International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Effectiveness of Deep Breathing versus Segmental Breathing Exercises on Chest Expansion in Pleural Effusion

Sambhaji B. Gunjal[1], Nisha K. Shinde[2], Atharuddin H. Kazi[2], Aashirwad A. Mahajan[1]

[1]Assistant Professor, [2]Associate Professor,
Department of Cardio-Respiratory Physiotherapy, College of Physiotherapy, Pravara Institute of Medical Sciences (PIMS), Pravara Rural Hospital, Pravara Deemed University, Loni.413 736

Corresponding Author: Sambhaji B. Gunjal

Received: 21/05/2015 *Revised: 18/06/2015* *Accepted: 25/06/2015*

ABSTRACT

Background: It is estimated that close to 30 % of diseases affecting the respiratory system involve the pleura and approximately 1.5 million patients are diagnosed with pleural effusion each year in the United States. Tuberculosis (TB) is a common cause of pleural effusion in India. Pleural effusion causes reduction of chest expansion it leads to lung atelectasis and excess fluid causes the lungs to collapse.
Purpose: The purpose of this study was to find out the effectiveness of deep breathing versus segmental breathing exercises on chest expansion and pulmonary function (FEV1, FVC IC) in individuals with pleural effusion.
Methods: The prospective comparative study consists of thirty participants between the ages of 20 to 40 years with the clinical diagnosis of unilateral pleural effusion. The deep breathing group (group A) received deep breathing exercises and segmental breathing group (group B) received segmental breathing exercises for two weeks of duration.
Results: The results of the study showed that there was a significant difference between both the groups on chest expansion ($p<0.05$), FEV_1 ($p<0.05$), FVC ($p<0.05$), IC ($p<0.05$) between both the groups.
Conclusion: Study concludes that the segmental breathing exercises have better effect on chest expansion and pulmonary function than deep breathing exercises in pleural effusion.

Keywords: Pleural Effusion, Deep Breathing, Segmental Breathing, Chest Expansion, Pulmonary Function.

INTRODUCTION

Pleural effusion, commonly known as "water in the lungs" is a usually diagnosed condition among restrictive diseases. It is defined as excessive accumulation of serous fluid between parietal pleura and visceral pleura (i.e. within the pleural cavity). [1,2] The pleural space averages 10 to 20 mm in width and normally is filled with 10 to 20 ml of serous fluid. [3,4] Normally, small blood vessels in the pleural linings produce a small amount of fluid that lubricates the opposed pleural membranes so that they can glide smoothly against one another during breathing movements.

The most common causes are diseases of the heart or lungs, and inflammation or infection of the pleura. Pleural fluid accumulates, when pleural fluid formation exceeds pleural fluid absorption. Normally, pleural fluid enters the pleural space from the capillaries in the parietal pleura and also enters from interstitial spaces of lung through the visceral pleura or from the peritoneal cavity through small holes in the diaphragm. Pleural Effusion can result from increased pleural fluid formation in the lung interstitial, parietal pleura, peritoneal cavity, or from decreased pleural fluid removal by the pleural lymphatics. [2-4]

It is estimated that close to 30 % of diseases affecting the respiratory system involve the pleura. Approximately 1.5 million patients are diagnosed with pleural effusion each year in the United States. [5] Tuberculosis (TB) is a common cause of pleural effusion in India. [6-9]

The intrapleural pressure is the pressure existing in pleural cavity. Normal intrapleural pressure is -5cmH_2O, during inspiration chest wall expands, which allows the lung to expand and the air to flow inward. During expiration, the intrapleural pressure decreases to approximately -4 cmH_2O, allowing the air to flow from the lung to the atmosphere. [10,11] So because of negativity, it keeps the lungs expanded and prevents the collapsing tendency of lung produced by elastic recoiling of tissues. [12,13] however, if air or fluid of any kind is allowed to enter the pleural space, the negative pressure will be lost and it will be positive and the affected lung will partially or fully collapse. [14-17]

