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Studying the Effects of Inspiratory Muscle Training in Patients with Obstructive Lung Diseases

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Abstract

Inspiratory Muscle Training (IMT) has been studied significantly as being used for pulmonary rehabilitation for patients with obstructive lung disease. By measuring the various test subjects' on the following parameters, researchers can develop a basis to determine whether the training is successful in helping the patients improve their inspiratory muscle function: level of dyspnea based on the Borg score, maximum inspiratory pressure, number of hospitalizations due to exacerbations of their disease, inspiratory muscle strength and endurance, 6 minute walking distance, exercise tolerance, and health related quality of life (HRQL). By assessing these critical values, researchers have determined that IMT does provide a significant form of exercise for the inspiratory muscles that can improve their function and offer many other health benefits.

INTRODUCTION

Inspiratory Muscle Training (IMT) is theorized to offer a basis for pulmonary rehabilitation to patients with obstructive lung diseases. It works by providing a threshold of Inspiratory resistance that the patients inhale against to strengthen their Inspiratory muscles. The threshold device is used repeatedly during a training session and offers patients a constant level of resistance to work against. Through routine daily exercise sessions patients should be able to increase their Inspiratory muscle strength. With the strengthening of these muscles, the patients' levels of dypnea should decrease as the work of breathing becomes easier. Also with the decreased work of breathing, it should follow that patients should be able to perform physical activities more easily and improver their overall Health Related Quality of Life (HRQL).

PROBLEM STATEMENT

Are there theoretical reasons for expecting any benefit from improved function of the inspiratory muscles?

REVIEW OF LITERATURE

Inspiratory muscle training (IMT) is a form of respiratory rehabilitation that is recognized as a key therapeutic tool in all clinical guidelines in managing COPD. According to Mota-Casals (2005), when assessing the IMT as a rehabilitation technique, the following questions should be addressed: 1. Are there theoretical reasons for expecting any benefit from improved function of the inspiratory muscles? 2. Can training improve muscle function of the inspiratory muscles in patients with COPD? 3. Does improved inspiratory muscle function produce a clinical benefit for these patients?

In a meta-analysis of 12 trials, it was found that when using a valve to create a resistance load, where the breathing pattern and pressure were not affected, allowed patients to develop a more regular breathing pattern. Further discoveries in this study showed that specific inspiratory training protocol with specified duration and work loads (>20% PImax) lead to improvement in strength and stamina of the inspiratory muscles. This increase in strength and stamina improve structural changes to the external intercostals, therefore producing functional changes with a structural basis when trained appropriately. A further sub analysis was performed and it was found that general training combined with specific training of the inspiratory muscles was significantly better at improving the strength and stamina of the inspiratory muscles. In this case, those subjects whose PImax was less than 60 cmH2O, there was an increase in the distance achieved during the 6 minute walk test.

Throughout the testing, one key point noted was that the control group, which trained at the minimal load allowed by the threshold device showed comparable improvement in all variables studied. This illustrates that low pressure administered at regular intervals provided a sufficient stimulus to induce training-related changes. These findings show that aggressive therapy is not necessarily the most beneficial to patients and more passive levels of training can be used in patients with severe cases of COPD.

In conclusion, all three of the previously proposed questions can be answered affirmatively with the following statement: There is a theoretical justification for using Inspiratory Muscle Training in the reduction of dyspnea, one of the main goals in managing COPD.

According to Weiner (2004), it is hypothesized that increasing the respiratory muscle strength and endurance with Specific Inspiratory Muscle Training (SIMT) will produce a reduction of symptoms in patients with asthma.

The study's design compared SIMT of 15 blinded patients with a “sham training” of 15 blinded patients who received no actual resistance training. The entire experiment was conducted over the course of a 6 month training session. Comparisons between the two groups were made in all of the following fields: inspiratory muscle strength, and endurance, hospitalization for asthma, asthma symptoms, absence from school or work, emergency department visits, and inhaled beta-2 agonists.

