EFFECT OF POSITIONING ON LUNG FUNCTION IN MIDDLE-AGED CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

Aakanksha Bajpai
Chhatrapati Shahu Ji Maharaj University

IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

EFFECT OF POSITIONING ON LUNG FUNCTION IN MIDDLE-AGED CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

[1]Jagrati Gautam, [2] Deepak Tyagi , [3*]Aakanksha Bajpai

[1]MPT Student, [2]Assistant Professor, [3]Assistant Professor

[11.]I.T.S Institute of Health and Allied Sciences,

[1]I.T.S. Dental College, Muradnagar, Ghaziabad, India

Abstract: Chronic Obstructive Pulmonary Disease (COPD) is a preventable disease characterized by airflow limitation which is usually progressive and is associated with an abnormal inflammatory response of the lungs. According to the observations of West, ventilation-perfusion relationships were optimal in the apex of lungs of upright subjects. The supine position was found to be associated with low peripheral arterial oxygen tensions, turning the patients to lateral positions was found to increase oxygen tensions to satisfactory levels. But in COPD patients, due to descended flattened diaphragm patients tend to have hyper inflated chest and increased residual volume. Thus, the flattened diaphragm of a patient with COPD cannot produce force as effectively as the diaphragm of a healthy individual and this contribute to an increased work of breathing and recruitment of accessory muscles of respiration in these patients. This study show, improvements in lung function parameters in sitting position with respect to standing, supine and side-lying positions, provides us with a possible intervention to maximize exercise capacity of COPD patients.

Keywords:_*COPD, Diaphragm, Lung function, Perfusion, Ventilation*

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a preventable disease characterized by airflow limitation which is usually progressive and is associated with an abnormal inflammatory response of the lungs to noxious particles or gases, primarily caused by cigarette smoking. [1] Alpha 1 antitrypsin deficiencies and a variety of occupational exposures are less common causes in non-smokers.[2] Although COPD affects the lungs; it also produces significant systemic consequences. [1] COPD is increasing worldwide because of increase in smoking in non-industrialized countries. [2] The prevalence of COPD is higher in males than females but total mortality is similar in both the genders.

According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) definition, COPD should be considered in any patient with the symptoms of cough, sputum production, or dyspnea, and/or a history of exposures to risk factors for the disease.[3]. Symptoms of COPD include decreased breath sounds, and wheezing whereas severe cases may get complicated by weight loss, pneumothorax, right heart failure and respiratory failure. [3]

COPD comprises Chronic Obstructive Bronchitis and Emphysema. Many patients may have features of both.[2]. Chronic Obstructive Bronchitis, which is defined in clinical terms, is the presence of a chronic productive cough for 3 months in each of 2 successive years, provided that other causes of chronic cough have been ruled out. [4] Emphysema, which is defined in anatomic terms, is as the destruction of alveolar walls and the permanent enlargement of the airspaces distal to the terminal bronchioles.[4]

Spirometry is the best standardized, most reproducible, and most objective measurement of airflow obstruction. [5]. It is well established that the Lung Volume changes with the changes in posture, particularly when affected by gravity. This change is mainly attributed to shift in blood flow from lower limbs to the thoracic cavity. . In healthy adults, ventilatory muscles work efficiently in any posture. [8]

According to the observations of West, ventilation-perfusion relationships were optimal in the apex of lungs of upright subjects. The supine position was found to be associated with low peripheral arterial oxygen tensions, turning the patients to lateral positions was found to increase oxygen tensions to satisfactory levels.[9] But in COPD patients, due to descended flattened diaphragm [11] patients tend to have hyper inflated chest and increased residual volume.[16]. Thus, the flattened diaphragm of a patient with COPD cannot produce force as effectively as the diaphragm of a healthy individual and this contribute to an increased work of breathing and recruitment of accessory muscles of respiration in these patients.[16]

To the best of my knowledge there is no evidence that studied the influence of body position on lung function among COPD patients. Hence, there is need to investigate this aspect.

