DOI: 10.7860/JCDR/2021/50259.15623

Original Article

Physiotherapy Section

Clinical Evaluation of the Peak Expiratory Flow Rate in Patients with Chronic Low Back Pain: A Cross-sectional Study

LEO RATHINARAJ ANTONY SOUNDARARAJAN[1], ALI IRANI[2], NG BORADE[3], TUSHAR J PALEKAR[4], SREEJA MANNICKAL THANKAPPAN[5], QURAIN T ALSHAMMARI[6]

(cc) BY-NC-ND

ABSTRACT

Introduction: Stabilisation of the spine is done by the abdominal and extensor muscles of the back. In chronic Low Back Pain (cLBP) patients, atrophy of these muscles lead to neuromuscular weakness and this may result in instability of the spine. Spinal instability and ineffective forced expiration due to weak contraction of the muscles may reduce the pulmonary function.

Aim: To find the alteration of Peak Expiratory Flow Rate (PEFR) in patients with cLBP and the factors responsible for it.

Materials and Methods: The cross-sectional study done in Maharashtra Institute of Physiotherapy, Latur, Maharashtra, India, from June 2019 to January 2020. Hundred patients with cLBP were recruited. Age, gender, weight, height and duration of the symptoms were recorded for demographic values. The PEFR was measured by Mini-Wright peak flow meter. Highest value of the three repetitions was documented for analysis. Statistical Package for the Social Sciences (SPSS) version 20.0 version was used to calculate the Pearson's correlation between the variables.

Results: Mean age of the participants were 37.31 years, and there were 50 males. Correlation coefficient between the patient value and their expected value of PEFR was 0.906 (p-value <0.01). Calculated t-value of 52.0733 (p-value <0.0001) showed a statistically significant reduction of PEFR value in cLBP patients in comparison to their expected PEFR value, calculated by the machine based on the age, height and weight of the individual person.

Conclusion: It was found that the reduction in PEFR among cLBP patients is due to core muscle weakness, instability of the spine, pain and kinesiophobia. Thus, clinicians should design their treatment to include the exercise to increase the PEFR in the management of cLBP.

Keywords: Forced expiration, Peak flow, Pulmonary function, Spirometry

INTRODUCTION

Musculoskeletal Disorders (MSDs) are considered to be one of the leading health problems throughout the world among the working population and Low Back Pain (LBP) is the most common MSD [1]. The LBP affects the population without any distinctions and impacts on clinical, social and economic factors of a nation [2]. The LBP is defined as an ache, pain or discomfort localised in the area between costal margin and gluteal folds [3]. The LBP is classified based on the duration of the symptom into acute (no more than localised weeks), subacute (6-12 weeks) and chronic (more than 12 weeks) [4]. Prevalence of chronic Low Back Pain (cLBP) is between 9% and 21% and most researchers believe that this cLBP is the cause for disability in most patients as well as absenteeism in the industry [5-7]. To stabilise the lumbar spine, Transverse Abdominis (TrA) muscle along with other abdominal muscles and lumbar multifidus contributes a lot [8]. Researchers found that TrA muscle activates more than other abdominal muscles during inspiration [9], similarly on expiration it contracts more than other expiratory muscles [10]. It is well documented that in cLBP there is weakness of core muscle which in turn reduces the respiratory effort [11].

Pulmonary function is usually assessed by the spirometry and the test is well accepted throughout the world and is used to diagnose both obstructive and restrictive lung diseases [12]. Restrictive lung disease is usually termed for a group of pulmonary disorders, in which there is impairment in filling the lungs with air [13]. Though reduced lung volume is the common sign of restrictive lung diseases, it may be associated with decreased respiratory flow also namely peak expiratory flow [13-15]. This is common in neuromuscular weakness as the respiratory muscles cannot produce forceful flow or pressure [14]. The strength of the abdominal muscle is found to assist in prolonging as well as forceful expiration [16]. Previous research study revealed that in cLBP patients, over a period of time are prone for respiratory dysfunction due to weakness of low back and abdominal muscles [17]. In cLBP, neuromuscular weakness is the primary sign, but in clinical practice coining neuromuscular pain with pulmonary function is rare.

