the Lung Flute Device can be used in other respiratory conditions for mucus clearance and can be added as a new curative device in Bronchial hygiene therapy regime.

**Keywords:** Autogenic Drainage, Lung Flute Device, PFT, Pulmonary Tuberculosis.

### INTRODUCTION

Pulmonary Tuberculosis (TB) is one of the top 10 causes of death worldwide. Tuberculosis is one of the oldest diseases known to man and remains one of the most widespread diseases in the world. In early writings, the disease was variously called "consumption," "Captain of the Men of Death," and "white plague."<sup>[1]</sup>

World TB Day celebrated on March 24th commemorates the day in March 1882 when Professor Robert Koch made the groundbreaking announcement in Berlin of his discovery of Mycobacterium tuberculosis as the cause of Tuberculosis (TB). For a disease which had effective treatment available for the past 50 years, TB exerts a huge and unacceptable global impact on morbidity and mortality rates.<sup>[2]</sup>

On 26 September 2018, the United Nations (UN) held its first high-level meeting on tuberculosis at its headquarters in New York. The title of the meeting United to End TB - An Urgent Global Response to a Global Epidemic highlighted the need for immediate action to accelerate progress towards the goal of ending the TB epidemic by 2030. [3] TB is a leading cause of morbidity and mortality in patients with Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS). HIV and TB are linked to malnutrition, unemployment, alcoholism, drug abuse, poverty and homelessness. Thus, co-infection with HIV and TB (HIV-TB) is not only a medical malady, but a social and an economic disaster and is aptly described as the “cursed duet”. HIV infection is one of the strongest risk factor for the development of TB. Severe weight loss is a common presenting feature of HIV-infected patients suffering with TB. Many patients with AIDS, particularly in Africa, develop severe wasting and this has been called “slim disease” [4] Chronic respiratory diseases (CRDs), including Chronic Obstructive Pulmonary Disease (COPD) and post-tuberculosis lung damage (P-TBLD), are an increasing problem globally. [5]

A more recent study compared previously treated Pulmonary Tuberculosis (PTB) patients with a control group with latent TB infection and found significant lung function impairment in the former group. Authors have postulated that PTB is an important but non recognised contributor to the global burden of chronic lung disease. This is important because reduced lung function has been clearly associated with cardiovascular, respiratory and all-cause mortality, illustrating the long-term impact of lung damage and impaired lung function on subsequent health. [6] TB is an infectious disease caused by rod shaped slightly bent, thin, aerobic, non-motile, non-spore forming beaded rods belonging to the family *Mycobacteriaceae*. Crowding in poor ventilated rooms is one of the most important factors in the transmission of

tubercle bacilli as it increases the intensity of contact with a case. In short, the risk of acquiring M. tuberculosis infection is determined mainly by exogenous factors. [7] [8] Fever is the most common symptom and occurs in 70% of patients; it persists for 14 to 21 days on average. Chest pain occurs in the 25%; cough is less common. [9]

It is estimated that, worldwide, 1.3 billion people consume tobacco and that most of them live in underdeveloped or developing countries, where the tuberculosis rates are also higher. The prevalence of tuberculosis in adult men in India is 2 to 4 times higher than that in women. Tobacco smoking is prevalent almost exclusively among men therefore tobacco smoking may be a risk factor for developing pulmonary tuberculosis. [10, 11]

The standard pharmacologic agents used to treat M. tuberculosis consist of two to four drugs for 6 to 9 months. Isoniazid is considered to be the most effective first-line antituberculosis agent whereas rifampin is bactericidal and is most commonly used with isoniazid. [1]

Ever thought much about coughing? It is one of those bother some things in life that no one likes and that you try to get rid of as soon as possible when it occurs. Any respiratory condition accompanied by the production of increased mucus whether it is acute or chronic depends upon an effective cough for mucus mobilization and removal. [12] An effective cough is a vital component of bronchial hygiene therapy. The normal cough involves taking a deep breath, closing the glottis, compressing abdominal and thoracic muscles (to generate pressure in excess of 80 mm Hg), followed by an explosive release of gas as the glottis opens. In addition, mobilizing and expelling secretions requires the high pressures generated during a cough that may be an important factor in re-expanding lung tissue. Cephalad airflow bias is a factor responsible for mucus movement in small airways during normal breathing. The diameter of flexible airways increases when individual inspires and narrows on expiration. Gravity

