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Original Article

Physiotherapy Section

Immediate Effect of Mulligan Therapy on Pulmonary Function and Chest Expansion in Healthy Individuals: A Quasi-experimental Study

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ABSTRACT

Introduction: Mulligan therapy includes Sustained Natural Apophyseal Glides (SNAGs) and Mobilisation With Movement (MWM), which can be applied for spinal pain and Range of Motion (ROM). It helps to stretch the structures on the convex side of the offending movement and opens the intervertebral foramen. Pulmonary Function Test (PFT) is an important diagnostic test that helps guide decisions for management. Normal chest expansion is crucial for respiratory system function and tissue oxygenation. The contraction of external intercostal muscles moves the ribs upwards and outwards, causing the rib cage to expand, which increases the volume of the thoracic cavity. After the age of 25 years, normal pulmonary function begins to decline. Inappropriate posture leads to reduced thoracic cage mobility, thereby decreasing chest expansion. Thoracic SNAGs and MWM help stretch the structures, which will aid in chest expansion.

Aim: To determine the effect of Mulligan therapy on pulmonary function and chest expansion in healthy individuals.

Materials and Methods: A quasi-experimental study was conducted at Ramaiah Hospitals in Bengaluru, Karnataka, India over an 11-month period between July 2021 and June 2022. Based on the inclusion criteria, 103 participants were included, and Mulligan therapy was performed. Pre- and post-PFT and chest expansion measurements were taken and analysed using Student's t-test.

Results: The results showed a statistically significant difference in chest expansion at all three levels ($p<0.001$) and Forced Expiratory Volume (FEV1) in the first second/Forced Vital Capacity (FVC) ($p=0.04$), Peak Expiratory Flow (PEF) ($p=0.03$), Forced Inhibitory Volume in the first second (FIV1) ($p=0.01$), and FIV1/FIVC ($p=0.03$) values in the PFTs.

Conclusion: Chest expansion and FEV1/FVC, PEF, FIV1, and FIV1/FIVC show a significant change post thoracic SNAGs, intercostal MWM, costochondral, and costovertebral MWM. However, no significant changes have been observed in the other parameters of pulmonary function.

Keywords: Costochondral joints, Intercostal muscles, Mulligan therapy, Pulmonary function test, Thoracic sustained natural apophyseal glides

INTRODUCTION

Joint mobilisation is a method that applies traction and gliding techniques passively to the articular surface to maintain mobility. Mulligan first proposed the use of SNAG, which can be applied for spinal pain and ROM [1]. Its principal techniques are SNAGs, NAGs, and Mobilisation with Movement (MWM). During SNAGs, the therapist applies the glide by pushing the desired vertebrae (spinous process) towards the eyeball, and the subject tries to actively move the joint while maintaining the glide. In MWM, the therapist sustains the glide while the patient performs the offending movement [2,3].

Indications of Mulligan therapy at thoracic joint and rib cage are mainly pain and ROM, but specifically, research investigating pulmonary function and chest expansion is currently lacking [4]. The concept of SNAG is to increase the treatment effects by having patients perform active movements while removing pain in the lesions through manipulative therapy. This concept in the manual therapy field differs from traditional manipulative therapy, where there is a combination of active movements of the patients with additional passive movements performed by therapists [4].

The SNAGs and MWM help in stretching the structures on the convex side of the offending movement and opening the intervertebral foramen. They might correct positional faults, thereby correcting the biomechanics of the joint, which will help in proper chest expansion. They might also stimulate mechanoreceptors and proprioceptors in and around these joints, which helps in releasing muscles around the joints [2].

Spirometry is one of the methods used to investigate pulmonary function measurements such as Forced Expiratory Volume in the first second (FEV1) and Forced Vital Capacity (FVC). In normal adults, FEV1 and FVC vary from 1.5 L to 5.8 L depending on age, gender, and height. If FEV1 is less than 80%, it is a sign of airflow limitation [5]. PFTs are important diagnostic tests in the management of respiratory conditions. They help guide decisions regarding further treatment and management.

The FEV1 refers to the volume of air that an individual can exhale during a forced breath in one second [6]. FVC refers to the maximal volume of air that can be expired following maximum inspiration, with maximum speed and effort [4]. The FEV1/FVC ratio (also known as FEV1(%) helps in distinguishing obstructive and restrictive lung diseases [7].