The PEFR is a test that measures how fast a person can exhale (breathe out). The PEFR test is commonly performed at home with an inexpensive handheld device called a Mini-Wright peak flow monitor. In clinical practice, including a specific respiratory tests like spirometry in the assessment and treatment of patients with back pain is not routine. At the same time, adding these kinds of respiratory function assessments may give additional information about the effect of our intervention [18]. Few studies described the relation of chronic pain on respiratory muscle activity and thoracic expansion, but no studies were done to find the effect of cLBP on PEFR.

Thus, the study aimed to evaluate the PEFR value in patients with cLBP and to compare the same with their expected value calculated by machine.

MATERIALS AND METHODS

This was a cross-sectional study done in Maharashtra Institute of Physiotherapy, Latur, Maharashtra, India, from June 2019 to January 2020. Institutional Ethical approval was done before commencing the research (MIP/EC/543/239). Written consent was taken from all the study participants after informing the objective and scope, procedures, risks and benefits of the research.

Sample size calculation: Sample size for this research was calculated using G power 3.1 software. Considering an alpha of 0.05. a power of 0.80, the calculated effect size was 0.51, with a required sample of 79 patients. Patients with cLBP attending the outpatient physiotherapy clinic were selected based on the selection criteria.

Inclusion criteria: The inclusion criteria for the study were patients with back pain felt between T12 and the gluteal folds, at least three months of duration, both sexes, aged between 20 and 50 years and without any cognitive impairments.

Exclusion criteria: Patients with history of pulmonary diseases such as pulmonary fibrosis, emphysema, bronchial asthma, cardiothoracic surgery, chronic bronchitis, lung cancer were excluded. The patients with specific cause for their back pain such as spondylolisthesis, fracture spine, due to any medical condition like tumour, pregnancy; complex conditions (sciatica, spinal stenosis, previous spinal surgery) were also excluded.

Hundred (50 males and 50 females) patients with the cLBP were recruited. Mean age, weight, height, duration of cLBP was recorded. All the patients underwent a standardised interview regarding their medical history, pain history, occupation, and duration of the symptoms and the data are recorded.

Study Procedure

Peak Expiratory Flow Rate (PEFR): Mini-Wright Peak Expiratory Flow Meter. Vitalograph 43602 Peak Flow Meter, United Kingdom was used. Before starting the procedure, the disposable mouthpiece was fixed to the apparatus and was confirmed that the indicator was moved to the lowest end of the numbered scale. The patients were instructed to sit straight and comfortable. The patients were advised to take a deep inhalation and blowout forcefully and quickly through the mouthpiece which was hold tightly by their lips. Patients were informed to repeat the same procedure for two more times and the highest reading was noted.

STATISTICAL ANALYSIS

Statistical Package for the Social Sciences (SPSS) version 16.0 was used for analysing the data. Descriptive statistics were documented as mean±standard deviation. Pearson's correlation coefficient and student t-test with p-value of 0.05 as cut-off were used to find the correlation and significance between the variables respectively.

RESULTS

Mean age, weight and height of the patients were 37.31 years, 65.19 kg and 160.55 cms, respectively [Table/Fig-1]. Correlation coefficient (r=0.906; p-value <0.01 showed that the recorded patients PEFR value had a strong positive relation with their expected PEFR value calculated by the machine [Table/Fig-2]. To identify the significance of altered PEFR value, the calculated t-value of 52.0733 (p-value <0.0001) showed that the reduction in PEFR value among the cLBP patients was statistically significant [Table/Fig-3].

Variables	Mean±Standard deviation	Range (Minimum, maximum value)
Age (years)	37.31±9.490	21, 50
Weight (kg)	65.19±9.066	45, 85
Height (cm)	160.55± 4.706	150, 172
Duration of cLBP (months)	6.42±2.790	3, 15

[Table/Fig-1]: Descriptive statistics of the study samples.

Correlations		Patient value	Expected value	r value	R^2 value	Standard error of the estimate
Patient value	Pearson correlation	1	0.906	0.906	0.818	30.169
	Sig.(2-tailed)	-	0			
Expected value	Pearson correlation	0.906	1			
	Sig.(2-tailed)	0.000	-			

[Table/Fig-2]: Pearson's correlation between the patient and their expected Peak Expiratory Flow Rate value with r value.

