

## ОЦЕНКА ЭФФЕКТИВНОСТИ ТРЕНИРОВКИ ДЫХАТЕЛЬНОЙ МУСКУЛАТУРЫ У БОЛЬНЫХ ХРОНИЧЕСКОЙ ОБСТРУКТИВНОЙ БОЛЕЗНЬЮ ЛЕГКИХ И ОЖИРЕНИЕМ

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**Цель.** Оценить влияние тренировки дыхательной мускулатуры на выраженность симптомов, переносимость физической нагрузки, спирометрические показатели, качество жизни у больных хронической обструктивной болезнью легких (ХОБЛ) и ожирением. **Материалы и методы.** В исследовании приняли участие 52 больных ХОБЛ (клиническая группа D) и ожирением, из них 42 мужчин и 10 женщин, средний возраст  $65,4 \pm 6,8$  лет, индекс массы тела  $33,6 \pm 2,9$  кг/м<sup>2</sup>. Больные были разделены на 2 группы: основная, в которой проводилась тренировка дыхательной мускулатуры (ТДМ) с применением дыхательного тренажера в течение 12 месяцев, и группа контроля – имитация ТДМ с применением того же тренажера, но на минимальном уровне нагрузки. **Результаты.** Через 12 месяцев у больных основной группы в отличие от пациентов группы контроля наблюдалось достоверное уменьшение выраженности одышки по шкале mMRC (The Modified Medical Research Council), улучшение качества жизни, связанного со здоровьем по опроснику госпиталя Св. Георгия (St. George's Respiratory Questionnaire, SGRQ), увеличение объема форсированного выдоха за 1 секунду и форсированной жизненной емкости легких, увеличение пройденного расстояния в тесте шестиминутной ходьбы, уменьшение средней продолжительности госпитализаций по поводу обострения ХОБЛ. **Заключение.** С учетом полученных данных ТДМ может рассматриваться как эффективный компонент программы легочной реабилитации у больных ХОБЛ и ожирением.

**Ключевые слова:** хроническая обструктивная болезнь легких, ожирение, тренировка дыхательной мускулатуры.

## ASSESSMENT OF EFFECTIVENESS OF TRAINING OF RESPIRATORY MUSCULATURE IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND OBESITY

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**Aim.** To assess the influence of training of respiratory musculature on the expressiveness of symptoms, tolerance to physical loads, spirometric parameters and quality of life of patients with chronic obstructive pulmonary disease (COPD) and obesity. **Materials and Methods.** The study included 52 patients with COPD (clinical group D) and obesity, of them 42 men and 10 women with the mean age  $65.4 \pm 6.8$  years and body mass index  $33.6 \pm 2.9$  kg/m<sup>2</sup>. The patients were divided to 2 groups: the main group with training of respiratory musculature (TRM) within 12 months



using a respiratory exerciser, and the control group with simulation of TRM using the same exerciser, but with minimal load. **Results.** In 12 months the patients of the main group showed a reliable reduction of dyspnea on mMRC scale (Modified Medical Research Council), improvement of health related quality of life on St. George's Respiratory Questionnaire (SGRQ), increase in forced expiration volume in 1 second and in forced vital capacity of lungs, increase in the covered distance in 6-minute walk test, reduction of the average duration of hospitalization for exacerbation of COPD. **Conclusion.** Taking into account the obtained data, TRM can be considered as an effective component of the lung rehabilitation program in patients with COPD.

**Keywords:** *chronic obstructive pulmonary disease; obesity; training of respiratory musculature.*

Chronic respiratory pulmonary disease (COPD) is an important problem of modern healthcare due to its high incidence, considerable limitation of physical activity of patients, reduction of the quality of their life; exacerbations and impairment of the course of COPD are among the main reasons for hospitalization [1-3].