Peak Expiratory Flow (PEF) measurement is a simple measure of the maximal flow rate that can be achieved during forceful expiration following full inspiration [8]. Peak Inspiratory Flow Rate (PIFR) is the maximal flow rate measured in liters/second during an inspiratory maneuver [9]. The Schiller SP-1 is a reliable and validated quantitated tool by American Thoracic Soceity (ATS)/European Respiratory Soceity (ERS) [10].

Normal chest expansion is important for respiratory system function and tissue oxygenation, making evaluation in physical examination crucial. Expansion and thoracic mobility can be assessed using tape measurement for accurate results [11]. During inspiration, as the first rib is freely moving about its costovertebral joint, it is elevated followed by the sternum. This movement is not parallel to its initial position, resulting in the anteroposterior diameter of the upper thorax being greater than that of the lower thorax. Due to axial rotation, there is widening of the costochondral angle. These actions occur in the sagittal plane. For the lower ribs, as they are more oblique in shape, the axis is parallel to the sagittal plane. Hence, during inspiration, elevation of the lower ribs increases the transverse diameter [12,13].

The elastic forces of the lung tissue are mainly determined by elastin and collagen fibers interwoven among the lung parenchyma. In deflated lungs, these fibers are in an elastically contracted and kinked phase. So when the lungs expand, they stretch and become unkinked, leading to elongation and exerting more elastic force [4].

The contraction of external intercostal muscles moves the ribs upwards and outwards, causing the rib cage to expand, which increases the volume of the thoracic cavity. Due to the adhesive force of the pleural cavity, the expansion of the thoracic cavity forces the lungs to stretch and expand [14,15].

Normal pleural pressure is -5 cm of water, which is the amount of suction required to hold the lungs open at a resting level. During inspiration, the thoracic cage expands and pulls the lungs outwards with greater force, creating more negative pressure up to -7 cm. This increase in negative pressure increases lung volume [11].

After the age of 25 years, normal pulmonary function begins to decline [5]. Inappropriate posture leads to reduced thoracic cage mobility, thereby decreasing chest expansion. It is the rate of decline that is important when trying to assess future pulmonary function [5]. SNAGs and MWM help in stretching the structures on the convex side of the offending movement and open the intervertebral foramen. They might correct positional faults, thereby correcting the biomechanics of the joint, which will help in proper chest expansion [2]. While previous studies have explored the effects of cervical spine mobilisation on pain, ROM, and respiratory function, authors research endeavors to investigate a novel aspect. The present study seeks to evaluate the impact of Mulligan therapy on pulmonary function and chest expansion, presenting a unique contribution to the existing body of literature in this field. Therefore, the aim of present study was to determine the effect of Mulligan therapy on pulmonary function and chest expansion in healthy individuals. The objectives of the current study were to determine and compare the values of pulmonary function and chest expansion pre and post Thoracic SNAGs and MWM.

In present study, it was hypothesised that performing MWM and thoracic SNAGs in healthy individuals will not cause an increase in pulmonary function and chest expansion, whereas the alternative hypothesis suggests that there will be an increase in pulmonary function and chest expansion after MWM and thoracic SNAGs in healthy individuals.

MATERIALS AND METHODS

Informed consent was obtained from a total of 103 healthy individuals aged between 20 and 40 years who were recruited from the community for an experimental pre-post trial.

A quasi-experimental study was conducted at Ramaiah Hospitals in Bengaluru, Karnataka, India spanning over a period of 11 months from July 2021 to June 2022.

The proposal was submitted for ethical approval to the Ethical Committee of the Institute. After receiving approval from the committee via reference number MSRMC/EC/SP-26/07-2021, all participants recruited in the study were provided with a participation information sheet. The study was then explained to the participants, and those willing to participate provided written informed consent and were then recruited into the study.

Sample size calculation: A total of 103 participants were required based on the sample size calculated with reference to a study carried out on the "Effects of Cervical SNAGs on forward head posture and respiratory function." The standard deviation was 0.75 liters to test a difference of 0.2 ml with an effect size of 0.36, an alpha of 0.05, and a power of 95% using the formula:

$$N=((t\beta/2,n-1+t\beta,n-1)\cdot\sigma\delta)2n=(\delta(t\alpha/2,n-1+t\beta,n-1)\cdot\sigma)2 \ [1]$$

Inclusion and Exclusion criteria: Participants aged between 20 to 40 years were recruited from the community using convenience sampling. Individuals diagnosed with neurological findings, those who underwent thoracic surgeries, individuals taking regular medications to relieve pain, any obstructive or restrictive findings in pretest spirometer, post Coronavirus Disease-2019 (COVID-19) individuals, and individuals with chronic orthopedic conditions related to the cervical and lumbar regions were excluded from the study.