Variable	Patient value Mean±SD	Expected value Mean±SD	t-value	Degree of freedom	Standard error of difference
Peak expiratory flow rate	301.38±49.88	474.31±70.77	52.0733	99	3.321

[Table/Fig-3]: Findings between the patient values and their expected values. (student t-test) p-value <0.0001 was highly significant

DISCUSSION

The result of this research study shows that there is a reduction in PEFR among cLBP patients. This decrease in PEFR may be because of the core muscle weakness in prolonged back pain, along with the pain and kinesiophobia associated to cLBP [19]. Perrin C et al., conducted a study on the pulmonary compliances of chronic neuromuscular diseases found that the respiratory muscles cannot reach optimal level of airflow and lung pressure in neuromuscular weakness [14]. Abdominal muscle contributes about 20% of the breathing work and thus the weakness of this muscle will definitely alter the pulmonary function [20].

Janda V described that in long lasting painful conditions, small hypersensitive points, called trigger points, develop in the muscles and this often led to muscle weakness and impaired proprioceptive function [21]. In chronic musculoskeletal problem there is loss of muscle contraction due to the pain inhibition [22]. Lurie M et al., documented reduced maximum expiratory and inspiratory pressures in chronic primary fibromyalgia when compared to the controls and this result indicate respiratory muscle dysfunction in this syndrome [23].

The present study found a statistically significant reduction in the PEFR in cLBP adult patients, and this reduction was similar to the study done by Lopes EA et al., in children with asthma [24]. As this study excluded patients diagnosed with acute or chronic pulmonary lung disease, the reason behind this reduction in PEFR is clinically important. Dimitriadis Z et al., found reduced respiratory muscle strength [25] as well as hypocapnia [26], in patients with chronic neck pain. Britto RR et al., described that the decrease in respiratory function may be due to the weakness of the respiratory muscle and postural dysfunction in the trunk [27]. Core muscle weakness especially the TrA and the lumbar multifidus will cause muscle imbalance and spinal instability thereby directly alters the respiratory function [28,29].

Biomechanical concepts support respiratory muscle has two main mechanisms behind an effective respiration. Firstly, the respiratory muscle pulls the ribcage down along the margins and secondly these muscles are vital in increasing the intra-abdominal pressure [29,30]. When these muscles fail to do this function, ability to produce effective respiratory force falls, plasticity of the lung tissue develops, thus end in a permanent pulmonary dysfunction [31]. On the otherside, weakness of respiratory muscles also reduces the capacity of inhalation so that less airflow into the lung to inflate it thus, ends in poor performance of the expiration [14]. De Troyer A et al., found that pain in musculoskeletal problem may alter the motor control pattern by reducing the muscle contraction, similarly the fear of movement (kinesiophobia) may prevent one from movement of the spine [33]. In contrast, Dimitriadis Z et al., studied the pulmonary function in chronic neck pain and found peak expiratory flow has reduced clinically but not statistically [32].

Clinical importance of this reduction in PEFR among cLBP patients has to be noted. Despite the fact that this finding indicates a similar pattern of peak flow meter values in patients with restrictive lung disease, these patients cannot be classified as having restrictive lung disease. De Troyer A et al., analysed the lung volume alteration in patients with respiratory muscle weakness and found that prolonged duration of decreased lung flow and volumes may result due to altered biomechanics of vertebras, stiffness of the thorax and pathological changes like plasticity in lung tissue and its pathology, finally end in restrictive lung disease pattern [33]. Comparison of this reduction in PEFR value with other pulmonary function parameters such as FEV1, VC and FEV1/FVC will add more information in future. Thus, pulmonary dysfunction expressed as reduced PEFR in this research among cLBP patients is associated with the core muscle weakness, pain and kinesiophobia among cLBP patients.

Limitation(s)

The main limitation of the present study was that there is a possibility of bias as the study subjects were not chosen randomly and there were no blind assessors. Furthermore, the present study did not reported the whole picture of lung volumes in patients with cLBP. Also, the present study did not included the evaluation of residual volume and, as a result, total lung capacity, because low total lung capacity is considered as an important measure for diagnosing true pulmonary restriction.