MATERIAL AND METHODS

Sample Size

A sample of thirty subjects was included in the study.

Study design

Pre-test and post-test experimental design.

Sampling

Purposive Sampling

INCLUSION CRITERIA

1. Age group- 40 to 60 years
2. Subjects of either gender.
3. Subjects able to perform Spirometry tests.
4. Haemo-dynamically stable subjects
5. Subjects willing to participate

Exclusion Criteria

1. Subjects with acute exacerbation of COPD
2. Subjects suffering from any other cardiopulmonary disorders
3. Subjects with musculoskeletal disorders of thoracic cage like, scoliosis, kyphosis.
4. Subjects suffering from mental illness and not able to understand instructions.
5. Subjects having history of any co-morbidities like HTN, DM.

Procedure

Thirty consecutive subjects with COPD who fulfill the inclusion/exclusion criteria were recruited for the study and informed consent was taken. Following this, the subjects were given verbal instructions regarding the test procedure. In all subjects the diagnosis was made on the basis of pre and post pulmonary function testing.

All subjects were placed in four body positions (sitting without arm support, standing, supine and side lying on right and left side), and then the Spirometric values were taken with the subject placed in each body position.

The body positions used in the study were-

1. Standing
2. Sitting
3. Supine
4. Side lying

The Pulmonary function test was carried in Spirometry room, Department of medicine, Pt. B. D. Sharma Post Graduate Institute of Medical Sciences, Rohtak. The Spiro Bank G, Ocean Win Spiro 2.36 B, 16 Bit was used to measure patients pulmonary function test. The method of testing on Ocean Win Spiro was demonstrated before test for every subject. Every effort was made to allay apprehension and promote co-operation of the subject. In accordance, with the recommendations of American thoracic Society (ATS), a minimum of three trials were carried at room temperature and pressure, subjects used nose clip and mouth-piece tightly applied so as to avoid leakage of breath.

Forced Vital Capacity (FVC), Forced Expiratory Volume in One second (FEV1) and Peak Expiratory Flow Rate (PEFR) were obtained using the Spiro meter in all four-body positions. The study was of single session and lasted for about one and half hour.

STATISTICAL ANALYSIS

The data was analyzed by paired t-test using SPSS statistical software, version 20.0 for finding the difference in lung volumes in sitting, standing, supine and side lying positions in COPD patients. A significance level of $p \leq 0.05$ was fixed.

RESULTS

The average age for the whole sample was 53.3 years, with a standard deviation of 5.446. The minimum age for the whole sample was 42 years and the maximum age was 60 years. The average value of FVC in sitting position was 1.85 L, with a standard deviation of 0.48 which decreases to a mean value of 1.78L, with a standard deviation of 0.47 in standing position. Paired difference between sitting and standing values found was 0.07, with a statistical significant increase in FVC in sitting position, with a p-value 0.032. In supine lying, the FVC value decreases further, with mean value (1.66L) and standard deviation (0.54). Paired difference in sitting and supine position found was 0.19, with a statistical significant increase in FVC values in sitting with a p- value of 0.01. While on side lying, the mean value of FVC further decreases to 1.65L, with a standard deviation of 0.48. Paired difference in sitting and Right Side lying position found was 0.20, suggesting statistical significant increase in FVC values in sitting with a p- value of 0.01.

The average value of FEV_1 in sitting position was 1.15 L ± 0.40. In standing, supine lying and in side lying position, the average value of FEV_1decreases as compared to sitting position to a mean value of 1.11 L ± 0.38, 0.98± 0.39 and 1.02L ± 0.38 respectively suggesting that statistical significant increase in FEV_1 in sitting position when compared with other three positions.