Study Procedure

Demographic data, including height and weight, were collected. After screening, PFT values were measured, including FVC, FEV1, FEV1/FVC ratio, PEF, Peak Inspiratory Flow (PIF), Forced Inspiratory Vital Capacity (FIVC), Forced Inspiratory Volume in the first second (FIV1), and FIV1/FVC ratio using Schiller's Spirometer SP-1. Chest expansion was measured using a tape measure, followed by Mulligan therapy in the form of Thoracic SNAGs for T1-T10 spinous processes and Mulligan with Movement (MWM) for intercostal spaces, costochondral joints, and costovertebral joints [2]. The heel of the hand is placed under the tubercle of the desired rib to be mobilised posteriorly, while the pisiform of the other hand is placed under the costochondral joint anteriorly. A scooping movement is then performed to mobilise the desired costochondral and costovertebral joints while the patient takes a deep breath and performs the movement [2]. The chest expansion was measured at three levels: axillary level; nipple level; and xiphisternal level. It was measured circumferentially with a centimeter tape measure and diametrically transversely by means of a tape measure at all three mentioned levels [16]. Post Mulligan therapy, PFTs, and chest expansion were repeated. The results of pre and post values were compared. The primary outcome of the study was to measure the pulmonary function value, and the secondary outcome was to analyse the chest expansion at all three levels.

STATISTICAL ANALYSIS

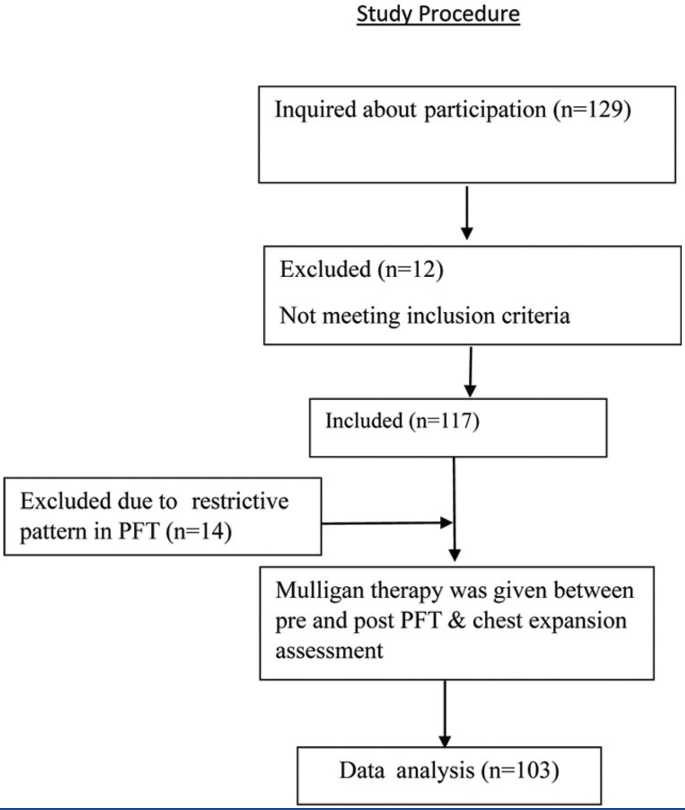
Statistical software Jamovi version 2.0 was used for analysis. Microsoft Word was used to generate tables, and Excel was used to generate figures. A parametric test (Student's t-test) was used to analyse the data, considering the level of significance to be <0.05.

RESULTS

The demographic data of the included participants are presented in [Table/Fig-1] in terms of mean and Standard Deviation (SD). The above table represents the mean and standard deviation of age, which is 23.3±2.87 years, height, which is 164±9.39 cm, and weight, which is 65.1±13.5 kg [Table/Fig-2]. The pulmonary function measurements were recorded pre- and post-therapy and compared in [Table/Fig-3]. The above table shows statistically significant changes were seen only in FEV1/FVC (p-value=0.04), PEF (p-value=0.03), FIV1 (p-value=0.01), and FIV1/FVC (p-value=0.03) values in pulmonary functions [Table/Fig-3]. The changes in FEV1/FVC, PEF, FIV1, and FIV1/FVC were found to be significant. The chest expansion measurements were found to be significant ($p<0.001$) at all levels in [Table/Fig-4].

DISCUSSION

The present study aimed to determine the immediate effect of Mulligan therapy on pulmonary function and chest expansion in



[Table/Fig-1]: Study flow diagram.