CONCLUSION(S)

In patients with cLBP there was reduced PEFR similar to that recorded in restrictive lung disease. This decrease in the expiratory effort is due to the core muscle weakness in prolonged LBP, which is vital for respiratory effort and spinal stabilisation to maximise the performance. Thus, it can be concluded that the pulmonary dysfunction in cLBP is predominantly a result of core muscle weakness but may also due to the intensity of pain and kinesiophobia (fear of movement) associated with it.

REFERENCES

[1] Picavet HSJ, Schouten JSAG. Musculoskeletal pain in the Netherlands: Prevalences, consequences and risk groups, the DMC(3)- study. Pain. 2003;102:167-78.
[2] Manchikanti L. Epidemiology of low back pain. Pain Physician. 2000;3(2):167-92.
[3] Hestbaek L, Leboeuf-Yde C, Manniche C. Low back pain: What is the long-term course? A review of studies of general patient populations. Eur Spine J. 2003;12:149-65.
[4] Van Tulder MW, Koes BW, Bouter LM. Conservative treatment of acute and chronic nonspecific low back pain. A systematic review of randomized controlled trials of the most common interventions. Spine. 1997;22:2128-56.
[5] Webb R, Brammah T, Lunt M, Urwin M, Allison T, Symmons D. Prevalence and predictors of intense, chronic, and disabling neck and back pain in the UK general population. Spine. 2003;28(11):1195-202.
[6] Freburger JK, Holmes GM, Agans RP, Jackman AM, Darter JD, Wallace AS, et al. The rising prevalence of chronic low back pain. Arch Intern Med. 2009;169(3):251-58.
[7] Sá KN, Baptista AF, Matos MA, Lessa I. Chronic pain and gender in Salvador population. Brazil Pain. 2008;139(3):498-506.
[8] Hides JA, Richardson CA, Jull GA. Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. Spine. 1996;21:2763-69.
[9] Kaneko H, Satou H, Maruyama H. Reliability of lateral abdominal muscles thickness measurement using ultrasonography. Rigakuryoho Kagaku. 2005;20:197-201.
[10] Abe T, Kusuhara N, Yoshimura N, Tomita T, Easton PA. Differential respiratory activity of four abdominal muscles in humans. J Appl Physiol. 1996;80:1379-89.
[11] Teixeira-Salmela LF, Parreira VF, Britto RR, Brant TC, Inácio EP, Alcântara TO, et al. Respiratory pressures and thoraco-abdominal motion in community-dwelling chronic stroke survivors. Arch Phys Med Rehabil. 2005;86:1974-78.
[12] Ruppel GL. Manual of pulmonary function testing, 9th edition. Missouri: Mosby; 2009.
[13] Thurlbeck WM, Macklem PT. Physiologic considerations in restrictive lung disease. Hum Pathol. 1970;1(2):259-64.
[14] Perrin C, Unterborn JN, Ambrosio CD, Hill NS. Pulmonary complications of chronic neuromuscular diseases and their management. Muscle Nerve. 2004;29(1):05-27.
[15] LoRusso TJ, Belman MJ, Elashoff JD, Koerner SK. Prediction of maximal exercise capacity in obstructive and restrictive pulmonary disease. Chest. 1993;104(6):1748-54.
[16] Abbina A, Mondam S. Influence of abdominal muscle strength on pulmonary function in post upper abdominal surgery subjects. Int Res J Medical Sci. 2013;1(4):01-05.
[17] Hagins M, Lamberg E. Individuals with low back pain breathe differently than healthy individuals during a lifting task. Journal of Orthopaedic and Sports Physical Therapy. 2011;41(3):141-48.
[18] Yozbatiran N, Gelecek N, Karadibak D. Influence of physiotherapy programme on peak expiratory flow rate (PEFR) and chest expansion in patients with neck and low back pain. J Back Musculoskelet Rehabil. 2006;19:35-40.
[19] Pryor JA, Prasad AS. Physiotherapy for respiratory and cardiac problems: Adults and paediatrics: Elsevier Health Sciences; 2008.
[20] Almeida VP, Guimarães FS, Moço VJR, Menezes SLS, Mafort TT, Lopes AJ. Correlation between pulmonary function, posture, and body composition in patients with asthma. Revista Portuguesa de Pneumologia. 2013;19:204-10.
[21] Janda V. Muscle strength in relation to muscle length, pain and muscle imbalance, In: Muscle Strength, Harms. K. Ringdahl (Editor), Churchill Livingstone; 1993:83-91.
[22] Sterling M, Jull G, Wright A. The effect of musculoskeletal pain on motor activity and control, J Pain. 2001;2:135-45.
[23] Lurie M, Caidahl K, Johansson G and Bake B. Respiratory function in chronic primary fibromyalgia. Scand J Rehabil Med. 1990;22:151-55.
[24] Lopes EA, Fanelli-Galvani A, Prisco CC, Gonçalves RC, Jacob CM, Cabral AL, et al. Assessment of muscles shortening and static posture in children with persistent asthma. Euro J Pediatr. 2007;166:715-21.
[25] Dimitriadis Z, Kapreli E, Strimpakos N, Oldham J. Respiratory weakness in patients with chronic neck pain. Man Ther. 2013;18(3):248-53.
[26] Dimitriadis Z, Kapreli E, Strimpakos N, Oldham J. Hypocapnia in chronic neck pain patients: Association with pain, muscle function, and psychological states. Am J Phys Med Rehabil. 2013;92(9):746-54.
[27] Britto RR, Rezende NR, Marinho KC, Torres JL, Parreira VF, Teixeira-Salmela LF. Inspiratory muscular training in chronic stroke survivors: A randomized controlled trial. Arch Phys Med Rehabil. 2011;92:184-90.
[28] Comerford MJ, Mottram SL. Movement and stability dysfunction–contemporary developments. Man Ther. 2001;6(1):15-26.
[29] Key J, Clift A, Condie F, Harley. A model of movement dysfunction provides a classification system guiding diagnosis and therapeutic care in spinal pain and related musculoskeletal syndromes: a paradigm shift–Part 1. J Body Mov Ther. 2008;12(1):07-21.
[30] Kapreli E, Vourazanis E, Strimpakos N. Neck pain causes respiratory dysfunction. Med Hypotheses. 2008;70(5):1009-13.
[31] Bruton A. Muscle Plasticity: Response to training and detraining. Physiotherapy. 2002;88(7):398-408.
[32] Dimitriadis Z, Kapreli E, Strimpakos N, Oldham J. Pulmonary function of patients with chronic neck pain: A spirometry study. Respiratory Care. 2014;59(4):543-49.
[33] De Troyer A, Borenstein S, Cordier R. Analysis of lung volume restriction in patients with respiratory muscle weakness. Thorax. 1980;35(8):603-10.

