THE EFFECT OF 8 WEEK PULMONARY REHABILITATION PROGRAMME ON CHEST MOBILITY AND MAXIMAL INSPIRATORY AND EXPIRATORY MOUTH PRESSURE IN PATIENTS WITH BRONCHIAL ASTHMA

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Bronchial asthma (AB) can lead not only to breathing disorders but also to musculoskeletal disorders. Breathing and musculoskeletal disorders can lead to health problems and decreased quality of life. These disorders may be also associated with psychosocial problems and could influence adult participation in various activities (physical activities and sports, activities of daily living – shopping, cleaning house, etc.). Breathlessness and cough are usually the most problematic symptoms of AB.

Comprehensive care is based on medical treatment and non pharmacological treatment. Chest physiotherapy is an important part of the non pharmacological treatment, but the optimal medical treatment is also necessary for successful rehabilitation.

The aim of this study was to find out if the pulmonary rehabilitation programme can influence the maximal inspiratory and expiratory mouth pressure and chest mobility of AB patients. The examined group consisted of 23 patients with AB. All AB patients had intermittent mild asthma and they were medically stable patients. All of them underwent an 8 week pulmonary rehabilitation programme (visits were twice a week, 30 minutes in length). The 8 week pulmonary rehabilitation programme was focused on breathing exercises (diaphragmatic breathing, activation of expiration, effective cough training, etc.) and on soft tissue techniques for releasing thoracic and shoulder muscles and fascias. Maximal inspiratory and expiratory mouth pressure and chest mobility were examined at the beginning and at the end of the 8 week pulmonary rehabilitation programme. Chest excursion measurements at the level of the fourth intercostal space and at the level of the tip of the xiphoid process were used for assessment of chest wall motion.

The results of this study showed improved chest mobility and increased values of maximal inspiratory and expiratory mouth pressure after the pulmonary rehabilitation programme. Such improvement can be very important for AB patients. An increase in chest mobility and maximal inspiratory and expiratory mouth pressure leads to easier breathing with less inspiratory effort and consequential physical fatigue. For that reason a pulmonary rehabilitation programme should be a part of comprehensive care for AB patients.

Keywords: Breathing disorders, musculoskeletal disorders, breathing exercises, soft tissue techniques.

INTRODUCTION

Bronchial asthma (AB) is an obstructive disease, which is one of the most common pulmonary diseases, affecting both children and adults. The main goal of comprehensive patient care is the minimization or elimination of symptoms. Comprehensive care involves not only using medicaments, but also non pharmacological treatment.

A chronic inflammatory process in the airway can result in wheezing, breathlessness and cough (Pryor & Prasad, 2002). Asthma can also affect chest wall motion. Upper chest breathing can be found in patients with AB and this type of breathing leads to biomechanical changes and musculoskeletal system dysfunction. Breathing function can be also influenced by muscles and fascia dysfunction such as muscle shortening, muscle weakness, fascial restriction and presence of trigger points (TPs) – for example TPs in diaphragm, serratus anterior muscle, pectoralis major et minor muscles (Chaitow, Bradley, & Gilbert, 2002; Simons, Travell, & Simons, 1999; Travel & Simons, 1982). All these musculoskeletal system dysfunctions could be the cause of respiratory insufficiency and could lead to chest, shoulder or arm pain.

For that reason pulmonary rehabilitation and chest physiotherapy is supposed to be a very important part of a comprehensive treatment and the rehabilitation programme can help to improve breathing and decrease the incidence of musculoskeletal system dysfunctions.

OBJECTIVES

This research views the effect of pulmonary rehabilitation on chest mobility and maximal inspiratory (MIP) and expiratory mouth pressure (MEP) in patients with AB.

MATERIALS AND METHODS

The examined group consisted of 23 medically stable outpatients with intermittent mild asthma (11 women, aged 27.6 ± 5.9 years, 12 men, aged 28.6 ± 4.5 years) who underwent an 8 week pulmonary rehabilitation. None of them had acute exacerbation of asthma during the rehabilitation programme. It was the first time for each of the patients to attend a pulmonary rehabilitation programme.

Rehabilitation programme

The 8 week rehabilitation programme involved two visits per week. Each visit was 30 minutes in length. During the rehabilitation programme, patients underwent an initial and a final examination (spirometric examination, chest mobility examination, examination of MIP and MEP), an interview with a physiotherapist, an introductory education lesson and 12 physiotherapeutic treatment visits.

