The immediate effect of soft tissue manual therapy intervention on lung function in severe chronic obstructive pulmonary disease

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Background and objective: In chronic obstructive pulmonary disease (COPD), accessory respiratory muscles are recruited as a compensatory adaptation to changes in respiratory mechanics. This results in shortening and overactivation of these and other muscles. Manual therapy is increasingly being investigated as a way to alleviate these changes. The aim of this study was to measure the immediate effect on lung function of a soft tissue manual therapy protocol (STMTP) designed to address changes in the accessory respiratory muscles and their associated structures in patients with severe COPD.

Methods: Twelve medically stable patients (n=12) with an existing diagnosis of severe COPD (ten: GOLD Stage III and two: GOLD Stage IV) were included. Residual volume, inspiratory capacity and oxygen saturation (SpO2) were recorded immediately before and after administration of the STMTP. A Student’s t-test was used to determine the effect of the manual therapy intervention (P<0.05).

Results: The mean age of the patients was 62.4 years (range 46–77). Nine were male. Residual volume decreased from 4.5 to 3.9 L (P=0.002), inspiratory capacity increased from 2.0 to 2.1 L (P=0.039) and SpO2 increased from 93% to 96% (P=0.001).

Conclusion: A single application of an STMTP appears to have the potential to produce immediate clinically meaningful improvements in lung function in patients with severe and very severe COPD.

Keywords: expiratory reserve volume, plethysmography, residual volume, inspiratory capacity

Introduction

Chronic obstructive pulmonary disease (COPD) is a common preventable and treatable disease characterized by progressive airflow limitation that is associated with an inflammatory response to noxious particles or gases.1 The disease has been categorized in to four stages according to severity: mild, moderate, severe and very severe.2 Exacerbations and comorbidities contribute to the overall severity in individual patients with the disease affecting not only the respiratory system but also the musculoskeletal system.2,3

In COPD, changes in the anatomy of the airways and lung parenchyma occur as the result of bronchial hypersecretion and bronchoalveolar instability. These changes cause expiratory flow limitation and air trapping, known clinically as dynamic hyperinflation. This phenomenon leads to increases in expiratory reserve volume, residual volume (RV) and end expiratory lung volume (EEV). The increase in EEV limits tidal and inspiratory reserve volumes resulting in a negative impact on inspiratory capacity (IC).4 The changes alter the position of the ribs causing a state similar to sustained
inspiration over time, often referred to as “inspiratory block”. This phenomenon is responsible for the characteristic “barrel chest” commonly seen in patients with COPD. In this state, the position of the diaphragm is flattened and shortened reducing its ability to generate force. Accessory respiratory muscles are recruited as a compensatory adaptation leading to shortening and overactivation of these muscles over time (overadaptation). The surrounding cervicothoracic fascia contracts producing postural changes, such as anterior projection of the head, neck hyperextension, increased thoracic kyphosis and internal rotation of shoulders. These changes contribute to an increase in chest tightness, a decrease in the ability to generate inspiratory pressures and volumes and an increase in the amount of effort required to breathe.

Current COPD management strategies include physical activity and respiratory muscle training. Physical activity improves exercise tolerance, whereas respiratory muscle training increases inspiratory muscle strength. Targeting disturbances in the respiratory pumping mechanism is not part of this approach making the addition of a therapeutic intervention that directly addresses the soft tissues of the chest wall a novel approach.

Manual therapy (MT) has been described as a therapeutic intervention that uses the hands to provide treatment to the musculoskeletal and/or visceral systems. MT includes techniques such as massage, myofascial release, muscle energy technique, ligament balance, joint mobilization and joint manipulation. The suggestion that MT can deliver ongoing benefits for people with COPD has been proposed in the literature. Since then, a number of small studies have reported improvements in lung function and/or exercise capacity following various forms of MT intervention over the immediate, short- and medium terms.

Two of these studies measured the immediate effect of MT on lung function: one measured the effect of a single session of soft tissue therapy in combination with thoracic mobilization, whereas the other measured the effect of six sessions of a single soft tissue technique – the manual diaphragm release technique. Neither study was capable of clearly delineating the proposed outcome assessments and the soft tissue manual therapy protocol (STMTP) used in the trial. After providing written consent, a patient was enrolled in the study.

