

Respifit S

Kliniske studier vedrørende
inspiratorisk muskelterapi



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LITERATURE GUIDE

In the following you find the abstracts of the most important clinical studies concerning the topic „Inspiratory Muscle Training“.

With the Literature Guide we want to give you a short overview of the clinical papers.

What is important:

Title?

Author?

Where?

Study Design?

Methods?

Outcome?

Inspiratory muscle training in patients with chronic obstructive pulmonary disease: structural adaptation and physiologic outcomes.

Am J Respir Crit Care Med 2002 Dec 1;166(11):1491-7

Ramirez-Sarmiento A; Orozco-Levi M; Guell R; Barreiro E; Hernandez N; Mota S; Sangenis M; Broquetas JM; Casan P; Gea J

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The present study was aimed at evaluating the effects of a specific inspiratory muscle training protocol on the structure of inspiratory muscles in patients with chronic obstructive pulmonary disease.

Fourteen patients (males, FEV₁, 24 +/- 7% predicted) were randomized to either inspiratory muscle or sham training groups. Supervised breathing using a threshold inspiratory device was performed 30 minutes per day, five times a week, for 5 consecutive weeks. The inspiratory training group was subjected to inspiratory loading equivalent to 40 to 50% of their maximal inspiratory pressure.

Biopsies from external intercostal muscles and vastus lateralis (control muscle) were taken before and after the training period. Muscle samples were processed for morphometric analyses using monoclonal antibodies against myosin heavy chain isoforms I and II.

Increases in both the strength and endurance of the inspiratory muscles were observed in the inspiratory training group. This improvement was associated with increases in the proportion of type I fibers (by approximately 38%, $p < 0.05$) and in the size of type II fibers (by approximately 21%, $p < 0.05$) in the external intercostal muscles. No changes were observed in the control muscle.

The study demonstrates that inspiratory training induces a specific functional improvement of the inspiratory muscles and adaptive changes in the structure of external intercostal muscles.

Effects of controlled inspiratory muscle training in patients with COPD: a meta-analysis.

Eur Respir J 2002 Sep;20(3):570-6

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The purpose of this meta-analysis is to review studies investigating the efficacy of inspiratory muscle training (IMT) in chronic obstructive pulmonary disease (COPD) patients and to find out whether patient characteristics influence the efficacy of IMT.

A systematic literature search was performed using the Medline and Embase databases.

On the basis of a methodological framework, a critical review was performed and summary effect-sizes were calculated by applying fixed and random effects models.

Both IMT alone and IMT as adjunct to general exercise reconditioning significantly increased inspiratory muscle strength and endurance. A significant effect was found for dyspnoea at rest and during exercise. Improved functional exercise capacity tended to be an additional effect of IMT alone and as an adjunct to general exercise reconditioning, but this trend did not reach statistical significance.

No significant correlations were found for training effects with patient characteristics.

However, subgroup analysis in IMT plus exercise training revealed that patients with inspiratory muscle weakness improved significantly more compared to patients without inspiratory muscle weakness.

From this review it is concluded that inspiratory muscle training is an important addition to a pulmonary rehabilitation programme directed at chronic obstructive pulmonary disease patients with inspiratory muscle weakness. The effect on exercise performance is still to be determined.

Comparison of Specific Expiratory, Inspiratory, and Combined Muscle Training Programs in COPD

Chest 2003 Oct;124(4):1357-64

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BACKGROUND: Respiratory muscle weakness may contribute to dyspnea and exercise limitation in patients with significant COPD. In an attempt to reduce the severity of breathlessness and to improve exercise tolerance, inspiratory muscle training has been applied in many COPD patients. On the other hand, there is a paucity of data related to expiratory muscle performance and training in COPD.

METHODS: Thirty-two patients with significant COPD (ie, mean FEV₁, 37% of predicted) were recruited for the study. The patients were randomized into four groups: eight patients were assigned to receive specific expiratory muscle training (SEMT); eight patients received specific inspiratory muscle training (SIMT); eight patients received SEMT and SIMT (ie, the SEMT + SIMT group); and eight patients who were assigned to a control group received training with very low load. All patients trained daily, six times a week, with each session consisting of one half hour of training, for 3 months. Spirometry, respiratory muscle strength and endurance, 6-min walk test distance, the perception of dyspnea, and the Mahler baseline dyspnea index (BDI) were measured before and following training.