Medical management of pleural effusion includes aspiration of fluid may be necessary to relive dyspnea, insertion of chest tube, if rapid accumulation of fluid occurs and pleurodesis in malignant effusion. The best way to clear up a pleural effusion is to direct the treatment to what is causing it, rather than treating the effusion itself. The physiotherapy management consists of dyspnea relieving positions, Breathing exercises, thoracic expansion and inspiratory exercises with incentive spirometer. Deep breathing exercises are used to expand lungs fully and to improve oxygenation & lung volumes in patients with pleural effusion. [18-23] This exercise helps to maintain function of the lung and prevent lung collapse from lack of use and long-term build-up of fluids in the pleural cavities. Elizabeth W. et al conducted study on the immediate effects of deep breathing exercises after cardiac surgery which suggests it decreases the atelectatic area and increases ventilation. [24,25] Segmental breathing exercises are given to encourage or increase localized expansion of affected lung in pleural effusion patients. Hypoventilation does occur in certain areas of the lungs because of pain and muscle guarding after surgery, atelectasis and pleural effusion. Therefore, it is important to emphasize expansion of problems areas of the lungs and chest wall. The exercises are supposed to act on a variety of mechanisms, including the stretch reflex mechanism. Quick stretch on the external intercostal leads to facilitation of their contraction. [27-30]

Pleural effusion causes reduction of chest expansion and it leads to lung atelectasis, because the capacity of the thorax is limited and excess fluid causes the lungs to collapse. So, present study aims to find out the effectiveness of deep breathing versus segmental breathing exercises on chest expansion and pulmonary function in individuals with pleural effusion.

MATERIALS AND METHODS

The research design used for the study was prospective comparative study. The sample was 30 participants (22 Male and 8 Female) with pleural effusion were selected based on the inclusion and exclusion criteria. The intervention period was once in a day, 6 days per week for 2 weeks. Both groups were given 6 breaths per minute. [31,32] Total were 18-20 breaths of exercises in one session and each treatment session lasted for 10-15 minutes including rest period. Both interventions were given once in a day (12 sessions) for 2 weeks.

The inclusion criteria for this study were both male and female participants, age between 20 to 40 years those willing to participate in this study, individuals with clinical diagnosis of unilateral pleural effusion with (intercostal drainage) ICDand decreased chest expansion.The exclusion criteria for the study were participants with unbearable chest pain, chylothorax, hemothorax, pneumothorax, participants with other pleural disorder and chest trauma & rib fracture

Outcome Measures

Chest Expansion Measurement: Chest expansion is the difference between maximum inspiration and maximum expiration. Chest expansion was measured with thumb method at different level of the chest which measures symmetry and extent of expansion. It was performed at three levels, for three lobes of the lungs from top to bottom. This method is active for measuring chest expansion in unilateral lung disease. The levels of measurements are at sternal notch, at the xiphiod process, at the T8 vertebra. [33,34]

Pulmonary Function: Forced Expiratory Volume in One Second (FEV_1), Forced Vital Capacity (FVC) and Inspiratory Capacity (IC).This specific measurement computed by the instrument called spirometry (RMS HELIOS 401)

The study received approval from Institutional Ethical Committee of Pravara Institute of Medical Sciences.

Intervention:

Group A (Deep breathing Group): The participants in this group received deep breathing exercises with18-20 breaths in one session (6 breaths/min) with rest interval after every 6 breaths. Treatment session was lasted for 10-15 minutes.

Group B (Segmental breathing Group): The participants in this group received segmental breathing exercises with 18-20 breaths in one session (6 breaths/min) with rest interval after every 6 breaths. Treatment session was lasted for 10-15 minutes.

DATA ANALYSIS AND RESULTS

Statistical analysis was carried out utilizing the trial version of SPSS 17.0 and Graph Pad Prism 5.0 and $p<0.05$ is considered as level of significance. Student's Paired' test and Unpaired' test was applied to analyze the data.