is not considered as primary mechanism of normal mucus transport in the lungs. If it was then there would be a strong tendency for secretions to migrate to dependent areas of the lung, settling in the peripheral and basal areas, where they could not be expelled and moved to the central airways. Only when there failure of normal mucociliary clearance and effective cough, gravity plays an important role to clear excessive airway secretions. Quality of life is significantly impaired in acute cough and this impairment affects males and females equally. In patients with chronic cough, quality of life is impaired to a greater extent in female patients compared with males which is not related to age, duration or aetiology. [13-15] On other hand, airway clearance techniques are used to facilitate mucociliary clearance. There are different techniques for airway clearance which include Active Cycle of Breathing Technique (ACBT), Forced Expiratory Technique (FET) & Autogenic Drainage(AD).Devices such as Flutter & RC-Cornet also aids in removal of secretions. [16]

Various techniques have been developed which are effective, comfortable and can be used independently by the majority of adults. [17] The aim of chest physiotherapy is to prevent respiratory complications and to improve pulmonary function in cases of acute or chronic pulmonary disease. Several techniques have been developed to reach these goals, which can be used according to patients' needs. One of such airway clearance technique is Autogenic drainage (AD). [18]

In the search for an improved self-performed chest physiotherapy to provide independence to the patient and the most effective lung clearance of secretions, Jean Chevaillier in Belgium (1967) introduced a novel technique of breathing exercises sequentially attain the highest possible expiratory flows to move secretions from peripheral to central airways, without forced expirations and associated airway closure. Autogenic drainage also called as Self

Drainage uses controlled breathing with minimal airway closure, starting with the small airways and moving secretions from smaller to larger airways in 3 phases: unsticking, collection and evacuation. [13,18,19] The first phase of unsticking secretions is started by a directed increased inspiration followed by deep expiration. The second phase i.e. collection of mucus in the larger bronchi is achieved by deepening inspiration and expiration. In the third and last phase i.e. evacuation phase, the patient increases inspiration into the inspiratory reserve volume range. This middle to high lung volumes breathing continues until the secretions are in the trachea and are ready to be expectorated. The collected mucus can be evacuated by a stronger expiration or a high volume huff. Non productive coughing should be avoided, since it may result in collapse of the airways. [18, 20] On the other hand, there are various devices people like Flutter, Acapella, RC Cornet and Shaker available for mucus clearance that is affordable, easy to use and independently used by the people all over the world. [16] One of such mucus clearance device is Lung Flute which uses low frequency acoustic wave technology to facilitate secretion clearance. [21]

The Lung Flute developed by Medical Acoustics, Buffalo, NY, USA is a new small self-powered audio device that belongs to the family of Oscillatory Positive Expiratory Pressure (OPEP) devices, which includes the Flutter and the Acapella. This device generates sound with a frequency of 18-22 Hz. This sound wave, when generated at the mouth by mild exhalation, travels back down the tracheobronchial tree and vibrates in tracheobronchial secretions and loosens and mobilizes them hence enhances mucociliary clearance of the lower respiratory tract thereby resulting in the induction of sputum that can be coughed out later. This functionality of the Lung Flute has been applied to sputum induction for diagnostic testing and is currently a Food and Drug Administration (FDA) approved device. [22, 23]

Unlike the Flutter that uses oscillatory back pressure, the Lung Flute has a unique mechanism based on acoustic energy that may benefit patients with low expiratory flows who may find the Flutter difficult to use. [24] While performing the Lung Flute Therapy, the participant should be into a relaxed position. The participant only needs to blow through the mouthpiece with as much force. They should not force a cough or use their diaphragm or stomach muscles to try to force out more air. [25] Therefore the present study has been taken up to evaluate the effect of Lung Flute Device and Autogenic Drainage on pulmonary function in Pulmonary Tuberculosis.

## MATERIALS AND METHODS

**Participants:** Total thirty participants both male and female diagnosed with Pulmonary Tuberculosis were included in the study. Participants were screened according to the inclusion and exclusion criteria. Participants with age group of between 18-65 years, diagnosed with Pulmonary Tuberculosis and willing to participate were selected for the study. Participants who were hemodynamically unstable and with other cardiorespiratory and neurological diseases were excluded from the study. The study received approval from Institutional Ethical Committee of Dr. APJ Abdul Kalam College of Physiotherapy, Pravara Institute of Medical Sciences, Loni. Written informed consent was taken from all the participants selected for the study.