The average value of PEFR in sitting position found was 2.23L ± 1.15. In standing position, the average value of PEFR decreases to a mean value of 1.93 L ± 0.97. While lying supine, the PEFR value further decreases to an average value of 1.67L ± 0.81. While lying on side, the mean value of PEFR decreases to 1.61L as compared to sitting, with a standard deviation of 0.87 depicting that sitting position has shown significant differences when compared with other three positions.

DISCUSSION

The present study shows significant increase in FVC, FEV1 and PEFR values when sitting was compared with the other positions. Lapier, Tanya Kinney [16]. David J. Pierson et al [18] and Michael B. Labowitz et al [54] found significant increase in lung volumes and PEFR when sitting was compared with the standing position. Talwar A, Sood S [12], Noah Lechtzin [14] and W. F. Hamilton [15], stated that the maximum inspiratory and expiratory flow rates decreases on assuming the supine position from sitting. Blair and Hickam [13] suggested the possibility that as the subjects' moves from sitting to supine position, there is decrease in lung volumes due to decreased tone of diaphragmatic muscle in supine position. In line with the previous reports [16, 39], it has been demonstrated that both the static and dynamic lung compliance decreases as the subjects' assumes supine posture. The reduction in lung compliance in horizontal posture can be probably attributed to: (1) increased pulmonary blood volume, which decreases the recoil of lung at low volumes. (2) To small airway closure resulting in 40 percent increase in pulmonary flow resistance [22, 39] decrease in mouth pressure [39]. The decrease in lung volumes observed on assumption of side lying is in keeping with previous reports. [10, 12.] This decrease is said to be due to increased airway resistance, a decrease in elastic recoil of the lung or decreased mechanical advantage of forced expirations, and decreased lung compliance secondary to the anatomical differences between left and right lungs and shifting of mediastinal structures[23].

In short, improvements in lung function parameters in sitting position with respect to standing, supine and side-lying positions, provides us with a possible intervention to maximize exercise capacity of COPD patients which would go a long way in rehabilitating these patients. Further research is needed in this area to more fully understand the effects of position in patients with COPD. More direct indices of diaphragm tension development, such as Trans-diaphragmatic pressure measurements and peak inspiratory/ expiratory mouth pressures, would help to more fully elucidate the effect of position on respiratory muscle fiber length in-patients with COPD.

CONCLUSION

The results of this study suggest that in patients with COPD some of parameters of pulmonary function are enhanced in sitting versus standing, supine and side-lying positions. These results suggest that in patients with COPD position affects the force generating capacity of the respiratory muscles. Clinically, these results suggest that a sitting position without arm support optimizes pulmonary function in patients with COPD.

REFERENCES

1. B. R. Celli, W. MacNee, A. Agusti, A. Anzueto, A. S. Buist, P.M.A. Calverly, N. Chavannes et al. Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ ERS position paper. Eur. Respir. J., 2004; 23: 932-946.

2. Merck. Chronic Obstructive Pulmonary Disease. Merck Manuals, 1995-2007

3. www.SpirXpert.com. GOLD guideline provides biased definition of Chronic Obstructive Pulmonary Disease

4. David M. Maninino. COPD. Epidemiology, Prevalence, Morbidity, and Mortalitity, and Disease Heterogeneity. Chest, 2002; 121: 121S- 126S.

5. A. Sonia Buist, Antonio Anzueto, Peter Calverly, Teresita S. deGuia, Christine Jenkins. Global Strategy for the Diagnosis, Management, and prevention of Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med 2006.

6. Barotolome R. Celli. The Importance of Spirometry in COPD and Asthma. Effect of Approach to Management. Chest, 2000; 117: 15S-19S.

7. Takeshi Kera and Hitoshi Maruyama. The Effect of Posture on Respiratory Activity of the Abdominal muscles. J. Physiol. Anthropol.: Appl. Human Sci., 2005; 24(4): 259-265.