Chest Expansion:

Chest expansion was measured at three levels in both the groups (Table 1).

At sternal notch, the mean difference of deep breathing group was 0.06±0.17 cm and in segmental breathing group it was 0.53±0.44cm.At xiphiod process, the mean difference of deep breathing group was 0.20±0.31 and in segmental breathing group it was 1.20±0.41cm. At T_8 vertebral level, the mean difference was 0.43±0.17 cm and in deep breathing group it was 1.60±0.47 cm.

Forced Expiratory Volume In One Second (FEV_1): In deep breathing group the difference between the pre and post values of FEV_1 was 0.24 Liters and 7.86 of % predicted. In segmental breathing group the difference between the pre and post values of FEV_1 was 0.63 Liters and 22.20 of % predicted (Table 2).

Forced vital capacity (FVC): In deep breathing group the difference between the pre and post values of FVC in deep breathing group was 0.34 Liters and 10.80 of % predicted. In segmental breathing group the difference between the pre and post values of was 0.79 Liters and 23.86 of % predicted (Table 2).

Inspiratory Capacity (IC): The difference between the pre and post values of IC in deep breathing group was 0.21±0.11 Liters. The difference between the pre and post values of IC in segmental breathing group was 0.58±0.19 (Table 2).

Table 1: Pre-Post Comparison of Chest Expansion at Sternal Notch of Both The Groups.

Levels of chest expansion	Group	Pre Test	Post Test	Mean Difference	t-value	p-value
At Sternal notch	Group A	1.60±0.54	1.66±0.52	0.06±0.17	1.46	0.164 ,p>0.05
	Group B	1.53±0.63	2.06±0.53	0.53±0.44	4.68	0.0004 ,p<0.05
At Xiphiod	Group A	1.26±0.49	1.46±0.44	0.20±0.31	2.42	0.028, p<0.05
	Group B	1.00±0.42	2.20±0.52	1.20±0.41	11.25	0.0002 ,p<0.05
At T_8 vertebra	Group A	1.06±0.41	1.50±0.46	0.43±0.17	9.53	0.002 ,p<0.05
	Group B	0.93±0.41	2.53±0.61	1.60±0.47	13.16	0.0005 ,p<0.05

Table 2: Pre-Post Comparison of PFT Parameters in Liters of Both the Groups.

PFT	Group	Pre Test	Post Test	Mean Difference	t-value	p-value
FEV_1	Group A	1.23±0.28	1.47±0.34	0.24±0.12	7.34	0.0001
	Group B	1.09±0.51	1.72±0.48	0.63±0.15	15.75	0.0008
	Group A	1.25±0.28	1.59±0.38	0.34±0.16	8.00	0.0001
FVC	Group B	1.11±0.53	1.90±0.48	0.79±0.18	16.77	0.0003
IC	Group A	0.88±0.24	1.10±0.23	0.21±0.11	7.06	0.0021
	Group B	0.81±0.28	1.39±0.31	0.58±0.19	11.49	0.0001

DISCUSSION

The result obtained in this study indicated that, there was significant increase in expansion and pulmonary function in both groups but there were significant differences between both the groups at the end of the study. It means that the result of segmental breathing group was more effective than the deep breathing group.

Chest Expansion:

There was significant improvement of chest expansion at middle and lower lobe of lung in deep breathing group and in segmental breathing group there was highly significant improvement in all the lobes of the lung, but more improvement was seen at middle and lower lobes.

The physiological mechanism underlying the more increase in chest expansion in segmental breathing group is probably due to this exercise which are supposed to act on the stretch reflex mechanism. Quick stretch on the external intercostal leads to facilitation of their contraction that assists in inspiration which leads to chest expansion and further lung expansion was increased. It helped in increasing inspiratory capacity and during expiration, it helped in full expiration there by helping the patient to relax comfortably.