To develop a baseline for comparison, each of the 30 test subjects were asked to record in a daily journal the severity of their asthma symptoms based on the following three parameters: nighttime asthma, daytime asthma, and cough severity. The journaling began 3 months prior to the beginning of their training sessions and was continued through the duration of the study.

The patients were also asked to perform the following quantitative tests to develop a basis for measuring their improvement with the training: spirometry, respiratory muscle strength, and respiratory muscle endurance. The actual training was conducted in 30 minute sessions 5 times per week over the course of 6 months. With the conclusion of the training sessions there were found to be significant increases in the 3 quantitative assessments for all members of the SIMT group, where there was little to no improvement for those in the control group.

One of the key discussions that arose from this study is focused on the increased FVC that was measured by the SIMT group. (It was found that the SIMT group's FVC rose from 76.8 [+ or - 3.1] to 86.6 [+ or – 2.5] percent of predicted normal values.) It is known that the resistance to airflow varies with lung volumes.

By increasing the FVC of a patient, their overall lung volume increases. This produces a direct decrease in their airway resistance and presumably a decrease in their levels of dyspnea. In conclusion, SIMT is a proven way to increase an asthma patient's FVC. This aids in reducing their levels of dyspnea and in turn can be used as an alternative physiologic form of therapy to reduce their intake of systemic corticosteroids and inhaled beta-2 agonists.

Effect of Inspiratory Muscle Training on Muscle Strength and Quality of Live in Patients with Chronic Airflow Limitation: A Randomized Controlled Trial, (2005) looks at inspiratory muscle training and assesses it as a technique for managing Chronic Airway Limitation (CAL). The overall aim of this study was to quantitatively determine the effectiveness of inspiratory muscle training on improved physiological and functional variables. In the study, 18 control patients and 17 experimental patients were subjected to experimental intervention over the course of 2 months. The experimental patients performed inspiratory muscle training using a device that administered a resistive load of 40% their maximal inspiratory mouth pressure (PImax). The parameters that were assessed included: inspiratory muscle strength, respiratory function, exercise tolerance, and quality of life.

The results of the study showed that there was a significant increase in the inspiratory muscle strength of the experimental training group. PImax was found to improve 8.9 cmH2o per month of training. Concurrently, the health-related quality of life scores were found to improve by 0.56 points. In conclusion, the IMT with use of threshold device was found to effectively strengthen inspiratory muscles when measured by the PImax. It was detected that the level of improvement would be significant enough to be considered as a respiratory rehabilitation program to improve HRQL for the patients.

The purpose of this study was to determine the appropriate level to set the training load for the inspiratory muscle trainer, IMT. Two groups were trained using two different levels of their PImax to assess which level would be most effective when offering pulmonary rehabilitation to patients with chronic airflow limitation (CAL) (Lisboa, 1994). The training was assessed by measuring the following variables: PImax, Inspiratory Muscle Power Output (IMPO), Sustainable Inspiratory Pressure (SIP), Maximal Inspiratory Flow Rate (VImax), pattern of breathing during loaded breathing, Mahler's dyspnea scores, and 6 minute walking distance. After 5 weeks, group 1 (their resistance load was set at 30% of their predetermined PImax) exhibited significant increases in all the parameters. Group 2 (resistance was set at 12% of PImax) showed no significant improvement in these measurements. Dyspnea was found to be decrease for group 1 and this group also showed an increase in tidal volume and reduction in inspiratory time.