8. Shimpachiro Ogiwara, Tomoyo Miyachi. Effect of Posture on Ventilatory Muscle Strength. J. Phys. Ther. Sci., 2002; 14: 1-5.

9. Roy H Clauss, Bertrand Y. Scalbrini, Jeffersson F. Ray, George E. Reed. Effects of changing body position upon improved Ventilation- Perfusion relationships. Supplement II Circulation 1968; 37-38: 217.

10. Talwar A, Sood S, Sethi J. Effect of body posture on dynamic lung functions in young non-obese Indian subjects. J Appl Physiol 2002; 56(12):607-12.

11. M. Orozco- Levi, J. Gea, J. Monells, X. Aran, M. C. Augar, J. M. Broquetas. Activity of Latissmus dorsi muscle during inspiratory threshold loads. Eur. Respir. J., 1995; 8: 441-445.

12. Charbel Badr, Mark R Elkins, Elizabeth R Ellis. The effect of body position on maximal expiratory pressure and flow. Australian J of Physiotherapy 2002; 48: 95-102.

13. E. Blair, J. B. Hickam. The Effect of change in body position on lung volume and intrapulmonary gas mixing in Normal subjects. From department of Medicine, Duke University, 1954.

14. Noah Lechtzin, Charles M. Wiener, David M. Shade, Lora Clawson, Gregory B. Diette. Spirometry in the Supine position improves the detection of Diaphragmatic Weakness in Patients with Amyotrophic Lateral Sclerosis. Chest 2002; 121: 436-442.

15. W. F. Hamilton, A. B. Morgan. Mechanism of the postural reduction in Vital Capacity in relation to orthopnea and storage of blood in the lungs. J Appl Physiol 1931: 526-533.

16. Lapier, Tanya Kinney, Donovan, Claire. Sitting and Standing Position affect pulmonary function in patients with COPD: A Preliminary study. Cardiopulmonary Physical Therapy Journal, Winter 1999.

17. Gunnar Gudmundsson, Melba Cerveny, D. Michael Shasby. Spirometric Values in Obese individuals. Effects of Body Position. Am. J. Respir. Crit. Care Med.,September 1997,998,999,; 56 (3).

18. David J. Pierson, Nathan p. Dick, Thomas L. Petty. A comparison of Spirometric values with subjects in Standing and Sitting Postions.

19. Francisco Moreno, Harold A Lyons. Effect of body posture on lung volumes. J Appl Physiol 1961; 16(1):27-29.

20. M. Rohdin, J. Petersson, P. Sundblad, M. Mure, R. W. Glenny, S. G. E. Lindahl, D. B Linnarsson. Effects of gravity on lung diffusing capacity and cardiac output in prone and supine humans. J Appl Physiol 2003; 95: 3-10.

21. I. E. Haffejee.Effect of supine posture on Peak Expiratory Flow Rates in Asthma. Archives of Disease in Childhood, 1988; 63: 127-129

22. M. Vittacca. Does the supine postion worsen Reapiratory Function in Elderly Subjects? Gerontology 1996; 42: 46-53

23. Fiona Manning, Elizabeth Dean, Jocelyn Ross, Raja T Abboud. Effects of Side lying on Lung Function in Older Individuals. Phys Ther. 1999; 79: 456-466.

24. Kenneth Davis Jr, Jay A Johannigman, Robert S Campbell, Marraccini,Fred A Luchette, Scott B Frame, Richard D Bell. The acute effects of body position strategy with respiratory therapy in paralyzed patients with acute lung injury. Critical Care 2001, 5:81-87.

25. Robert Castile, Jere Mead, Andrew Jacjson, Mary Ellen Wohl, Dennis Stokes. Effects of posture on flow-volume curve configuration in normal humans. J. Appl

Physiol: Respirat. Environ. Exercise Physiol. 1982 ; 53(5) : 1175-1183.