As per this study these exercises demonstrate benefits in restrictive dysfunction, as they help in re-expansion of lungs to some extent. So it may help in early recovery and reducing the late complications as pleural fibrosis.

In the 1970's, unilateral breathing techniques by applying pressure with either a hand over one side in order to facilitate regional lung expansion were considered to be viable treatment options. Sarkar P. and Sharma H. (July 2010) conducted study on segmental breathing exercises in 40 empyema patients and they found that chest expansion was increased at all the levels Moreover it was found that the increase at the 10^{th} costal cartilage level was more than the other two levels, which could be probably because of restriction due to accumulation of pus. The middle lobe showed a better expansion than axillary level. There was comparatively lesser expansion at axillary level as this level had near to normal ranges of expansion in most of the cases, even prior to exercise application. Presents study states that segmental breathing exercises are better than deep breathing exercises to improve chest expansion in pleural effusion. Therefore, early initiation of segmental breathing exercises should be included in regular medical intervention for early re-expansion and better prognosis in patients with pleural effusion.

FEV_1& FVC:

There were significant differences between both the groups at the end of the study. It means FEV_1 and FVC were more increased in segmental breathing group as compare to deep breathing group. Decreased FVC is also a common feature of restrictive disease. Any disease that affects the action of the chest or dispensability of lung tissue, itself tends to reduce FVC. This space occupying lesion (pleural effusion) reduces FVC by compressing surrounding lung tissue. Restrictive diseases such as pleural disorder or pleural effusion may cause FEV_1 to be reduced. Reduction of FEV_1 occurs in much the same way as reduction in FVC. In this disease FVC and FEV_1 values are proportionately decreased. Some patient with moderate to severe restriction may have FEV_1 nearly equal to the FVC. The entire FVC is exhaled in the first second because it is reduced. [35-37] The physiological mechanism underlying the increase in forced vital capacity of deep breathing is probably due to deep inspiration and deep expiration with increased chest expansion and that more increased in segmental breathing group is probably due to deep inspiration along with facilitated intercostal muscle contraction with increased chest expansion at all levels.

Shravya K. et al (2013) conducted the study to test 10 minutes of slow deep breathing (6 breaths/min) which have any effect on pulmonary function in healthy volunteers. From the result it is evident that immediate effect of deep breathing has shown significant improvement in FVC, FEV_1, PEFR. Physiological changes occurring during different phases of deep breathing are during inspiration, the lungs are expanded considerably and the walls of alveoli are stretched maximum. After a particular degree of stretching, the stretch receptors situated in the alveolar walls are stimulated. The stretch receptors are thus trained to withstand more and more stretching. During this phase the intra-pulmonary pressure is also raised and the diaphragm does not move freely. Therefore the alveoli in the lung apices are filled with air. [37]

Vikram M. and Kamaria K. (June 2012) conducted study on effect of intercostal stretch on pulmonary function Parameters and they stated that the use of manual stretching procedures has become more prevalent in cardiorespiratory physiotherapy to improve pulmonary functions. The results of the study showed, FEV_1 and FVC in the experimental group significantly improved than the control group, which means intercostal stretch increased lung volume and lead to improved lung function. Therefore, future design of stretching protocol in cardiorespiratory physiotherapy may be considered in order to promote ventilation. [38]

Inspiratory Capacity (IC)

Pleural effusion is restrictive respiratory disease characterized by difficulty in inspiration may be because of abnormality in lungs or pleural cavity or patient may not be able to inspire due to collapse or restricted lung expansion. So in this condition we get reduced inspiratory capacity.

In deep breathing group there is significant increase in inspiratory capacity due to the lungs are expanded considerably and the walls of alveoli are stretched maximum. Physiological mechanism underlying in more increase of inspiratory capacity in segmental breathing group is probably due to deep inspiration with facilitation of intercostal muscle contraction by passive intercostal stretch prior to inspiration.