PARTICULARS OF CONTRIBUTORS:
1. Adjunct Professor, Department of Physiotherapy, Saveetha College of Physiotherapy, Chennai, Tamil Nadu, India.
2. Professor and Head, Department of Physiotherapy and Sports Medicine, Dr. B. Nanavati Hospital, Mumbai, Maharashtra, India.
3. Professor and Head, Department of Physiology, Dr. D.Y. Patil Medical College, Pune, Maharashtra, India.
4. Professor and Head, Department of Physiotherapy, Dr. D.Y. Patil College of Physiotherapy, Pune, Maharashtra, India.
5. Lecturer, Department of Anatomy, University of Hail, Hail, Saudi Arabia.
6. Assistant Professor, Department of Diagnostic Radiology, University of Hail, Hail, Saudi Arabia.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Leo Rathinaraj Antony Soundararajan,
C/o. Mr. Antony S. Selvam, AF2 Sai Kiruba Flats, Near Kids Shadow School,
Old State Bank Colony, West Tambaram, Chennai, Tamil Nadu, India.
E-mail: leo_rathinaraj@yahoo.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: May 08, 2021
- Manual Googling: Sep 16, 2021
- iThenticate Software: Oct 04, 2021 (11%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **May 07, 2021**
Date of Peer Review: **Aug 18, 2021**
Date of Acceptance: **Sep 28, 2021**
Date of Publishing: **Nov 01, 2021**