Baseline interview

Patients had an interview with a physiotherapist. The interview concentrated on the time of asthma onset, on the symptoms of asthma (wheezing, breathlessness, cough, exercise induced asthma, restriction of activity of daily living, night breathing disorders, etc.), pharmacotherapy, smoking history, physical activity and work disability.

Education

Breathing disorders and breathing problems, the pathophysiology of bronchial asthma, the importance of breathing exercises and possibilities of treatment were discussed with the physiotherapist at an education lesson. The physiotherapist gave them materials about AB and materials describing exercises.

Physiotherapy

The physiotherapeutic treatment focused on breathing exercises (pursed lip breathing, diaphragmatic breathing, etc.), an active cycle of breathing techniques (control breathing, thoracic expansion exercises, forced expiratory technique), autogenic drainage, effective cough training and elimination of upper chest breathing. Furthermore, the physiotherapist used mobilization to improve joint play and soft tissue techniques to release muscles and fascias (trapezius muscle, levator scapulae muscles, pectoralis major and minor muscles, pectoral fascia, etc.). Patients learned about stretching muscles and the automobilization of joints (cervical and thoracic spine) and learned breathing exercises and techniques for expectoration.

Examination of chest mobility

We used chest excursion measurements to assess chest wall motion. Both chest circumferences – at maximal voluntary inspiration (INS_{max}) and at maximal voluntary expiration (EXP_{max}) – were measured in a standing position using a tape measure at the level of the fourth intercostal space and at the level of the tip of xiphoid process at the beginning and at the end of an 8 week rehabilitation programme. The difference between INS_{max} and EXP_{max} was defined as chest expansion at the level of the fourth intercostal space (IC) and at the level of the tip of xiphoid process (XP).

Examination of maximal inspiratory and expiratory mouth pressure

We used the measurements of MIP and MEP for the evaluation of respiratory muscle strength. MIP and MEP were measured with respiratory pressure meter MicroRPM at the beginning and at the end of the 8 week rehabilitation programme. The measurement was non invasive and this assessment of respiratory muscle strength is useful for monitoring patients with breathing disorders. This examination is well tolerated by patients and recommended by The American Thoracic Society and The European Respiratory Society (Green, Road, Sieck, & Similowski, 2002) as a test of respiratory muscle strength.

Statistical analysis

The initial and final results were statistically compared. Analysis of the data was done separately for men and women. We used a repeated measure analysis of variance (ANOVA).

RESULTS

Baseline interview

10 patients had asthma onset during their childhood (the existing average duration of AB was 16.3 ± 6.8 years) and 13 patients had adult asthma onset (the existing average duration of AB was 7.2 ± 5.1 years). All 23 patients experienced breathlessness during physical activities and during common illnesses, 4 of them had breathing difficulties during routine daily activities such as cleaning house, shopping, carrying bags, etc. 19 of them claimed that they had coughing problems during

common illnesses (cold, flu, bronchitis, etc.) including chest pain, and they were exhausted by coughing.

Of the participating patients, 20 were non smokers, 2 patients stopped smoking before the programme (one of them had been smoking 5 cigarettes daily for 6 months, the other had been smoking 8 cigarettes daily for 3 years) and 1 of them stopped smoking at the beginning of rehabilitation programme (he had been smoking 3 cigarettes daily for 10 years). Only one patient had to change employment because of asthma. All patients used their medicaments regularly (use of inhaled steroids, inhaled ß agonists, antihistamines, etc.).

After the rehabilitation programme patients felt better, they had fewer breathing disorders (breathlessness, chest pain, etc.) during physical activities and during activities of daily living.

Chest mobility – women

The average value of chest expansion at the level of the fourth intercostal space (IC) was 3.6 cm at the beginning of the treatment and 5.6 cm at the end of the treatment. The average value of chest expansion at the level of the tip of xiphoid process (XP) was 3.9 cm at the beginning of the treatment and 5.9 cm at the end. There were significant improvements of chest expansion at the level of the fourth intercostal space and at the level of the tip of xiphoid process at the end of the treatment (TABLE 1).

TABLE 1
Initial and final values of IC and XP – women

Chest mobility (cm) women	AB_{prae} n = 11		AB_{post} n = 11		
	M	SD	M	SD	p
IC	3.6	0.8	5.6**	1.2	0.00018
XP	3.9	0.7	5.9**	1.2	0.00075

Legend:
IC – examined value of chest expansion at the level of the fourth intercostal space,
XP – examined value of chest expansion at the level of the of the tip of the xiphoid process,
n – number of women,
M – mean,
SD – standard deviation,
p – significance level,
** $p < 0.01$ (ANOVA),
AB_{prae} – initial values,
AB_{post} – final values.