Baseline measurements, including age, weight, height and lung volumes, were recorded. Lung volumes were measured using body plethysmography (Sensormedics VMAX 22 Pulmonary Function Test System; SensorMedics Corporation, Yorba Linda, CA, USA) and collected according to the standards and procedures outlined by the American Thoracic Society. Lung volumes included total lung capacity (TLC), vital capacity (VC), RV, inspiratory reserve volume (ERV), IC and airway resistance ($R_{aw}$).

Heart rate (HR) was assessed manually through palpation of the radial pulse for 1 minute with the patient at rest. Respiratory rate (RR) was measured using the direct observation method and calculated by counting the number of respiratory cycles in 1 minute while the patient was at rest. Oxygen saturation ($\text{SpO}_2$) was measured using a portable finger oximeter (Prince 100I; Heal Force Bio-meditech Holdings Limited, Hong Kong, People’s Republic of China) with the patient at rest. All measurements were taken immediately before and after administration of the STMTP.

**MT protocol**

The STMTP used in this trial consisted of a pre-determined set of seven soft tissue techniques delivered as part of a single treatment session lasting ~30 minutes (Table 1). The techniques and their respective durations were sub-occipital release, 5 minutes; anterior thoracic myofascial and sternum release, 5 minutes; anterior cervical myofascial release, 5 minutes; costal ligament balance, 5 minutes; and muscular energy technique to the following muscles: scalenes, 1 minute and 40 seconds, pectoralis minor, 1 minute and 40 seconds and latissimus dorsi and serratus anterior, 1 minute and 40 seconds. All techniques were administered in the same order and by a single therapist with the patient positioned in Fowler’s position ($45^\circ$) throughout the session.
Statistical analysis was performed using the SPSS 15.0 software (SPSS for Windows Version 15.0; SPSS Inc, Chicago, IL, USA). Normal distributions for HR, RR, SpO₂ and lung volumes were assessed using the Shapiro–Wilk test (P>0.05). A Student’s t-test for comparison before and after intervention was used to determine the effect of the STMTP. A P-value of <0.05 was set as the threshold for statistical significance.

The Metropolitan North Health Service of Santiago, Chile, approved the study and all participants provided written informed consent to participate in the study. The trial was registered with the US National Institutes of Health (Trial registration number: NCT02534831). The research was conducted in accordance with the Declaration of Helsinki.

**Results**
A total of 300 clinical records were reviewed as part of this trial. Twenty-five met the inclusion/exclusion criteria, and these patients were invited to participate in the study. Thirteen participants did not complete the study either through non-attendance or through incomplete assessments. Patient flow through the study is outlined in Figure 1. Ten patients had severe (GOLD Stage III) and two had very severe (GOLD Stage IV) COPD. Nine were males. The mean age was 62.4±7.8 years, mean weight was 71.8±9.3 kg and mean height was 164±6.1 cm (Table 2). Table 3 shows the pre- and postintervention measurements for HR, RR and SpO₂ for all 12 patients who completed the study. Average HR decreased from 83.8±14.1 beats per minute (bpm) pre-intervention to 76.5±15.3 bpm postintervention (P=0.001); RR decreased from 20.4±4.3 respirations per minute (rpm) preintervention to 15.7±3.8 rpm postintervention (P=0.001) and SpO₂ increased from 92.8±2.8% preintervention to 95.8±2.4% postintervention (P=0.001). TLC decreased by 0.4 L (pre: 6.8±2.0; post: 6.4±1.8; P=0.031), ERV by 0.05 L (0.33±0.17; 0.28±0.16; P=0.005) and RV by 0.6 L (4.5±1.5; 3.9±1.4; P=0.002), whereas IC increased by 0.1 L (2.0±0.5; 2.1±0.6; P=0.039; Figure 2). There were no changes in VC and R_{aw} (P=0.799 and P=0.068, respectively).
MT, the most likely cause of the improvements reported in our study is a reduction in chest tightness produced by soft tissue MT intervention. This is in line with results from other studies that showed that soft tissue MT was capable of reducing hypertonicity in myofascial tissues when applied to other areas of the body.17–22 Reduced tonicity in the muscles, fascia and ligaments of the neck and chest would facilitate an improvement in the passive components of expiration by reducing the extent of any inspiratory block. In support of this concept are the results from a recent exploratory study, which reported a correlation between pulmonary function, postural alignment and mobility of the upper quadrant in patients with COPD.23