RESULTS: Training caused a statistically significant specific increase in the expiratory muscle strength and endurance (in the SEMT and SEMT + SIMT groups) and in the inspiratory muscle strength and endurance (in the SIMT and SEMT + SIMT groups). There was significant increase in the distance walked in 6 min in the SEMT, SIMT, and SEMT + SIMT groups. However, the increase in the SIMT and SEMT + SIMT groups was significantly greater than that in the SEMT group. There was a statistically significant increase in the BDI, and a decrease in the mean Borg score during breathing against resistance in the SIMT and SEMT + SIMT groups, with no changes in the SEMT and control groups.

CONCLUSIONS: The inspiratory and expiratory muscles can be specifically trained with improvement of both muscle strength and endurance. The improvement in the inspiratory muscle performance is associated with an increase in the 6-min walk test distance and the sensation of dyspnea. There is no additional benefit gained by combining SIMT with SEMT, compared to using SIMT alone.

Preoperative respiratory muscle training.

Assessment in thoracic surgery patients with special reference to postoperative pulmonary complications.

Chest 1994 Jun;105(6):1782-8

Nomori H; Kobayashi R; Fuyuno G; Morinaga S; Yashima H

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STUDY OBJECTIVE: To assess the usefulness of preoperative respiratory muscle training to increase muscle strength and its effects on postoperative pulmonary complications. **DESIGN:** We measured maximum inspiratory (MIP) and maximum expiratory (MEP) mouth pressure before and after training in 50 patients undergoing thoracic surgery. For control purposes, MIP and MEP were measured in 50 age- and sex-matched healthy subjects at two different times without training. **RESULTS:** Preoperative respiratory muscle training increased both MIP and MEP significantly ($p < 0.01$), while the control subjects showed no increase in these parameters. Eight patients who had postoperative pulmonary complications had significantly lower values ($p < 0.01$) and did not show significant increases in either MIP or MEP even after the training, unlike the other patients, who were without postoperative pulmonary complications. On the other hand, there were also another six patients who had equally low MIP and MEPs before training, but who raised their values with training and avoided the postoperative pulmonary complications.

CONCLUSION: Preoperative respiratory muscle training may prevent postoperative pulmonary complications by increasing both inspiratory and expiratory muscle strength in patients undergoing thoracic surgery. Patients with respiratory muscle weakness have a higher risk of postoperative pulmonary complications.

**Long-term effects of outpatient rehabilitation of COPD:
A randomized trial.**

Chest 2000 Apr;117(4):976-83

Guell R; Casan P; Belda J; Sangenis M; Morante F; Guyatt GH; Sanchis J

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OBJECTIVE: To examine the short- and long-term effects of an outpatient pulmonary rehabilitation program for COPD patients on dyspnea, exercise, health-related quality of life, and hospitalization rate.

SETTING: Secondary-care respiratory clinic in Barcelona.

METHODS: We conducted a randomized controlled trial with blinding of outcome assessment and follow-up at 3, 6, 9, 12, 18, and 24 months. Sixty patients with moderate to severe COPD (age 65 +/- 7 years; FEV(1) 35 +/- 14%) were recruited. Thirty patients randomized to rehabilitation received 3 months of outpatient breathing retraining and chest physiotherapy, 3 months of daily supervised exercise, and 6 months of weekly supervised breathing exercises. Thirty patients randomized to the control group received standard care.

RESULTS: We found significant differences between groups in perception of dyspnea ($p < 0.0001$), in 6-min walking test distance ($p < 0.0001$), and in day-to-day dyspnea, fatigue, and emotional function measured by the Chronic Respiratory Questionnaire ($p < 0.01$). The improvements were evident at the third month and continued with somewhat diminished magnitude in the second year of follow-up. The PR group experienced a significant ($p < 0.0001$) reduction in exacerbations, but not the number of hospitalizations. The number of patients needed to treat to achieve significant benefit in health-related quality of life for a 2-year period was approximately three.