Chest mobility – men

The average value of chest expansion at the level of the fourth intercostal space (IC) was 3.6 cm at the beginning of the treatment and 5.1 cm at the end of the treatment. The average value of chest expansion at the level of the tip of xiphoid process (XP) was 3.8 cm at the beginning of the treatment and 5.9 cm at the end. There were significant improvements of chest expansion at the level of the fourth intercostal space and at the level of the tip of xiphoid process at the end of the treatment (TABLE 2).

TABLE 2
Initial and final values of IC and XP – men

Chest mobility (cm) men	AB_{prae} n = 12		AB_{post} n = 12		
	M	SD	M	SD	p
IC	3.6	1.1	5.1**	1.2	0.00055
XP	3.8	0.7	5.9**	1.2	0.00029

Legend:
IC – examined value of chest expansion at the level of the fourth intercostal space,
XP – examined value of chest expansion at the level of the of the tip of xiphoid process,
n – number of men,
M – mean,
SD – standard deviation,
p – significance level,
** $p < 0.01$ (ANOVA),
AB_{prae} – initial values,
AB_{post} – final values.

Maximal inspiratory and expiratory mouth pressure – women

The initial average value of MIP was 44.3 cmH_2O and the final average value of MIP was 67.2 cmH_2O. The initial average value of MEP was 66.3 cmH_2O and the final average value of MEP was 93.5 cmH_2O. There were significant improvements of MIP and MEP at the end of the treatment (TABLE 3, Fig. 1).

TABLE 3
Initial and final values of MIP and MEP – women

Mouth pressure (cmH_2O) women	AB_{prae} n = 11		AB_{post} n = 11		
	M	SD	M	SD	p
MIP	44.3	16.1	67.2**	15.2	0.00023
MEP	66.3	14.6	93.5**	13.4	0.00033

Legend:
MIP – maximal inspiratory mouth pressure,
MEP – maximal expiratory mouth pressure,
n – number of women,
M – mean,
SD – standard deviation,
p – significance level,
** $p < 0.01$ (ANOVA),
AB_{prae} – initial values,
AB_{post} – final values.

Fig. 1
Initial and final values of MIP and MEP – women

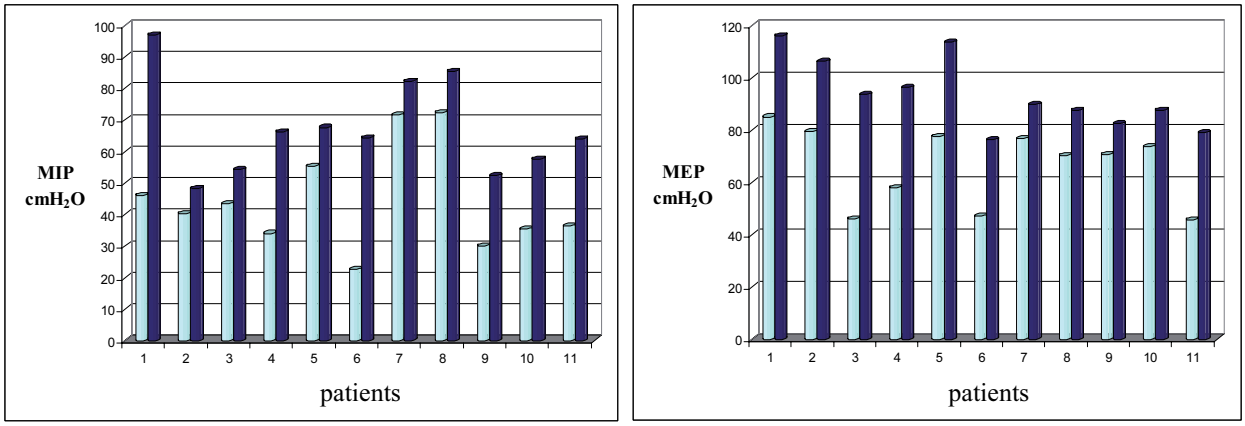
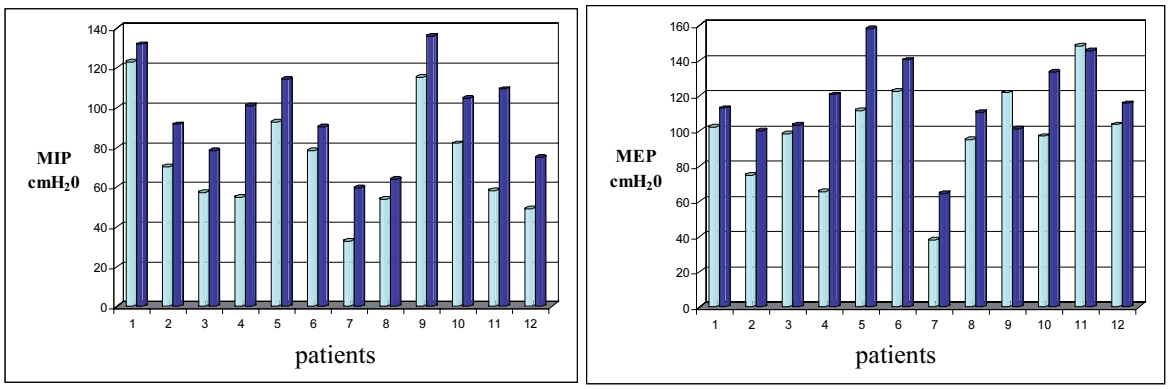