According to an article found in Chest (2002), the use of Inspiratory Muscle Training can be used to aid in the weaning of mechanically ventilated patients who were previously unable to be weaned from their ventilator (Martin 2002). Through aggressive training with high levels of intensity and low repetitions, the patients were able to increase their duration of spontaneous breathing periods (SBP). Each of the 10 patients started out with an average of 2.1 [+ or – 3.4] consecutive hours of SBPs. They had been on mechanical ventilation for an average of 34 [+ or – 31] days. The daily training consisted of four sets of six breaths through a threshold inspiratory muscle trainer. The initial resistance load was 7 [+ or – 3] cmH20 and it was increased to 18 [+ or – 7] cmH2O when the patient was successfully weaned. After 44 [+ or – 43] days, 9 of 10 patients were successfully weaned from mechanical ventilation. The use of endurance respiratory muscle training has been successful in aiding patients when weaning them off of the ventilator. This test was different than those previously attempted because it used a pressure threshold rather than a restrictive flow device and the inspiratory muscles were trained in strength rather than endurance. Based upon this study it is predicted that a “high-intensity pressure-threshold IMST program coupled with progressively longer SBPs would increase inspiratory muscle strength and endurance, decrease the patients' perception of respiratory distress during spontaneous breathing, and facilitate weaning.”

Weiner, (2003) compares specific inspiratory muscle training against training of both the inspiratory and expiratory muscles when training for improvement in respiratory muscle strength and endurance. Inspiratory Muscle Training has been used to decreased the severity of breathlessness and improve exercise tolerance in patients with COPD. In this study, there were 4 groups in randomized individuals to assess different training variations: group 1 received specific expiratory muscle training (SEMT), group 2 received specific inspiratory muscle training (SIMT), group 3 received a combination of SIMT and SEMT training, group 4 was the control group and received training with a minimal load. The training sessions lasted ½ hour six days a week for 3 months.

The results of the study showed that there was a significant increase in the 6 minute walking distance for groups 1, 2, and 3, however the results for the SEMT group were not nearly as high as those for the SIMT and SIMT + SEMT groups. There was a decrease in the mean Borg score during breathing against resistance for the SIMT group and the SEMT + SIMT group, where as the SEMT and control group exhibited no change. In conclusion, both the inspiratory and expiratory muscle groups can be trained to have improved muscle strength and endurance. However, there is no additional benefit gained when combining SIMT and SEMT when comparing to SIMT alone.

The effects of inspiratory muscle training were recorded in an 8 week study performed on patients with cystic fibrosis (Beckerman, 2005). The patients (n=29) were randomized into three study groups. One group received 80% maximal inspiratory muscle training (n=9), one group received 20% maximal inspiratory muscle training (n=10), and one group (n=10) did not participate in inspiratory muscle training. The study demonstrated the benefits of inspiratory muscle training based on inspiratory muscle function, lung volumes, and psychosocial factors. In the two clinical trial groups, the following were observed: increased maximal inspiratory pressure and increased sustained maximal inspiratory pressure, increased vital capacity and total lung capacity, and decreased anxiety and depression scores.

Patients with mild asthma with high consumption of beta-2 agonists were studied to evaluate the effects of inspiratory muscle training (Enright, 2004). The patients were randomized into two groups, an experimental group and a control group. The experimental group received training for 3 months; the control group received sham training. The study was measured by perception of dyspnea and frequency of beta-2 agonist consumption. Inspiratory muscle training was found to decrease the perception of dyspnea of patients based on the Borg score. Furthermore, inspiratory muscle training was associated with decreased frequency of consumption of beta-2 agonists.

The effects of long-term inspiratory muscle training were documented in a study performed on 42 patients with COPD (Oh, 2003). All patients involved in the study exhibited at least a moderate obstructive component, as represented by FEV1 < 50%. The study was conducted for 1 year. The subjects were randomized into two groups: one group received the inspiratory muscle training and one group received a greatly reduced training program. The study conclusively showed the benefits of inspiratory muscle training based on inspiratory muscle strength, perception of dyspnea, improved exercise capacity, and decrease in primary care usage and hospitalization. In comparison to the control, the patients demonstrated improvement in maximal inspiratory pressure, decreased perception of dyspnea as evidenced by a decrease in the mean Borg score, improvement in six-minute walking distance, and decreased use of primary care physician, and decreased frequency of hospitalizations.