Demographic data	Mean±SD
Age (years)	23.3±2.87
Height (cm)	164±9.39
Weight (kg)	65.1±13.5

[Table/Fig-2]: Mean and standard deviation of the demographic data.

PFT values	Mean and standard deviation (Pre values)	Mean and standard deviation (Post values)	p-value	Effect size
FEV1 (l)	2.63±0.6	2.6±0.5	0.09	0.16
FVC (l)	2.84±0.7	2.84±0.6	0.99	9.01
FEV1/FVC (%)	92.9±5.37	91.9±6.4	0.04*	0.2
PEF (l/s)	5.9 ±1.49	5.73±1.5	0.03*	0.2
PIF (l/s)	3.71±1.28	3.79±1.3	0.36	-0.08
FIVC (l)	2.8±0.7	2.83±0.7	0.48	-0.06
FIV1 (l)	2.3±0.7	2.45±0.6	0.01*	-0.24
FIV1/FIVC (%)	83.3±20	87.2±14.9	0.03*	-0.21

[Table/Fig-3]: Effect of Mulligan therapy on pulmonary functions.

Chest expansion values	Mean±SD (Pre values)	Mean±SD (Post values)	p-value	Effect size
Axillary (cm)	3.26±1.4	3.96±1.4	<0.001	-1.07
Nipple (cm)	2.83±1.5	3.52±1.6	<0.001	-1.15
Xiphisternum (cm)	3.27±1.7	3.93±1.7	<0.001	-1.08

[Table/Fig-4]: Effect of Mulligan therapy on chest expansion.

healthy individuals, as research investigating pulmonary function and chest expansion was lacking. However, since some pulmonary function values did not show statistical significance, the null hypothesis was accepted.

It is believed that thoracic SNAGs, intercostal MWM, costochondral MWM, and costovertebral MWM can help stretch the structures of the rib cage, which in turn may promote proper chest expansion when combined with breathing [2]. The present study found a statistically significant change in chest expansion at all levels-axillary, nipple, and xiphisternum-and in PFTs, specifically in FEV1/FVC, PEF, FIV1, and FIV1/FIVC [Table/Fig-3]. However, no differences were observed in other pulmonary function values, as PFT assesses impairment [Table/Fig-3]. This result can be attributed to a study conducted by Engel RM and Vemulpad S, which examined the combined effect of manual therapy with exercise on respiratory function. It was found that the exercise group demonstrated a statistically significant decrease in pulmonary function, FVC, and FEV1 due to smooth muscle relaxation leading to temporary bronchodilation. Since, PFT was immediately performed after exercise and exercise-induced respiratory resistance was present, this resulted in reduced function [5].

A study conducted by Wall BA et al., examined the immediate and transient effects of a single session of manual therapy on pulmonary functions but did not show any significant changes [13]. This result is similar to present study, which also concluded that there were no significant changes observed in terms of pulmonary functions, possibly due to participants becoming tired. Continuous movement, hyperventilation in some cases, and feeling light-headedness at the end of Mulligan therapy were cited as reasons by the subjects, which support the reduction in PFT values.

Upon analysing, authors observed a significant increase in chest expansion values pre and post MWM at the intercostals, costovertebral, and costochondral joints [Table/Fig-4]. This finding in present results is attributed to the stretching effect on the contractile structures, which stimulates mechanoreceptors and proprioceptors, leading to muscle relaxation around the joints and thereby improving the ROM at the joints. A study by Moutzouri M et al., explains the effect of reducing pain and improving ROM, which supports the findings of our study regarding the improvement in chest expansion [14].

Mulligan therapy demonstrated immediate improvement in chest expansion measurements, which can be utilised as an additional method in pulmonary rehabilitation to help enhance breathing patterns in various respiratory disorders.

Limitation(s)

However, a limitation of present study was that the PFT was conducted without any break following Mulligan therapy. The fatigue induced by the therapy might have influenced the PFT results. The absence of a break could potentially confound the interpretation of the study's findings regarding the effects of Mulligan therapy on pulmonary function.

CONCLUSION(S)

Thoracic SNAGs, intercostal MWM, and costochondral and costovertebral MWM improve chest expansion measurements, which were assessed at three different levels using tape. However, the enhancement in pulmonary function did not show statistical significance. It can be concluded that Mulligan therapy, including Thoracic SNAGs, intercostal MWM, and costochondral and costovertebral MWM, can have an immediate effect on joint movement, as evidenced by the recorded changes. However, these effects may not be sufficient to bring about measurable changes in lung function impairment within the pulmonary system.

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