The decreases in ERV and RV can be directly attributed to the increase in IC as it would return the inspiratory muscles closer to their optimal length, thereby improving mechanical efficiency.4,5 Improvements in mechanical efficiency may also explain the increase in SpO2 and decrease in RR, which if sustainable, could alter input to the central and peripheral chemoreceptors.24,25 The decrease in HR may be the result of a flow-on effect from a decreasing RV where lower pressure within the lungs leads to a reduction in pulmonary hypertension.24,26,27 The absence of any changes in VC and Rrs may simply be the result of the small size of the changes in RV, ERV, TLC and IC.

It is worth noting that the TLC values reported in this study were higher than those traditionally reported in patients with severe and very severe COPD. This may be due to two reasons: (1) patients with COPD and lung hyperinflation can have a TLC that is >100% of the predicted value,4 and (2) spirometric values for the Chilean population have been reported as being higher than in other populations.28
Although the findings from a recent systematic review into the effect of MT on COPD were inconclusive with respect to benefiting lung function,^{29} technique choice may have played a role in influencing this view as MT techniques that use compression/decompression maneuvers can increase airway obstruction by accelerating airflow to the extent that airways collapse.\(^{23}\) Patient positioning during the STMTP may have influenced our results as having the patient supine for an extended period of time can increase the effect of inefficient diaphragm motion. The way lung function was measured may also have influenced the results. Although the previous study used spirometry to assess lung function and focused on measures, such as forced expiratory volume in the first second and forced vital capacity,\(^{10}\) we used plethysmography and were, therefore, able to measure changes in RV accurately, which directly relate to the extent of dynamic hyperinflation.\(^{30–32}\)

The MT techniques used in this study were chosen because of their potential to reduce the effects of overactivation and overadaptation in the respiratory muscles. The results reported here are supported by results in other studies, involving the administration of MT to patients with COPD. These studies used a similar approach in producing short-term\(^{11–13,15}\) and medium-term\(^{14}\) improvements in lung function. Notwithstanding, to our knowledge, this is the first study to use plethysmography to report a clinically meaningful reduction in RV following MT intervention.

The STMTP could be used in a repeated manner as part of a pulmonary rehabilitation program for patients with COPD. As it has the potential to reduce overactivation in the respiratory muscles, it may also be beneficial following an exacerbation.

**Limitations**

Apart from the recognized limitations associated with a study design of this nature, there are a number of other limitations associated with this study. Gender mix differences may have altered the statistical analyses as males and females have different lung volumes. The contribution toward the decreases in HR and RR of leaving the patient in Fowler’s position for an extended period of time (30 minutes) is unclear. By not gathering data on adverse events, the safety of this STMTP remains unknown. As a study aimed at evaluating the immediate effect of a specific intervention, the impact of these limitations should be considered within this context and not measured against other study designs.

**Conclusions**

A single application of an MT protocol consisting of seven soft tissue techniques has the potential to deliver immediate improvements in lung function for people with severe and very severe COPD. The results from this study support the call for further research in the field on larger cohorts that include multiple measuring points and a control group. Such studies would help to confirm if the benefits reported here can be sustained in patients with advanced COPD.

**Authors’ contribution**

CCM helped in concept, design, data collection, analysis and interpretation, drafting and revising the manuscript; DGO contributed to design, data collection, analysis and interpretation, drafting and revising the manuscript; FACB performed data analysis and interpretation, drafting and revising the manuscript; PG carried out design, data collection, analysis and interpretation, drafting and revising the manuscript; RTC helped in data analysis and interpretation, drafting and revising the manuscript; LMV carried out design, data collection, analysis and interpretation, drafting and revising the manuscript; RME contributed to data interpretation, drafting and revising the manuscript. All authors gave final approval of this version to be published and agreed to be accountable for all aspects of the work and for ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
Disclosure
The authors report no conflicts of interest in this work.

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