The effects of inspiratory muscle training were observed in patients with COPD in Spain (Lotters, 2002). The patients were randomized into two groups, an experimental group (n=10) and a control group (n=10). The experimental group trained at home for 30 minutes a day, 6 days a week, for 6 months. The control group did not participate in any form of inspiratory muscle training. The outcomes were measured in sustained maximal inspiratory pressure, shuttle walking test, and health related quality of life questionnaires. The results showed improvement in the measured factors in the experimental group, whereas the control group demonstrated no statistically significant improvement. Therefore, the study exhibited the correlation of inspiratory muscle training and relief of dyspnea, increased exercise capacity, and improved health related quality of life.

In a study performed in South Korea, the effects of inspiratory muscle training were observed in a home-based pulmonary rehabilitation program (Riera, 2001). The patients (n=23) were randomized into two groups, in which the first group (n=15) received inspiratory muscle training and the second group (n=8) only received education. All of the patients involved with the study exhibited a moderate to severe obstructive component in the presentation of COPD. The outcome measures were FEV1, level of dyspnea based on the Borg score, and six-minute walking distance. The experimental group demonstrated decreased perception of dyspnea and improved exercise capacity.

The documented effects of inspiratory muscle training were examined in a meta-analysis. The meta-analysis involved a thorough, systematic literature research to provide a critical examination of the effects of inspiratory muscle training (Weiner, 2000). The literature used in the meta-analysis was limited to patients with COPD. The study conclusively determined the beneficial effects of inspiratory muscle training. The effects were improved inspiratory muscle strength and endurance, improved functional exercise capacity, and decreased dyspnea, during exercise and at rest. The meta-analysis strongly suggested that inspiratory muscle training is a very essential addition to pulmonary rehabilitation programs.

METHODOLOGY

The layouts for developing the different studies for patients using the Inspiratory Muscle Training follow the same clinical standards. The project was first introduced to IRB for acceptance. The patients were then informed of the nature of the study and signed written consent to participate. The studies were performed within compliance of HIPPA guidelines. The subjects were all selected at random in a double blind approach. The patients' disorders consisted of COPD, asthma, cystic fibrosis, and those who were ventilator dependent. Their physical ability as assessed by questionnaire and they were divided into a control group and an experimental group. The control group did not receive any inspiratory muscle training where the experimental group received various levels of threshold resistance training. The training lasted for a predetermined amount of time daily and was continued over the course of a preset time frame. The data from the experiments was collected and the information of the experiment group was compared to that of the control group. The data collected ranged from the following parameters: 6 minute walking distance, FEV1, level of dyspnea based of the Borg scale, HRQL, PImax, exercise tolerance, frequency of hospitalizations and primary care usage.

DISCUSSION

Based on the reviewed studies, the Inspiratory Muscle Training provides a form of muscle exercise that builds the inspiratory muscles for patients with obstructive lung disease. The resistance training helps them improve muscle function which leads to decrease in their levels of dyspnea and an increase in their HRQL.

All of the studies conducted were performed on a limited number of subjects. There has yet to be any collaboration between large research groups to quantitatively analyze the results of IMT on a large scale. An option for future studies is to incorporate a much larger number of test subjects to be studied and possibly off a definitive number for a threshold resistance load that might offer the highest level of results for specific chronic lung conditions.

There also seems to be a lack of unified measurements assessing the success of the IMT. For future studies, there should be a set of universal parameters that is measured for a basis to determine the full effects of the training. After a number of large studies have been conducted with these universal measurements, they can be generalized into a basis for setting goals for future patients receiving IMT.

CONCLUSION

Based on the previously discussed studies IMT does show a positive correlation between an optimal threshold resistance level and increased Inspiratory muscle strength in patients with obstructive lung diseases. This increased muscle strength contributes significantly to the patients' decreased work of breathing and level of dyspnea as graded on the Borg score. These studies prove that IMT does provide a successful form of pulmonary rehabilitation for obstructive lung patients. This offers improved lung function in those who trained with it appropriately. At optimal resistance levels, Inspiratory Muscle Training can be viewed as a successful way to help improve obstructive lung patients' overall health related quality of life.

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