## PROCEDURE

The study received approval from Institutional Ethical Committee Ref no. PIMS/CPT/IEC/2018/206 of Dr. A. P. J. Abdul Kalam College of Physiotherapy, Pravara Institute of Medical Sciences, Loni. Total thirty participants (n=30) were selected and screened according to inclusion and exclusion criteria, the participants diagnosed with Pulmonary Tuberculosis. Informed written consent form was obtained

from the patient. Group A: included 15 participants and Group B included 15 participants. Before starting the intervention, participants were assessed for the baseline parameters of pulmonary function test (FVC, FEV<sub>1</sub>, FEV<sub>1</sub>/FVC ratio, PEFR) and were recorded with help of spirometry. After three days of (4-5cycles/2-3 sets/2 times in a day/15-30min/three days in a week) of intervention all baseline parameters were taken and the participants were re-assessed.

**Outcome Measures:** The specific measurement was computed by the instrument called spirometry (RMS HELIOS 401) in the study for measuring parameters of pulmonary function such as FVC, FEV<sub>1</sub>, FEV<sub>1</sub>/FVC ratio and PEFR.

## DATA ANALYSIS AND RESULTS

The objective of the study was to find the effect of Lung Flute Device and Autogenic Drainage on Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV<sub>1</sub>), FEV<sub>1</sub>/FVC Ratio and Peak Expiratory Flow Rate (PEFR) in Pulmonary Tuberculosis participants. The data was entered into an excel spread sheet, tabulated and subjected to statistical analysis by using the trial version of Graph Pad InStat software. Descriptive statistics for all outcome measures were expressed as mean, standard deviations and test of significance such as t test. The confidence interval was set at 95% and data was considered statistically significant with p<0.05 and highly or highly significant with p<0.0001

15 participants were included in group A, in which 11 were male (73.33%) and 4 were female (26.6%). 15 participants were included in the controlled group, in which 9 were male (60%) and 6 were female (40%). The mean age of the participants in group A was 33.8 with standard deviation of  $\pm 12.87$  and in group B was 40.8 with standard deviation of  $\pm 10.04$ .

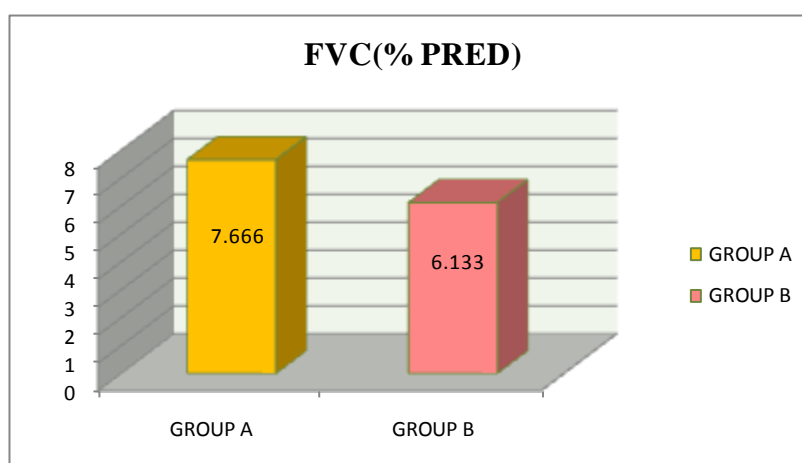
The mean difference between Group A and Group B in FVC(% pred) is  $7.76 \pm 1.49$  and  $6.13 \pm 1.18$  with t value of

3.109 and p value of 0.0043 which is very significant with 28 degree of freedom. The mean difference between Group A and Group B in FEV<sub>1</sub>(% pred) is 7.73±0.96 and 5.2±0.77 with t value of 7.94 and p value of <0.0001 which is highly significant with 28 degree of freedom. The mean difference between Group A and Group B in FEV<sub>1</sub>/FVC Ratio (% pred) is 1.46±2.80 and

2.53±3.8 with t value of 3.264 and p value of 0.0029 which is considered significant with 28 degree of freedom. The mean difference between Group A and Group B in PEFR(% pred) is 6.26±2.12 and 4.46±0.63 with t value of 3.14 and p value of 0.0039 which is very significant with 28 degree of freedom.