Fig. 2
Initial and final values of MIP and MEP – men



Maximal inspiratory and expiratory mouth pressure – men

The initial average value of MIP was 72.3 cmH_2O and the final average value of MIP was 96.3 cmH_2O. The initial average value of MEP was 98.2 cmH_2O and the final average value of MEP was 117.2 cmH_2O. There were significant improvements of MIP and MEP at the end of the treatment (TABLE 4, Fig. 2).

TABLE 4
Initial and final values of MIP and MEP – men

Mouth pressure (cmH_2O) men	AB_{prae} n = 12		AB_{post} n = 12		
	M	SD	M	SD	p
MIP	72.3	27.1	96.3**	24.6	0.00018
MEP	98.2	28.8	117.2**	24.9	0.00509

Legend:
MIP – maximal inspiratory mouth pressure,
MEP – maximal expiratory mouth pressure,
n – number of women,
M – mean,
SD – standard deviation,
p – significance level,
** $p < 0.01$ (ANOVA),
AB_{prae} – initial values,
AB_{post} – final values.

DISCUSSION

The results of this study show that AB patients had subnormal chest expansion at the level of the fourth intercostal space and at the level of the tip of xiphoid process at the beginning of the rehabilitation programme. We noticed a similar average value of chest expansion at both levels in women and men.

Initial lower chest expansion could influence breathing and could lead to an increased inspiratory effort and to breathing disorders. The improvement of chest mobility could have been caused by the combination of pharmacological treatment, mobilization and soft tissue techniques, breathing exercises and better timing

of inspiratory and expiratory muscles during breathing. Improvement of chest mobility at the end of the treatment could lead to easy breathing and a lower presence of breathing disorders. When we find decreased chest mobility, the treatment should be focused not only on mobilization of costovertebral joints, but also on the activation of respiratory muscles and better timing of the movement of these muscles.

Measurement of chest excursion with a tape measure is a very simple and quick method for the assessment of chest mobility and this measurement has high intertester and intratester reliability (Bockenhauer, Chen, Julliard, & Weedon, 2007; Lapier et al., 2000). For that reason, the measurement of chest excursion is useful in clinical practice for the determination of rehabilitation treatment and for choosing types of techniques and methods. We can use this examination for the assessment of rehabilitation treatment effect.

We require for the determination of MIP and MEP values the patient's maximal effort and that is why it is very important to explain the basis of the examination to the patient. The patient's cooperation is necessary. The assessment of measured values of MIP and MEP has been very difficult, because we have found a wide range of the predicted normal values of MIP and MEP, which were mentioned in the literature (Green, Road, Sieck, & Similowski, 2002; Harik-Khan, Wise, & Fozard, 1998; Neder, Andreon, Lerario, & Nery, 1999). We haven't found any predicted normal value for the Czech population nor any research about MIP and MEP being conducted in the Czech Republic.

At the end of the treatment we have noticed higher values of MIP and MEP. This increase of MIP and MEP values could have been caused by the combination of soft tissue techniques for releasing trigger points in respiratory muscles and respiratory muscle training (breathing exercises concentrated on the inspiratory and expiratory muscles and their coordination during breathing).