Patients with COPD often have related diseases, such as anxiety, depression, osteoporosis, metabolic syndrome, obesity [4-6]. This comorbid pathology impacts the health condition of patients with COPD and the outcome of the disease [1,7,8]. To estimates of different researchers, incidence of obesity in patients with COPD makes from 10 to 50%, besides, a link was shown between obesity and COPD morbidity [9].

The Global Initiative for Chronic Obstructive Pulmonary Disease (GOLD) gives much attention to the programs of pulmonary rehabilitation (PR) that include physical training, especially of the muscles of shoulder girdle and of respiratory muscles, which reliably reduces the evidence of clinical manifestations of the disease, the need for specialized medical care (outpatient visits to a physician, calling ambulance), the rate of exacerbations and hospitalizations, and improves the quality of life [1,10].

Low weight and reduction of muscle mass are well studied and are determined as factors that negatively influence the prognosis for patients with COPD [11]. However, not much information exists about influence of

obesity on PR of patients with COPD. In a relatively recent research the effect of obesity on the outcome of PR was retrospectively evaluated in 114 patients with COPD [12]. With the exception of lower basic values of the covered distance in 6-minute walk test (6MWT) in patients with obesity in comparison with patients with COPD with no obesity, both groups demonstrated comparable improvement of 6MWT results upon completion of the outpatient program of PR. Similar results were obtained in a prospective study of the effect of excessive body weight or obesity on PR in 261 patients with COPD [13]. In another study with participation of patients with COPD and excessive body mass it was shown that the body mass index (BMI) more than 25 kg/m<sup>2</sup> is an independent factor of effectiveness of rehabilitation, at least from the point of view of improvement of 6MWT results [14]. The most probable explanation of this is based on the fact that patients with COPD and excessive body mass present with a more evident impairment of physical condition, and, consequently, possess a higher rehabilitation potential in comparison with patients with normal weight. On the basis of this data it can be suggested that obesity in itself does not produce a negative influence on the effect of PR in patients with COPD. However, the available literature contains very little information about effectiveness of training of the respiratory musculature as one of components of PR in patients with COPD and obesity. Nevertheless, it is just this component of

PR program that can be most effective and preferable taking into account probable difficulties and a relatively low adherence of patients with excessive weight and obesity to general physical training, and impossibility to provide adequate loads in some cases because of related cardio-vascular pathology that is more common in patients with COPD and obesity than in patients with COPD with normal body mass.

*Aim* of our study was assessment of the effect of training of the respiratory musculature on the expressiveness of symptoms, tolerance to physical load, spirometric parameters, quality of life of patients with COPD and obesity.

### Materials and Methods

In the study, 52 patients with COPD participated (clinical group D), of them 42 men and 10 women with the average age

65.4±6.8 years, with similar spirometric parameters – considerable limitation of the air flow: forced expiratory volume in 1 second (FEV<sub>1</sub>) <50% of predicted, ratio of FEV<sub>1</sub> to forced vital capacity of lungs (FEV<sub>1</sub>/FVCL) <70% of predicted. Patients with cardiac pathology and also those that needed oxygen support, were not included into the study. All patients had obesity with BMI more than 30 kg/m<sup>2</sup>.

Using a random number table, patients were randomized into two groups: the main group – 26 patients, who performed training of respiratory musculature (TRM) within a year, and a control group of 26 patients with simulation of TRM using the same device and training program, but with minimal load. Comparative characteristics of patients of the studied groups in the initial period are given in Table 1.

Table 1

### Comparative Characteristics of Studied Group on Inclusion into Study

| Parameter                         | Main Group | Control Group |
|-----------------------------------|------------|---------------|
| n                                 | 26         | 26            |
| Age, years                        | 66.5±4.1   | 65.7±4.6      |
| Men/women, n                      | 21/5       | 21/5          |
| BMI, kg/m <sup>2</sup>            | 33.7±2.5   | 34.5±2.8      |
| FVCL, l                           | 2.45±1.6   | 2.42±0.8      |
| FVCL, % of predicted              | 63±3.7     | 64±4.2        |
| FEV <sub>1</sub> , l              | 1.36±0.7   | 1.39±0.8      |
| FEV <sub>1</sub> , % of predicted | 45.2±2.4   | 43.8±3.5      |
| 6MWT, m                           | 243±39     | 251±48        |
| Smokers, n                        | 8          | 9             |
| Past smokers, n                   | 12         | 13            |

*Note:* for all comparisons p>0.05.