Table 1.1: Represents the Mean Difference in FVC (Litres and Pred %) of Group A and Group B

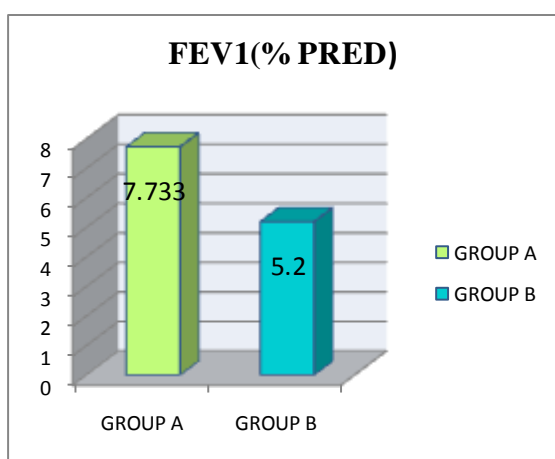
	GROUP A (Mean±SD)	GROUP B (Mean±SD)	t value	p value	Level of Significance
Litres	0.31±0.04	0.21±0.03	7.05	<0.0001	Highly Significant
Pred %	7.66±1.49	6.133±1.18	3.10	0.0043	Very Significant



Graph 1.1: Represents the Mean Difference of FVC (Pred %) of Group A and Group B

Table 1.2: Represents the Mean Difference in FEV<sub>1</sub>(Litres and Pred %) of Group A and Group B

	GROUP A (Mean±SD)	GROUP B (Mean±SD)	t value	p value	Level of Significance
Litres	0.31±0.04	0.20±0.02	8.325	<0.0001	Highly Significant
Pred %	7.7±0.96	5.2±0.77	7.948	<0.0001	Very Significant



Graph 1.1: Represents the Mean Difference of FEV<sub>1</sub> (Pred %) of Group A and Group B

## DISCUSSION

The main purpose of this study was to determine the effect of Lung Flute Device and Autogenic Drainage on Pulmonary Function Tests value in Pulmonary Tuberculosis patients. Total 30 participants were included in the study. Few studies have focused on the use of Lung Flute Device as a therapeutic purpose in respiratory. Novel method for sputum induction using the lung flute in patients with suspected pulmonary tuberculosis which was a preliminary trial to evaluate the usefulness of the Lung Flute for sputum sampling in patients suspected of pulmonary tuberculosis. Thirty-four patients, for whom

sputum examination was required for the differential diagnosis of TB or other diseases, were enrolled in the study. Patients were instructed to blow out fast and hard through the Lung Flute and to repeat this for a total 20 sets of two blows each and they concluded that using the Lung Flute device, sputum samples were collected within 10 to 20 min from 30 of 34 patients (88%). The device also permitted a rapid diagnosis of TB in seven of 15 confirmed TB cases. Hence, the application of the Lung Flute may represent a promising technique for the rapid diagnosis of pulmonary TB. [22]

An eight-week, randomized, controlled, two arm parallel study on Comparison of the Lung Flute with the Acapella in the Treatment of COPD with Chronic Bronchitis was powered to demonstrate equivalency of the new device, the Lung Flute, to the predicate device, the Acapella by Sanjay Sethi et al, which showed that Chronic Obstructive Pulmonary Disease (COPD) is characterized by mucus hypersecretion that contributes to the morbidity and is associated with increased mortality. This was the first study done for therapeutic purpose, which concluded that the Lung Flute was equivalent to the Acapella 40 COPD patients out of which 37 patients completed the study and concluded that the Lung Flute is a safe and effective OPEP treatment for mucus hypersecretion in COPD and is equivalent to the Acapella. [23]

As per the literature mentioned above, Lung Flute was easy to use and it could be a promising technique for removal of secretions similarly in the present study, Lung Flute was easy to use and more sputum was expectorated and could be a curative device for use in respiratory conditions.

Cough is the natural defense mechanism for protection of the respiratory tract and is used to mobilize and remove secretions from the respiratory tree, moving them from the peripheral to the central airways. Therefore airway physiology should be understood and equal pressure

point and the collateral ventilation system should be utilized between airways which makes the airway clearance activities most effective. [12] A study was carried out by Ganeshwara Rao Melam et al, on Comparison of Autogenic Drainage & Active Cycle Breathing Techniques on FEV<sub>1</sub>, FVC & PEFr in Chronic Obstructive Pulmonary Disease where 30 subjects of 40 - 60 years of age who had moderate chronic obstructive pulmonary disorder were allocated randomly into three groups, each consisting of 10 subjects. Group A received autogenic drainage and Group B received active cycle breathing technique whereas Group C received medications. The results of the study concluded that there was significant improvement in FVC, FEV<sub>1</sub> & PEFr values in both A and B groups when compared to group C patients. The study concluded that there was no significant difference in FVC, FEV<sub>1</sub> & PEFr values between Group A and Group B. The results of this study revealed that both autogenic drainage and active cycle breathing technique are effective in clearance of secretions in patients with COPD. [26]

