International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Review Article

Inspiratory Muscle Training and Chronic Heart Failure

[1,5]Petra Žurková, [1,2]Filip Dosbaba, [1,2]Ladislav Baťalík, [1]Hana Dosbaba, [2,3,4]Ondřej Ludka, [2,3,4]Jindřich Špinar

[1]Department of Rehabilitative Medicine, The University Hospital Brno - Jihlavská, Brno, Czech Republic,
[2]Clinic of Internal Medicine - Cardiology, The University Hospital Brno - Jihlavská, Brno, Czech Republic,
[3]Faculty of Medicine, Masaryk University, Brno - Kamenice 5, 625 00, Brno, Jihlavská, Brno, Czech Republic,
[4]International Clinical Research Center, Brno - Pekařská 53, 656 91, Brno, Czech Republic,
[5]Clinic of Pulmonary Diseases and Tuberculosis, The University Hospital Brno - Jihlavská, Brno, Czech Republic

Corresponding Author: Petra Žurková

Received: 25/02/2015 *Revised: 24/03/2015* *Accepted: 26/03/2015*

ABSTRACT

A lot has been written about appropriately selected locomotory activity for people suffering from chronic heart failure (CHHF). The benefits of cardiovascular rehabilitation for people with this disease were unequivocally confirmed. However, its availability and low amount of workstations focusing on these problems remain its main disadvantage. However, there are techniques, using which we are able to demonstrably reduce CHHF symptoms and thus improve the quality of life. By the said techniques, we meant Threshold IMT® inspiratory breathing aids, which work on the principle of direct activation of inspiratory muscles that are afflicted with skeletal myopathy in patients with CHHF. On the basis of first-rate theses, this short revue presents a guide on how to approach these problems.

Key words: heart failure, inspiratory muscle training, cardiorehabilitation.

INTRODUCTION

Heart failure (HF) is among one of the most significant causes of morbidity and mortality in civilized countries. In European population, the prevalence is between 0.4 - 2.0%. The number of deaths increases regularly with population ageing, the average age of patients with HF is 74 years. In people older than 70 years, the prevalence rate is around 10%. Acute heart failure can lead to death in the end. Most often, it leads to chronicity and thus a lifetime treatment is necessary. [1,2] Socioeconomic impacts of this disease towards patients, their families and healthcare system are huge. Statistics show that approximately 45% of new HF is rehospitalized within one year with an average length of rehospitalization of 11 days. [3] The following rehospitalizations significantly decrease quality of life and increase expenses of treatment of these patients.

Inspiratory muscles training in patients with chronic heart failure

CHHF is a disease, which subsequently affects not only the heart, but also striated muscles, arteries, neurohormonal system and lungs. [4] Patients with CHHF suffer from dyspnea, fatigue and exercise intolerance, which significantly affects quality of their

lives in a negative manner. Breathing muscles play a significant role in the development of symptoms and limitation of locomotory activities mainly at pulmonary, cardiac and neuromuscular diseases. Occurrence of weakening of aspiratory muscles and imbalance between strain and effectiveness of muscles leads to development of dyspnea, decrease of locomotory efficiency, development of hyperventilation and respiratory failure. Expiratory muscles weakening can affect effectiveness of coughing, which causes inadequate removal of mucus from respiratory tracts, which is connected with higher risk of infection of respiratory tracts, especially in the terrain of stasis.[5] Weakening of both groups of breathing muscles then significantly correlates with the degree of dyspnea. [6]

The first research work focusing on aspiratory muscles training was written in 1995 by Mancini et al. [7] It is generally known that fatigue during exercise and dyspnea, which are a result of inner abnormalities of bone muscles, are one of the main symptoms of the CHHF. Exercise induced dyspnea occurs during increased stress of breathing muscles or as a result of their actual weakening. Weakening of breathing muscles reflects increased breathing work in patients suffering from HF. Restrictive ventilation breathing pattern, breathing insufficiency and increase of dead space are one of the aspects of the HF and it partially aids to overstressing of breathing muscles. Decrease of strength of aspiratory muscles (PI_{MAX}) can occur because of generalized dysfunction of skeletal muscles. Meyer et al. [8] states in his study that chronic heart failure is apart from other things characterized with a dysfunction of breathing muscles and that strength of respiratory muscles is an independent predictor of a prognosis in this group of patients.

Prescription for the inspiratory muscles training

To determine the rate of training stress, it is necessary to examine the strength of aspiratory muscles by measuring maximal inspiratory pressure (PI_{MAX}). It has an inter-individual size, which is affected by age, gender, body weight, height and cooperation during measuring. On the basis of 12 published studies (chart 2) with the help of Threshold IMT® breathing aid (chart 1), the most effective method is a prescription of aspiratory muscles training at 30% PI_{MAX} for the period of 30 minutes, with training frequency of 5 - 7 days of the week and for the period of 4 - 12 weeks. The largest decrease of dyspnea at the current studies was registered approximately after 4 weeks of training. [9] We believe that the sufficient strength of inspiratory muscles we would like to achieve through a regular training is > 70% PI_{MAX}. It is very important to pay attention to indications and contraindications within the inspiratory muscle training (see the chart 1).