The values of MIP and MEP were lower in women than the values of MIP and MEP measured in men. The initial average MIP value of men was 30.2% higher than the initial average MIP value of women. The final average MIP value of men was 38.7% higher than the final average MIP value of women. The initial average MEP value of men was 32.6% higher than the initial average MEP value of women. The final average MEP value of men was 20.2% higher than the final average MEP value of women. These results correspond with results of research studies in literature. Harik-Khan, Wise and Fozard (1998) report that the average MIP values of the men are about 30% higher than those of women. Neder et al. (1999) and Terzano, Ceccarelli, Conti, Graziani, Ricci and Petroianni (2008) noticed in their research that values of MIP and MEP are dependent on gender and age (MIP and MEP values of men are higher than MIP and MEP values of women, MIP and MEP values decrease in people older than 70).

CONSLUSIONS

From the given results it can be concluded that a combination of special breathing and postural exercises and mobilization and soft tissue techniques has a positive effect on the chest mobility and respiratory muscle strength of AB patients. In our opinion, the pulmonary rehabilitation programme is useful for AB patients and this programme should start as soon as asthma is diagnosed because it can help to improve or maintain chest mobility and respiratory muscle strength. Furthermore, initial education can help asthma patients better cope with their disease. Better timing of the movement of respiratory muscles and increase of chest mobility can lead to lower inspiratory effort.

Unfortunately the number of examined AB patients hasn't been sufficient for the generalization of results, it is necessary to have larger group of AB patients for better assessment of the rehabilitation treatment effect. Furthermore, it is important to compare the measured MIP and MEP values of AB patients with those of healthy adults for the assessment and determination of whether the MIP and MEP values of AB patients are lower or higher than those of healthy adults.

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ÚČINEK OSMITÝDENNÍHO PLICNÍHO REHABILITAČNÍHO PROGRAMU NA HRUDNÍ MOBILITU A MAXIMÁLNÍ VDECHOVÝ A VÝDECHOVÝ ÚSTNÍ TLAK U PACIENTŮ S BRONCHIÁLNÍM ASTMATEM

(Souhrn anglického textu)

U nemocných s bronchiálním astmatem se mohou vyskytovat nejen poruchy dýchání, ale také muskuloskeletální poruchy. Poruchy dýchání a muskuloskeletální poruchy mohou vést k dalším zdravotním problémům a mohou tak snižovat kvalitu života. Tyto poruchy mohou být také spojeny s psychosociálními problémy a mohou mít vliv na omezení různých aktivit nemocných (pohybové aktivity, sportování, běžné denní aktivity – nakupování, uklízení atd.). Mezi nejvíce omezující symptomy u nemocných s bronchiálním astmatem patří ztížené dýchání a kašel.

Komprehensivní léčba je založena nejen na farmakoterapii, ale také na nemedikamentózní léčbě, jejíž důležitou součástí je respirační fyzioterapie. Pro účinek rehabilitační léčby je ale nutné správné nastavení farmakoterapie.

Cílem této studie bylo zjistit, zda program plicní rehabilitace ovlivní hodnoty maximálních nádechových a výdechových ústních tlaků a rozvíjení hrudníku u nemocných s bronchiálním astmatem. Výzkumný soubor byl tvořen 23 nemocnými s bronchiálním astmatem, kteří absolvovali osmitýdenní program plicní rehabilitace (30minutová terapie dvakrát týdně). Jednalo se o pacienty s intermitentním lehkým stádiem bronchiálního astmatu beze změn ve farmakoterapii. Program plicní rehabilitace byl zaměřen na dechová cvičení (aktivace bráničního dýchání, aktivace výdechu, nácvik efektivní expektorace atd.) a techniky měkkých tkání s cílem uvolnění svalů a fascií v oblasti hrudního koše a pletence ramenního. Na začátku a konci osmitýdenního programu plicní rehabilitace byly vyšetřeny maximální nádechové a výdechové ústní tlaky a rozvíjení hrudníku. Rozvíjení hrudníku bylo hodnoceno ve dvou úrovních – mezosternální a xiphosternální.

Po absolvování osmitýdenního programu plicní rehabilitace bylo zaznamenáno zlepšení rozvíjení hrudníku v obou úrovních a zvýšení hodnot maximálních nádechových a výdechových ústních tlaků. Zvýšení rozvíjení hrudníku a hodnot maximálních nádechových a výdechových ústních tlaků je velmi důležité pro nemocné s bronchiálním astmatem, neboť může vést ke snazšímu dýchání, menšímu nádechovému úsilí a menší únavě. Z tohoto důvodu by měla být respirační fyzioterapie součástí komprehensivní péče o nemocné s bronchiálním astmatem.

Klíčová slova: poruchy dýchání, muskuloskeletální poruchy, dechová cvičení, techniky měkkých tkání.

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