26. H. Sasaki, W. Hida, T. Takishima. Influence of body position on dynamic compliance in young subjects. J. Appl Physiol. : Respirat. Environ exercise Physiol. 1977, 42(5): 706-710

27. Jon A. Hardie, Odd Morkve, Ivar Ellingsen. Effect of Body Position on Arterial Oxygen Tension in the Elderly. Respiration 2002; 69: 123-128.

28. Doughlas B. Craig, W. M. Wahba, H. F. Don, J. G. Couture, and Margaret R. Becklake. "Closing Volume" and its relationship to gas exchange in seated and supine positions. J. Appl Physiol, 1971; 31(5): 717-721.

29. Vu-Dinh Minh, Duck Chun, Ronald D. Fairshter, Patrica Vasquez, Archie F. Wilson and Gerald F. Dolan. Supine change in Arterial Oxygenation in Patients with Chronic Obstructive Pulmonary Disease. Am Rev Respir. Dis. 1986; 133: 820-824.

30. Vu-Dinh Minh, Duck Chun, Gerald F. Dolan, HWA M. Lee, and Patrica Vasquez.Mixed Venous Oxygenation, Exercise, Body Posture, V/Q Ratio in Chronic Obstructive Pulmonary Disease. Am Rev Respir. Dis. 1981; 124: 226- 231.

31. Anna Marklew. Body positioning and its effect on oxygenation- a literature review. Nursing in Critical Care, 2006; 11(1): 16

32. Jacquelyn L. Banasik, Roberta J. Emerson. Effect of Lateral positions on tissue oxygenation in the critically ill. Heart & Lung, 2001 jul/ August; 30(4): 269-275.

33. Michael B. Zack, Henning Pontoppidian, and Homayoun Kazemi. The effect of Lateral Positions on Gas Exchange in Pulmonary Disease. A Prospective Evaluation. Am Rev Respir. Dis., 1974; 110: 55.

34. Andrew L. Ries, Robert M. Kaplan, Jae Chang. Effect of posture on Arterial Oxygenation in Patients with Chronic Obstructive Pulmonary Disease. Respiration 1992; 59: 317-321

35. Michael I. Polkey, Dimitris Kyroussis, Carl-Hugo Hammnegard, Gary H. Mills, Malcolm Green, and John Moxham. Diaphragm Strength in Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med 1996; 154: 1310-1317.

36. J. E. Butler, D. K. McKengie, and S. C. Gandevia. Discharge Frequencies of Single motor units in human diaphragm and parasternal muscles in sitting and standing. J. Appl. Physiol., 2001; 90: 147- 154.

37. Walter S. Druz and John T. Sharp. Activity of Respiratory muscles in Upright and Recumbent humans. J. Appl. Physiol: Respirat Environ. Exercise Physiol, 1981; 51(6): 1552-1561.

38. Fernando J. Martinez, James I. Couser, and Barotome R. Celli. Factors influencing Ventilatory Muscle Recruitment in Patients with Chronic Airflow Limitation. Am Rev Respir Dis, 1990; 142: 276-282.

39. Panagiotis K. Behrakis, Ahmet Baydur, Marc J. Jaeger, and Joseph Milic-Emili. Lung Mechanics in Sitting and Horizontal Body Positions. Chest, 1983; 83(4):843-846.

40. Thomas P.K. Lim and Ulrich C. Luft. Alterations in Lung Compliance and Functional Residual Capacity with Posture. J. Appl. Physiol., 1959; 14(2): 164-166.

41. James M. Turner, Jere Mead and Mary Ellen Wohl. Elasticity of Human Lungs in relation to Age. J. Appl. Physiol., 1968; 25(6): 664-671.

42. John W. Walsh, Charles L. Webber, Patrick J. Fahey, and John T. Sharp. Structural change of thorax in patients with Chronic Obstructive Pulmonary Disease. J. Appl. Physiol., 1992; 72(4): 1270-1278.