Figure 1. Threshold IMT® breathing device

Potential indications and contraindications to inspiratory muscle training in CHHF

The chart 1 shows possible indications and contraindications of inspiratory muscle training in patients suffering from CHHF.

Indications and contraindications of inspiratory muscle training at CHHF
Indications
• strain or resting dyspnea • inspiratory muscles weakening (<70% PImax) • pulmonary hypertension
Contraindications
• significant increase of end-diastolic volume and pressure in the left ventricle • deterioration of signs and symptoms of heart failure after the initiation of inspiratory muscle training • desaturation during inspiratory muscle training • paradoxical breathing pattern • deterioration of effectiveness of inspiratory muscles* • permanent breathing discomfort caused by weakened respiratory muscles

Table 1. Overview of indications and contraindications of the inspiratory muscle training in patients with CHHF; *(CHHF – chronic heart failure; PImax – maximal inspiratory pressure; *this concerns an incapability of performing PImax repeatedly, and the ability to maintain PImax and muscle endurance during the current training);* (modified in accordance with Cahalin et al., 2013) [9]

Study (year)	n	Manner of IMT	Selected significant results
Padula et al. [10]	E = 15 K = 17	Threshold 30% PI_{MAX} 12 T (10 – 20 min.) 7 times per week	improvement of PI_{MAX}, DF, dyspnea
Stein et al. [11]	E = 16 K = 16	Threshold 30% PI_{MAX} 12 T (30 min.) 7 times per week	improvement of PI_{MAX}, OUES
Winkelmann et al. [12]	E = 12 K = 12	Threshold 30% PI_{MAX} 12 T (30 min.) 7 times per week	improvement of PI_{MAX}, PE_{MAX}, OUES, peak VO_2, VE, VE/VCO_2 slope,
Bosnak-Guclu et al. [13]	E = 16 K = 14	Threshold 40% PI_{MAX} 6 T (30 min.) 7 times per week	improvement of PI_{MAX}, PE_{MAX}, pulmonary parameters, 6-MWT, balance, dyspnea, depression, QoL
Mello et al. [14]	E = 13 K = 14	Threshold 30% PI_{MAX} 12 T (10 min., 3 times a day) 7 times per week training at home	improvement of PI_{MAX}, peak VO_2, VE/VCO_2 slope, VT, QoL, LVEF
Mancini et al. [7]	E = 8 K = 6	Threshold 30% PI_{MAX} 12 T (90 min., 3 times/T)	improvement of PI_{MAX}, PE_{MAX}, 6-MWT, dyspnea
Cahalin et al. [15]	E = 8	Threshold 20% PI_{MAX} 8 T, (5 – 15 min, 3 times a day) 7 times per week	improvement of PI_{MAX}, PE_{MAX}, dyspnea
Johnson et al. [16]	E = 8 K = 8	Threshold 30% PI_{MAX} 8 T (15 min., 2 times a day) 7 times per week	improvement of PI_{MAX}, PE_{MAX}
Weiner et al. [17]	E = 10 K = 10	Threshold 60% PI_{MAX} 12 T (30 min./day) 6 times per week	improvement of PI_{MAX}, PE_{MAX}, pulmonary parameters, 12-MWT, dyspnea
Martinez et al. [18]	E = 11 K = 9	Threshold 30% PI_{MAX} 6 T (15 min., 2 times a day) 6 times per week	improvement of PI_{MAX}, PE_{MAX}, peak VO_2, 6-MWT, dyspnea
Dall´Ago et al. [19]	E = 16 K = 16	Threshold 30% PI_{MAX} 12 T (30 min./day) 7 times per week	improvement of PI_{MAX}, PE_{MAX}, peak VO_2, VE, VE/VCO_2 slope, 6-MWT, dyspnea
Chiappa et al. [20]	E = 18	Threshold 30% PI_{MAX} 4 T (30 min./day) 7 times per week	improvement of PI_{MAX}, PE_{MAX}, improvement of blood flow in the antebrachium area

Table 2. Overview of studies of inspiratory muscle training with the Threshold IMT device.
(Philips Respironics®) in patients with HF (modified in accordance with Cahalin et al., 2013)[9]; (n – number of monitored patients, E – experimental group, K – control group, T – weeks, DF – respiratory rate, OUES – oxygen uptake efficiency slope, 6-MWT – 6-minute walking test, 12- MWT – 12-minute walking test, QoL – quality of life, VT – tidal volume, LVEF – left ventricular ejection fraction, PI_{MAX} – Maximal inspiratory pressure, PE_{MAX} – maximal expiratory pressure, VE – minute ventilation, VE/VCO_2 slope – the ratio of minute ventilation and expenditure of carbon dioxide)