CONCLUSION: Outpatient rehabilitation programs can achieve worthwhile benefits that persist for a period of 2 years.

**Inspiratory muscle training in patients with COPD:
Effect on dyspnea, exercise performance, and quality of life.**

Chest 2001 Sep;120(3):748-56

Sanchez Riera H; Montemayor Rubio T; Ortega Ruiz F; Cejudo Ramos P; Del Castillo Otero D; Elias Hernandez T; Castillo Gomez J

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OBJECTIVE: The aim of the study was to assess the effect of target-flow inspiratory muscle training (IMT) on respiratory muscle function, exercise performance, dyspnea, and health-related quality of life (HRQL) in patients with COPD.

PATIENTS AND METHODS: Twenty patients with severe COPD were randomly assigned to a training group (group T) or to a control group (group C) following a double-blind procedure. Patients in group T (n = 10) trained with 60 to 70% maximal sustained inspiratory pressure (SIPmax) as a training load, and those in group C (n = 10) received no training. Group T trained at home for 30 min daily, 6 days a week for 6 months.

MEASUREMENTS: The measurements performed included spirometry, SIPmax, inspiratory muscle strength, and exercise capacity, which included maximal oxygen uptake (VO₂), and minute ventilation (VE). Exercise performance was evaluated by the distance walked in the shuttle walking test (SWT). Changes in dyspnea and HRQL also were measured.

RESULTS: Results showed significant increases in SIPmax, maximal inspiratory pressure, and SWT only in group T (p < 0.003, p < 0.003, and p < 0.001, respectively), with significant differences after 6 months between the two groups (p < 0.003, p < 0.003, and p < 0.05, respectively). The levels of VO₂ and VE did not change in either group. The values for transitional dyspnea index and HRQL improved in group T at 6 months in comparison with group C (p < 0.003 and p < 0.003, respectively).

CONCLUSIONS: We conclude that targeted IMT relieves dyspnea, increases the capacity to walk, and improves HRQL in COPD patients.

Effects of combined inspiratory muscle and cycle ergometer training on exercise performance in patients with COPD.

Eur Respir J 1994 Dec;7(12):2205-11

Wanke T; Formanek D; Lahrmann H; Brath H; Wild M; Wagner C; Zwick H

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Cycle ergometer training plays an important role in the rehabilitation of patients with chronic obstructive pulmonary disease (COPD), but the usefulness of specific inspiratory muscle training as part of pulmonary rehabilitation remains uncertain. To determine whether inspiratory muscle training could intensify the known beneficial effects of cycle ergometer training on exercise performance in these patients, we compared the effect of an 8 week inspiratory muscle training combined with cycle ergometer training with that of an 8 week cycle ergometer training alone on inspiratory muscle performance and general exercise capacity.

Patients were randomly assigned to the two training groups; 21 patients received additional inspiratory muscle training (Group 1) and 21 did not (Group 2). Maximal sniff assessed oesophageal and transdiaphragmatic pressures served as parameters for global inspiratory muscle strength and diaphragmatic strength, respectively. The duration for which the patient could breathe against a constant inspiratory pressure load was used as an index of inspiratory muscle endurance. Exercise capacity was determined by an incremental symptom-limited cycle ergometer test. After the training period, inspiratory muscle performance improved significantly in the patients with inspiratory muscle training, but not in those without.

Both training regimens increased maximal power output and oxygen uptake, but this **improvement was significantly greater in the patients with inspiratory muscle training than in those without.**

Inspiratory muscle training in patients with Duchenne muscular dystrophy.

Chest 1994 Feb;105(2):475-82

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PURPOSE: The aim of this study was to assess the usefulness of a specific inspiratory muscle training in Duchenne muscular dystrophy (DMD).

PATIENTS AND METHODS: Fifteen patients with DMD started 6 months of training the inspiratory muscles and 15 patients served as a control group. Pulmonary and inspiratory muscle function parameters were assessed 3 months before and at the beginning of training, in the first and third month of training, at the end, and 6 months after its cessation. Maximal sniff assessed esophageal and transdiaphragmatic pressure values served as indices for global inspiratory muscle strength and diaphragmatic strength, respectively. Inspiratory muscle endurance was assessed by the length of time a certain inspiratory task could be maintained.