Ernst M. App et al studied on Sputum Rheology Changes in Cystic Fibrosis Lung Disease Following Two Different Types of Physiotherapy Flutter vs. Autogenic Drainage which aimed to evaluate the efficacy of two frequently used Physiotherapy technique i.e. Autogenic Drainage (AD) and Flutter. Fourteen CF patients underwent either twice daily AD or Flutter treatment for 4 consecutive weeks in which, pulmonary function was measured before and after an acute 30-min therapy. At the end of the 9-week study, both groups (Group 1 starting with AD, Group 2 starting with Flutter) showed a tendency toward improved Forced Vital Capacity (FVC), up to 200 ml on average. The study concluded that both AD and Flutter can be frequently used and are not different in terms of efficacy. [27]

As mentioned above, AD is difficult to make patient understand also it takes time for the patient to learn the technique

compare to Lung Flute which is easy to understand and can be used efficiently. This is the main reason why PFT values were better improved in Group A compared to Group B. In the present study there is significant improvement in all the Pulmonary Function Test values in both the groups but there is slightly more improvement in Group A were Lung Flute was given as an intervention because of its ease to perform and unique mechanism.

## CONCLUSION

The present study shows significant improvement in pulmonary components in both the groups. Therefore, the study concludes that Lung Flute Device can be used in Pulmonary Tuberculosis and respiratory conditions for improving the lung functions and also expectorating more sputum than Autogenic Drainage, thus improving Quality of life of the patients.

### Limitation of Study:

- 1) At times, it was very difficult to make patient understand and perform the Autogenic Drainage technique
- 2) It was difficult for the patient to perform Pulmonary Function Test.
- 3) Sterilization procedure for the Lung Flute Device was at times difficult.
- 4) It was difficult to make device available in India for the study.

### Suggestion for future research:

- (1) Future research should be done with more focus on the effect of only Lung Flute device for immediate and its short term effects in various respiratory conditions
- (2) Further studies can be carried out in large sample size
- (3) To study the effect of Lung Flute Device in other mucus secreting conditions (Cardiac, Renal, and Postoperative)

## ACKNOWLEDGEMENTS

Authors are thankful to the Almighty, the College Principal, Staff for the continuous support and encouragement and all the participants who very well co-operated for the study. Special thanks to those who directly and indirectly helped us for the study.

### Ethical Approval Ref. no.:

PIMS/CPT/IEC/2018/206

**Conflict of Interest:** None

**Funding:** None

## REFERENCES

1. Terry Des Jardins, George G. Burton. Clinical Manifestations and assessment of Respiratory Disease. Seventh Edition, pg no 273-282.
2. Tiberi S, Petersen E, Maeurer M, Ntoumi F, Yeboa-Manu D, Mwaba P, Vilaplana C, Dar O, Bates M, Corrah T, Rao M. Taking forward the Stop TB Partnership and World Health Organization Joint Theme for World TB Day March 24th 2018-“Wanted: Leaders for a TB-Free World. You can make history. End TB”.
3. World Health Organization. Global Tuberculosis Report 2018. Geneva: WHO:2018
4. Sharma SK, Mohan A, Kadiravan T. HIV-TB co-infection: epidemiology, diagnosis & management. Indian J Med Res. 2005 Apr 1;121(4):550-67.
5. Jones R, Muyinda H, Nyakoojo G, Kirenga B, Katagira W, Pooler J. Does pulmonary rehabilitation alter patients' experiences of living with chronic respiratory disease? a qualitative study. International journal of chronic obstructive pulmonary disease. 2018;13:2375.
6. Maguire GP, Anstey NM, Ardian M, Waramori G, Tjitra E, Kenangalem E, Handojo T, Kelly PM. Pulmonary tuberculosis, impaired lung function, disability and quality of life in a high-burden setting. The International Journal of Tuberculosis and Lung Disease. 2009 Dec 1;13(12):1500-6.
7. Joseph Loscalzo et al, Harrison's Pulmonary and Critical Care Medicine.17<sup>th</sup> Edition.pg no 115-138.
8. Paolo Palange, Anita Simonds.ERS Handbook Respiratory Medicine;European Respiratory Society: First Edition; pg no 200-218.
9. Robert M. Kacmark, James K. Stoller et al. Egans Fundamentals of Respiratory Care; 10<sup>th</sup> Edition; pg no 418-427,520-523
10. Silva DR, Muñoz-Torrico M, Duarte R, Galvão T, Bonini EH, Arbex FF, Arbex MA, Augusto VM, Rabahi MF, Mello FC. Risk factors for tuberculosis: diabetes, smoking, alcohol use, and the use of other