CONCLUSION

This study concludes that two weeks of segmental breathing exercises have better effect on chest expansion and pulmonary function than deep breathing exercises in pleural effusion.

REFERENCES

1. Mathew KG, Aggarwal P, Prep manual for undergraduates, 3rd Edition. Elsevier, India, 2008; 167-168
2. Longo DL, Fauci AS, Braunwald E, Kasper DL, Hauser SL, Jameson JL, .Harrison's Principles of Internal Medicine, 18th Edition. McGraw-Hill. 2012. vol. 2; 2178-2181.
3. Robert L. Wilkins, James K.Stoller, Craig L. Scanlan , Egan's fundamentals of respiratory care 8th edition; Mosby Inc, St. Louis; 2003;chapter 22; 503-518
4. Light R W. Pleural Diseases. 4th ed. Philadelphia: Lippincott Williams &Wilkins; 2001. Chapter 2;45-56
5. Hyeon Yu. MD; Management of pleural effusion, empyema and lung abscess. Seminars in interventional radiology/volume 28, number 1 2011; 75-86.
6. Payne DK, kinasewitz GT. Comparative permeability of canine visceral and parietal pleura. J APPL physiol. 1988;64:2558-2564
7. Light RW, and others: pleural effusions: the diagnostic saparation of transudates and exudates, Ann Intern Med;1972; 77:507,
8. American Lung Association.1740 Broadway, New York, NY 10019. (800) 586-4872. http://www.lungusa.org.
9. FarokhErachUdwadia, Zarir F. Udwadiaand Anirudh F. Kohli; Principles of Respiratory Medicine. Published by: Oxford University; Press, New Delhi; 2010; section 17; chapter 62; page 655-665.
10. KirasewitzGT, Fisherman AP, Influence of alteration in starling forces on visceral fluid movement; Journal of Applied Physiology; 2004; (51); 617-677.
11. BansalPankaj, Kansal H.M., GoyalSumit, Bansal Puja. "tuberculosis pleural effusion :A study on 250 patients";Journal of Medical Science & Research. Year: 2010, Volume: 1, Issue : 2. ISSN : 0976-5948.
12. JJ Gilmartin, AJ Wright, GJ Gibson, Effects of Pneumothorax or Pleural Effusion on Pulmonary Function. Thorax oct.1985; 40:60-65.
13. Judson MA, Sahn SA; physiological abnormalities caused by pleural disease, journal of respiratory critical care medicine; 1995;16; 346,
14. Cash J. Cash's Textbook of Chest, Heart, and Vascular Disorders for Physiotherapist. 1st ed. London: Faber and Faber; 1979.
15. Hillegass EA, Sadowsky HS. Cardiopulmonary Physical Therapy; 4th edition; Philadelphia; Saunders; 2001; 659-662
16. kundu AK, bedside clinics in medicine. Part 1; long short spot cases; 6th edition,; Kolkata, India; April 2010;56 – 60:.
17. sembulingam, textbook of physiology; 4th edition;2005; chapter 120;654-650
18. Stuart B. Porter, Tidy's Physiotherapy, 14th Edition Elsevier, India; 2009; 268-270.
19. Kisner C, Colby LA. Therapeutic Exercise Foundations and Techniques. 5th edition, jaypee, Philadelphia (PA): F.A. Davis Company; 2007: 862–862.
20. Sarkar A, Sharma A,Razdan S, Kuhar , Bansal N, KaurG. Effect of segmental breathing exercises on chest expansion in empyema patients; Indian Journal of Physiotherapy and Occupational Therapy, July 2010; volume 3(4) ;17-20
21. EmmetE.and Paul B. Anderson; Diagnosis of pleural effusion: a systematic approach; American Journal of Critical Care, March 2011, Volume 20, No. 2;119-127
22. Frownfelter, D., Dean, E. Cardiovascular and Pulmonary Physical Therapy - Evidence in Practice.St. Louis: Mosby Elsevier. 2006, p.329.
23. Pushpal Kumar Mitra. Handbook Of Practical Chest Physiotherapy; Jaypee; India; 2007(121-125).