RESULTS: In 10 of the 15 patients, respiratory muscle function parameters improved significantly after 1 month of training. Further improvements were to be seen after 3 and after 6 months. Even 6 months after the end of training, those effects remained to a large extent. In the other five patients, there was no such improvement after 1 month of training, which was therefore discontinued. All these five patients had vital capacity values of less than 25 percent predicted and/or PaCO₂ values of more than 45 mm Hg. The 15 control patients had no significant change in their respiratory muscle function parameters.

CONCLUSION: We conclude that a specific inspiratory muscle training is useful in the early stage of DMD.

Dose-dependent effects of inspiratory muscle training in neuromuscular disorders.

Muscle Nerve 2000 Aug;23(8):1257-60

Winkler G; Zifko U; Nader A; Frank W; Zwick H; Toifl K; Wanke T

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The goal of this study was to show whether a correlation exists between the intensity of specific respiratory muscle training and the improvement of strength and endurance in inspiratory musculature in patients with neuromuscular disorders (NMD). Sixteen patients with NMD (13 with Duchenne muscular dystrophy and 3 with spinal muscular atrophy) performed inspiratory muscle training (IMT) at home with a special training apparatus for 9 months.

Maximal inspiratory mouth pressure (PI(MAX)) and 12s-maximum voluntary ventilation (12s-MVV) test served as parameters for inspiratory muscle strength and endurance, respectively. In patients whose inspiratory vital capacity (VC(in)) declined by less than 10% during the year before training began (n = 10), a significant positive correlation was found between the number of successfully completed strength and endurance exercises and the improvement of PI(MAX) (P < 0.05) and 12s-MVV (P < 0.05). In patients whose VC(in)-decline exceeded 10% (n = 6), indicating more progressive respiratory system involvement of the disease, no significant correlation between the improvement of PI(MAX) and 12s-MVV and the intensity of training was found.

In patients with NMD, the effects of IMT-runs are dose-dependent, provided that the respiratory system involvement of the disease is only slowly progressive.

2 Years' experience with inspiratory muscle training in patients with neuromuscular disorders.

Chest 2001 Sep;120(3):765-9 (ISSN: 0012-3692)

Koessler W; Wanke T; Winkler G; Nader A; Toifl K; Kurz H; Zwick H

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PURPOSE: The aim of our study was to assess the long-term effects of specific inspiratory muscle training (IMT) in patients with neuromuscular disorders (NMDs) who have various degrees of respiratory impairment. **Patients and methods:** Twenty-seven patients with NMDs (Duchenne's muscular dystrophy, 18 patients; spinal muscular atrophy, 9 patients) underwent 24 months of IMT. Patients were divided into three groups according to their vital capacity (VC) values. VC was measured as the parameter for the respiratory system involvement of the disease. Maximal inspiratory pressure (P_Imax) was assessed as the parameter for respiratory muscle strength, and the results of the 12-s maximum voluntary ventilation test (12sMVV) were assessed as the parameter for respiratory muscle endurance. Pulmonary and inspiratory muscle function parameters were assessed 6 months before training, at the beginning of training, and then every 3 months.

RESULTS: The P_Imax values improved in group A (VC, 27 to 50% predicted) from 51.45 to 87.00 cm H₂O, in group B (VC, 51 to 70% predicted) from 59.38 to 94.4 cm H₂O, and in group C (VC, 71 to 96% predicted) from 71.25 to 99.00 cm H₂O. The 12sMVV values improved in group A from 52.69 to 69.50 L/min, in group B from 53.18 to 62.40 L/min, and in group C from 59.48 to 70.5 L/min. For all three groups, there was a significant improvement of P_Imax ($p < 0.007$) and 12sMVV ($p < 0.015$) until the 10th month when a plateau phase was reached with no decline in the following month until the end of training. **CONCLUSION:**

With IMT, respiratory muscle function can be improved in the long term of up to 2 years.

Inspiratory muscle training in patients with cystic fibrosis.