- drugs. *Jornal Brasileiro de Pneumologia*. 2018 Apr;44(2):145-52.
11. Kolappan C, Gopi PG. Tobacco smoking and pulmonary tuberculosis. *Thorax*. 2002 Nov 1;57(11):964-6.
  12. Michael Donahue. "Spare The Cough Spoil The Airways: Back To The Basics In Airway Clearance". *Pediatric Nursing/March-April-2002/Vol.28/No 2*.pg no-107-111.
  13. Fink JB. Forced expiratory technique, directed cough, and autogenic drainage. *Respiratory care*. 2007 Sep 1;52(9):1210-23.
  14. Toussaint M, Boitano LJ, Gathot V, Steens M, Soudon P. Limits of effective cough-augmentation techniques in patients with neuromuscular disease. *Respiratory Care*. 2009 Mar 1;54(3):359-66.
  15. Morice AH, Fontana GA, Belvisi MG, Birring SS, Chung KF, Dicpinigaitis PV, Kastelik JA, McGarvey LP, Smith JA, Tatar M, Widdicombe J. ERS guidelines on the assessment of cough. *European respiratory journal*. 2007 Jun 1;29(6):1256-76.
  16. Jennifer A Pryor, S Ammani Prasad. *Physiotherapy for Respiratory and Cardiac Problems. Adults and Paediatrics; Fourth Edition*;pg no-134-143.
  17. Pryor JA. *Physiotherapy for airway clearance in adults. European Respiratory Journal*. 1999 Dec 1;14(6):1418-24.
  18. Schöni MH. Autogenic drainage: a modern approach to physiotherapy in cystic fibrosis. *Journal of the Royal Society of Medicine*. 1989;82(Suppl 16):32.
  19. Donna Frownfelter. *Principles and Practice of Cardiopulmonary Physical Therapy; Third Edition*; pg no 332-333.
  20. Donna Frownfelter, Elizabeth Dean. *Cardiovascular and Pulmonary Physical Therapy; Fifth Edition*;pg no. 137-142,321-324.
  21. Eleanor Main, Linda Denehy. *Cardiorespiratory Physiotherapy. Adults and Paediatrics. Fifth Edition*; pg no-271-274
  22. Fujita A, Murata K, Takamori M. Novel method for sputum induction using the Lung Flute in patients with suspected pulmonary tuberculosis. *Respirology*. 2009 Aug; 14(6):899-902.
  23. Sethi S, Maloney J, Grove L, Anderson P. Comparison of the lung flute with the acapella in the treatment of COPD with chronic bronchitis. unpublished data. 2018.
  24. Silva YR, Greer TA, Morgan LC, Li F, Farah CS. A Comparison of 2 Respiratory Devices for Sputum Clearance in Adults With Non-Cystic Fibrosis Bronchiectasis. *Respiratory care*. 2017 Oct 1;62(10):1291-7.
  25. Lung Flute for Hospitals and Clinics. *Secretion Mobilization and Induction Device Dual-Indication for Diagnostic & Therapeutic Use :Manufactured in the USA for: Medical Acoustics, LLC 640 ellicott St., Buffalo, NY 14203 USA (716) 759-6339 (888) 820-0970 www.lungflute.com*
  26. Melam GR, Zakaria AR, Buragadda S, Sharma D, Alghamdi MA. Comparison of Autogenic Drainage & Active Cycle Breathing Techniques on FEV<sub>1</sub>, FVC & PEFr in Chronic Obstructive Pulmonary Disease. *World Applied Sciences Journal*. 2012;20(6):818-22.
  27. App EM, Kieselmann R, Reinhardt D, Lindemann H, Dasgupta B, King M, Brand P. Sputum rheology changes in cystic fibrosis lung disease following two different types of physiotherapy: flutter vs autogenic drainage. *Chest*. 1998 Jul 1;114(1):171-7.

How to cite this article: Shaikh S, Vardhan GDV. Effect of lung flute device versus autogenic drainage in pulmonary tuberculosis- a comparative study. *Int J Health Sci Res*. 2019; 9(4):90-97.

\*\*\*\*\*