All patients were familiarized with the TRM program, nobody was administered additional regular physical exercises. Not a single patient had contraindications for TRM ((recent exacerbation of COPD (within a month), past exacerbation of COPD, a history of spontaneous pneumothorax, signs of bul-

lous disease identified on X-ray examination, evident osteoporosis in combination with spontaneous fracture of ribs in history, surgery on lungs in the previous year)).

All patients received bronchial spasmolytics of long-term effect on regular basis and inhalation glucocorticosteroids.

TRM was carried out with use of respiratory trainer Threshold Inspiratory Muscle Trainer (Philips Respironics, Great Britain) [15]. Here, a patient was in a sitting position, outlet of air through the nose in a respiratory maneuver was prevented by application of the nose clamp. The training started with warming-up for 1 min with 50% of the supposed full load. This was followed by alternation of a 2-minute period of inspirations with 1-minute period of rest. This 3-minute cycle repeated 7 times. Thus, the overall duration of training session was 21 minutes. The training was terminated upon completion of the program or in case of appearance of unfavorable symptoms – cough, dyspnea, a feeling of evident fatigue, chest pain. Training sessions were conducted 2 times a week.

All the patients were evaluated for the respiratory function by spirometry (including FVCL, FEV<sub>1</sub>), for tolerance to physical load in 6MWT, evidence of dyspnea using mMRC (The Modified Medical Research Council) questionnaire, health related quality of life using St. George's Respiratory Questionnaire (SGRQ). Information of seeking medical assistance in the outpatient conditions, of frequency of hospitalizations, duration of hospitalizations was analyzed.

All tests were conducted before the study in 3, 6, 9 and 12 months by the same

researcher who did not know if a patient belonged to the main or to the control group, like the patients themselves.

This research work was approved at the meeting of Ethic Committee of N.N. Burdenko Voronezh State Medical University, Protocol №1 of 21.02.2018. All patients gave written voluntary informed consent for participation in the research.

Statistical analysis of the data was conducted using program packages STATGRAPHICS 5.1 Plus for Windows. The quantitative data are presented in the form of  $M \pm \sigma$ , where M is sample mean,  $\sigma$  – standard deviation. Comparison of the quantitative parameters was conducted using one-sided dispersion analysis (ANOVA). Correlation analysis was conducted using Pearson's correlation coefficient. The results were considered statistically significant at  $p < 0.05$ .

### Results and Discussion

Through evaluation of spirometric parameters, statistically significant differences were found between the groups starting from the 6<sup>th</sup> month of study to the end of observation (the 12<sup>th</sup> month). Thus, in the main group FEV<sub>1</sub> on average increased from  $45.2 \pm 2.4\%$  to  $52 \pm 4.1\%$  of predicted ( $p < 0.05$ ), and FVCL – from  $63 \pm 3.7\%$  to  $68 \pm 4.2\%$  of predicted. In the control group no statistically significant changes in these parameters were noted (Table 2).

Table 2

#### *Dynamics of Parameters in Studied Groups within 12 Months*

| Parameters                        | Main Group<br>(n=26) |              | Control Group<br>(n=26) |              |
|-----------------------------------|----------------------|--------------|-------------------------|--------------|
|                                   | Before study         | In 12 months | Before study            | In 12 months |
| FVCL, % of predicted              | 63.0±3.7             | 68.0±4.2*    | 64.0±4.2                | 65.0±5.8     |
| FEV <sub>1</sub> , % of predicted | 45.2±2.4             | 52.0±4.1*    | 43.8±3.5                | 44.1±5.6     |
| 6MWT, m                           | 243±39               | 298±38**     | 251±48                  | 265±62       |
| mMRC, score                       | 3.5±0.6              | 2.9±0.6*     | 3.6±0.7                 | 3.5±0.3      |
| SGRQ, total score                 | 56.0±7.2             | 45.0±8.3*    | 57.1±5.4                | 55.0±6.8     |

Note: \* –  $p < 0.05$  in comparison with the data at the start of study, \*\* –  $p < 0.005$  in comparison with the data at the start of study.