Respir Med 2001 Jan;95(1):31-6

de Jong W; van Aalderen WM; Kraan J; Koeter GH; van der Schans CP

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Little information is available about the effects of inspiratory muscle training in patients with cystic fibrosis (CF). In this study the effects of inspiratory-threshold loading in patients with CF on strength and endurance of the inspiratory muscles, pulmonary function, exercise capacity, dyspnoea and fatigue were evaluated. Sixteen patients were assigned to one of two groups using the minimization method: eight patients in the training group and eight patients in the control group. The training was performed using an inspiratory-threshold loading device. Patients were instructed to use the threshold trainer 20 min a day, 5 days a week for 6 weeks. Patients in the training group trained at inspiratory threshold loads up to 40% of maximal static inspiratory pressure (P_{imax}) and patients in the control group got 'sham' training at a load of 10% of P_{imax}. No significant differences were found among the two groups in gender, age, weight, height, pulmonary function, exercise capacity, inspiratory-muscle strength and inspiratory-muscle endurance before starting the training programme. Mean (SD) age in the control group was 19 (5.5) years, mean (SD) age in the training group was 17 (5.2) years. Mean FEV₁ in both groups was 70% predicted, mean inspiratory-muscle strength in both groups was above 100% predicted. All patients except one, assigned to the training group, completed the programme.

After 6 weeks of training, mean inspiratory-muscle endurance (% P_{imax}) in the control group increased from 50% to 54% (P = 0.197); in the training group mean inspiratory muscle endurance (% P_{imax}) increased from 49% to 66% (P = 0.003). Statistical analysis showed that the change in inspiratory-muscle endurance (% P_{imax}) in the training group was significantly higher than in the control group (P = 0.012).

After training, in the training group there was a tendency of improvement in P_{imax} with an increase from 105 to 123% predicted, which just fell short of statistical significance (P = 0.064). After training no significant differences were found in changes from baseline in pulmonary function, exercise capacity, dyspnoea and fatigue.

It is concluded that low-intensity inspiratory-threshold loading at 40% of P_{imax} was sufficient to elicit an increased inspiratory-muscle endurance in patients with CF.

Inspiratory muscle training during treatment with corticosteroids in humans.

Chest 1995 Apr;107(4):1041-4 (ISSN: 0012-3692)

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In a previous study performed by us, functional alterations in the inspiratory muscles were evaluated in patients receiving corticosteroids for diseases other than respiratory. We have shown that patients who received high-dose steroids for several weeks developed inspiratory muscle weakness that was reversible following withdrawal of the drug treatment. The present study was designed to evaluate the ability of specific inspiratory muscle training (SIMT) to prevent the effects of a therapeutic dosage of corticosteroids on inspiratory muscle function in patients receiving the drug for diseases other than pulmonary, with no underlying respiratory or muscular disease. Twelve patients, 5 men and 7 women, with ages ranging from 19 to 41 years, who received corticosteroids for diseases other than respiratory were recruited into two groups: 6 patients were assigned to the control group and got sham training and 6 patients received SIMT while receiving corticosteroids in a single-blind group-comparative trial.

In both groups, there was no difference between the post-treatment and pretreatment values as regard to the FEV1/FVC relationship. However, in the control group but not in the training group, there was a small but significant decrease, from 99.2 +/- 3.0 to 94.3 +/- 2.8 (mean +/- SEM, $p < 0.01$) in FEV1 (percent of predicted normal values) and from 103.5 +/- 4.0 to 88.7 +/- 3.1 ($p < 0.001$) in the FVC, following treatment. All subjects had normal inspiratory muscle strength, as expressed by the maximal inspiratory mouth pressure (P_Imax) at residual volume, and inspiratory muscle endurance as expressed by the relationship between peak pressure and the P_Imax before treatment. Following administration of corticosteroids, there was a gradual decrease in both inspiratory muscle strength (from 117.5 +/- 9.4 to 80.5 +/- 3.3 cm H₂O, $p < 0.005$) and endurance (from 82.7 +/- 2.6 to 40.2 +/- 1.7%, $p < 0.001$) in the control group. On the contrary, despite corticosteroid therapy, there were no significant changes in the inspiratory muscle function in the patients whose inspiratory muscles were specifically trained. **We conclude that corticosteroids have a significant deteriorating effect on respiratory muscle function in humans. This weakness is preventable by using SIMT during corticosteroid treatment.**