24. Deep Breathing Exercises For Pleural Effusion Removal; cited on 01/09/2013; 12.20 pm.http://www.livestrong.com /article/268521
25. Elizabeth Westerdahl, B.Lindmark, The immediate effects of deep breathing exercises on atelectasis and oxygenation after cardiac surgery; Scandinavian Cardiovascular Journal; 2003, Vol. 37, No. 6, Pages 363-367.
26. Marie C. Valenza. Effects of Respiratory Physiotherapy on Pleural Effusion; National Institutes of Health, Spain; Dec 2012; 134-136.
27. Burges LJ, Maritz FJ, Taljaard JJ. Epidemiology of pleural Effusion (Letter)/ S sfr Med J 2008, 86; 186.
28. Mattison LE, Coppagel, Alderman DF, Herlong JO, Sahn SA. Pleural effusions in the medical ICU: Prevalance, causes and clinical implications. Chest 2010:111:1018-1023.
29. Jennifer A Pryor, SAmmani Prasad. Physiotherapy for respiratory and cardiac problems, adults and paediatrics. 4th edition;2008; Elsevier; china;chapter 12;416-417.
30. Elisabeth Westerdahl, Birgitta Lindmark, Tomas Eriksson, Örjan Friberg, Göran Hedenstierna; Deep-Breathing Exercises Reduce Atelectasis and Improve Pulmonary Function After Coronary Artery Bypass Surgery; chest journal; November 2005, Vol 128, No. 5): 3482-3488.
31. Pal GK, Velkumary S, Madanmohan. Effect of short-term practice of breathing exercises on autonomic functions in normal human volunteers. Indian J Med Res. 2004 Aug; 120(2):115-21. PMID: 15347862 [Online]
32. Bernardi L, Porta C, Spicuzza L. Slow breathing increases arterial baroreflex sensitivity in patients with chronic heart failure. Circulation. 2002 Jan 15;105(2):143-5. PMID: 11790690 [Online]
33. Richard W. Light, Jeffrey T. Rogers, Dong-sheng Cheng, R. Michael Rodriguez; Large Pleural Effusions Occurring after Coronary Artery Bypass Grafting. Annals of Internal Medicine, American college of physician, 1 June 1999, Vol 130, No. 11 :891-896.
34. P H Nielsen; S B Jepsen; A D Olsen ; Postoperative pleural effusion following upper abdominal surgery. American college of chest physicians; chest journal; Nov.1989 ;96(5): 1133-1135
35. Richard W. Light, Jeffrey T. Rogers; Prevalence and Clinical Course of Pleural Effusions at 30 Days after Coronary Artery and Cardiac Surgery; American Journal of Respiratory and Critical Care Medicine, dec.2012; Vol. 166, No. 12,1567-1571.
36. Benjamin G. Ferris J; effect of deep and quiet breathing on pulmonary compliance in man; Journal of applied physiology; 1959; 143-149.
37. Shravya k, Hari k, Suresh , Reddy m; effect of slow deep breathing (6 breaths/min) on pulmonary function in healthy volunteers; international journal of medical research & health sciences; volume 2 issue 3 July -Sep 2013: 2319-5886.
38. Vikram M, Badlisyah K, Kamaria K., Joseph L; Effect of intercostal stretch on pulmonary function Parameters among healthy males; EXCLI Journal 2012;11:284-290

How to cite this article: Gunjal SB, Shinde NK, Kazi AH et. al. Effectiveness of deep breathing versus segmental breathing exercises on chest expansion in pleural effusion. Int J Health Sci Res. 2015; 5(7):234-240.

****