In 3 months after the start of training, patients of the main group showed a considerable improvement of tolerance to physical loads judged by the results of 6MWT (from  $251\pm 48$  to  $265\pm 62$  m,  $p>0.05$ ). In the subsequent months of study this parameter continued rising in the main group (to  $317\pm 45$  m in 6 months,  $321\pm 41$  m in 9 months, and  $323\pm 44$  in 12 months), while no significant differences were observed in the control group.

By evidence of dyspnea in the first stage of study, evaluated by mMRC questionnaire, there was no statistically significant differences between the groups; they began to be recorded in 3 months after the start of study manifested by decrease in mMRC score in the main group that persisted throughout the study, and were absent in the control group ((from  $3.5\pm 0.6$  to  $2.9\pm 0.6$  in 12 months ( $p<0.05$ ) and from  $3.6\pm 0.7$  to  $3.5\pm 0.3$  in 12 months ( $p>0.05$ ), respectively)).

By the results of SGRQ, health related quality of life gradually improved that was manifested by a decrease in the total score from  $56.0\pm 7.2$  at the beginning of study to  $45.0\pm 8.3$  in 12 months ( $p<0.05$ ), while in the control group no significant changes in this parameter were noted throughout the entire period of observation. Statistically significant ( $p<0.01$ ) differences between the groups began to be recorded starting from the 6<sup>th</sup> month.

Besides, the data of statistical analysis revealed a close correlational relationship between dynamics of changes of FEV<sub>1</sub> and evidence of dyspnea on mMRC scale ( $r=-0.63$ ,  $p<0.05$ ), and of FEV<sub>1</sub> and tolerance to physical load by the results of 6MWT ( $r=0.57$ ,  $p<0.05$ ) in the main group throughout the whole period of observation.

Based on the results of prospective observation within 12 months, patients of the main and control groups were hospitalized for exacerbation or worsening of the course of

COPD 19 and 21 times, respectively. With this, 13 patients of the main group and 14 ones of the control groups were hospitalized at least once. Difference between the groups in these parameters did not reach statistical significance. However, the difference in the days of stay in hospital reached the statistical significance:  $9.6\pm 2.8$  days in the main group and  $12.3\pm 2.1$  in the control group ( $p<0.05$ ).

The obtained data do not contradict the results of study of J. Villiot-Danger, et al., with participation of 20 patients with morbid obesity ( $BMI=45\pm 7$  kg/m<sup>2</sup>) [16]. Despite the fact that the authors did not show increase in the force of respiratory muscles, in patients with COPD and with obesity who did TRM, reduction of dyspnea was observed. Besides, TRM considerably improved results of 6MWT and the quality of patients' life, while no such changes were observed in the group without TRM. A suggestion was made that TRM potentially prevents early development of fatigue in respiratory muscles during training, and that it is possible to increase tolerance to physical loads in patients with obesity through reduction of the evidence of dyspnea which, in turn, may be the basis for improvement of the quality of life observed in patients.

### Conclusion

Thus, the results of our study evidence a positive effect of training of respiratory musculature in patients with obstructive pulmonary disease and obesity that was manifested by a subjective reduction of dyspnea, increase in tolerance to physical loads judged by the results of six-minute walk test, improvement of spirometric parameters and the quality of life of patients.

Nevertheless, further studies are required for final evaluation of different types and regimes of training of respiratory muscles in programs of pulmonary rehabilitation of patients with chronic obstructive pulmonary disease and obesity.

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