43. John T. Sharp, Norma B. Goldberg, Walter S. Druz, Howard C. Fishman, and Joseph Danon. Thoracoabdominal Motion in Chronic Obstructive Pulmonary Disease. Am. Rev. Respir. Dis., 1977; 115: 56.

44. Reed M. Gardener, Charles D. Baker, A. Michael Broennle, Benjamin Burrows. ATS Statement- Snowbird Workshop on Standardization of Spirometry. Am. Rev. Respir. Dis., 1979; 119: 831-839.

45. James E. Hansen, Karlman Wasserman. Spiro metric criteria for airway obstruction. Use percentage of FEV1/ FVC Ratio below the fifth percentile, not < 70%. Chest, 2007; 131: 349-355.

46. M. R. Miller, J. Hankinson, V. Brusasco, F. Burgos, R. Casaburi, A. Coates, R. Crapo, P. Enright, C. P. M. van der Grinten, P. Gustafsson, R. Jensen, D. C. Johnson, N. MacIntyre, R.McKay, D. Navajas, O. F. Pedersen, R. Pellegrino, G.Viegi and J. Wanger. Standarization of Spirometry. Eur Respir J 2005; 26:319-338

47. G. Viegi, A. Scognamiglo, S. Baldacci, F. Pistelli, L. Carrozzi. Epidemiology of Chronic Obstructive Pulmonary Disease. Respiration, 2001; 68.

48. Steven D. Shapiro and Edward P. Ingenito. The Pathogenesis of Chronic Obstructive Pulmonary Disease. Advances in the Past 100 years. Am J Respir Cell

Molecular Bio, 2005; 32: 367-372.

49. Bela Suki, Kenneth R. Lutchen and Edward P. Ingenito. Pulmonary Perspective. On the Progressive Nature of Emphysema. Role of Proteases, Inflammation, and Mechanical Forces. Am J Respir Crit Care Med, 2003; 168: 516-521.

50. Saetta M, Di Stefano A, Turato G et al. CD8+ T-lymphocytes in peripheral airways of smokers with Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med 1998; 157: 822-826.

51. O'Donnell DE, Revill SM, Webb KA. Dynamic hyper inflation and exercise intolerance in Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med 2001; 164: 770-777.

52. Michael D. Lebowitz, Ronald J. Knudson, Greta Robertson, Benjamin Burrows. Significance of intra-individual changes in Maximum Expiratory Flow Volumes and Peak Expiratory Flow measurements. Chest 1982; 81: 566-570.

53. R. A. Stockley. Neutrophils and Protease/ antiProtease Imbalance. Am J Respir Crit Care Med Nov. 1999; 160(5): S49-S52.

54. John E. Repine, Aalt Bast, Ida Lankhorst and The Oxidative Study Group. Oxidative Stress in Chronic Pulmonary Obstructive Disease. Am j Respir Crit Care Med 1997; 156: 341-357

55. Thrulbeck W. Diaphragm and Body weight in Emphysema. Thorax 1978; 33: 483-487.

56. Rochester DF. Tests of Respiratory muscle function. Clin Chest Med. 1988; 9(2): 249-261.

57. Beck KC, Babb TG, Staats BA, Hyatt RE. Dynamics of breathing during exercise. In: Whipp BJ, Wasserman K, eds. Exercise Pulmonary Physiology and Path physiology. New York, NY: Marcel Dekker, Inc.; 1991: chap 2.

58. Rochester DF, Braun NM. Determinants of maximal inspiratory pressure in Chronic Obstructive Pulmonary Disease. Am Rev Respir Dis. 1985; 132(1); 42-47.

59. Hillegass E, Sadowski HS. Essentials of Cardiopulmonary Physical Therapy. Philadelphia, PA: W.B. Saunders of Company; 1994.

60. Frownfelter DL. Chest Physical Therapy and Pulmonary Rehabilitation: An Interdisplinary Approach. Chicago, IL: Year Book Medical Publishers