Key parameters of evaluation of the inspiratory muscle training effect

Maximal inspiratory pressure (PI_{MAX}), maximal expiratory pressure (PE_{MAX}), 6

minute walking test (6MWT), (peak VO_2), quality of life measured by questionnaire methods (QoL) and degree of dyspnea belong among the key parameters for evaluation of the inspiratory muscle training effect. Further, the following parameters can be used: minute ventilation (VE), (VE/VCO_2slope), inflammatory markers, endothelial vasodilatation and assessment of immunity system function. [9]

CONCLUSION

On the basis of available information, we believe that a specific inspiratory muscle training should be incorporated into standard cardiorespiratory rehabilitation in patients with CHHF, who suffer from exercise induced dyspnea and weakening of inspiratory muscles (PI_{MAX} <70% of the adequate values) with verified low function parameters of a transport system. [9] There is a very important aspect in play, which is motivating patients to a long-term training, which can significantly increase their quality of life because of reduction of breathing problems and also decrease the number of repeated hospitalizations, which leads to a decrease of medical care expenses. Because of increasing number of senior population, the cardiovascular rehabilitation will be an indispensable part of comprehensive care for patients with CHHF.

ACKNOWLEDGEMENT

Supported by the project (Ministry of Health Czech Republic) for conceptual development of research organization 65269705 (University Hospital Brno, Brno, Czech Republic).

REFERENCES

1. Markku S. Nieminen, Dirk Brutsaert, Kenneth Dickstein, Helmut Drexler, Ferenc Follath, Veli-Pekka Harjola, Matthias Hochadel, Michel Komajda, Johan Lassus, Jose Luis Lopez-Sendon, Piotr Ponikowski and Luigi Tavazzi on behalf of the EuroHeart Survey Investigators .EuroHeart Failure Survey II (EHS II): a survey on hospitalized acute heart failure patients: description of population. Euro H.J. advance access published September 25, 2006.
2. Mosterd A., Hoes A. (2007) Clinical epidemiology of heart failure. Heart 93: 1137–1146
3. Cowie MR, Mosterd A, Wood DA, et al. The epidemiology of heart failure. Eur Heart J 1997;18(2):208-25.
4. Brubaker PH. Exercise intolerance in congestive heart failure: a lesson in exercise physiology. Cardiopulm Rehabil 1997; 17 (4) 217 – 221
5. Moran F, Piper A, Elborn JS, Bradley JM. Respiratory muscle pressures in non-CF bronchiectasis: Repeatability and reliability. Chronic Respiratory Disease 2010; 7(3): 165 – 171
6. McParland C, Krishnan B, Wang Y. et al. Inspiratory muscle weakness and dyspnea in congestive heart failure. *Am. Rev. Respir. Dis.* 1992; 146, 467
7. Mancini DM, Henson D, La Manca J. et al. Benefit of selective respiratory muscle training on exercise capacity in patients with chronic congestive heart failure. Circulation 1995; 91 (2): 320 – 329
8. Meyer FJ, Borst MM, Zugck Ch et al. Respiratory muscle dysfunction in congestive heart failure: clinical correlation and prognostic significance. Circulation 2001; 103: 2153 – 2158
9. Cahalin LP, Arena R, Guazzi M. et al. Inspiratory muscle training in heart disease and heart failure: a review of the literature with a focus on method of training and outcomes. *Expert Rev. Cardiovasc. Ther*. 2013; 11(2), 161-177
10. Padula CA, Yeaw E, Mistry S. A home-based nurse-coached inspiratory muscle training intervention in heart failure. Appl. Nurs. Res. 2009; 22(1): 18 – 25
11. Stein R, Chiappa GR, Güths H. et al. Inspiratory muscle training improves oxygen uptake efficiency slope in patients with chronic heart failure. 2009; 29(6): 392-395
12. Winkelmann ER, Chiappa GR, Lima CO. et al. Addition of inspiratory

muscle training to aerobic training improves cardiorespiratory responses to exercise in patients with heart failure and inspiratory muscle weakness. Am Heart Journal 2009; 158 (5): 768.el – 768.e7
13. Bosnak-Guclu M, Arikan H, Savci S. et al. Effects of inspiratory muscle training in patients with heart failure. Respir. Med. 2011; 105(11): 1671 – 1681
14. Mello PR, Guerra GM, Borile S. et al. Inspiratory muscle training reduces sympathetic nervous aktivity and improves inspirátory muscle weakness and quality of life in patients with chronic heart failure: a clinical trial. J. Cardiopulm. Rehabil. Prev. 2012; 32(5): 255 – 261
15. Cahalin LP, Semigran MJ, Dec GW. Inspiratory muscle training in patients with chronic heart failure awaiting cardiac transplantation: results of a pilot clinical trial. Phys. Ther. 1997; 77(8): 830 – 838
16. Johnson PH, Cowley AJ, Kinnear WJ. A randomized controlled trial of inspiratory muscle training in stable chronic heart failure. Eur. Heart. J. 1998; 19(8): 1249 – 1253
17. Weiner P, Waizman J, Magadle R. et al. The effect of specific inspiratory muscle training on the sensation of dyspnea and exercise tolerance in patients with congestive heart failure. Clin. Cardiol. 1999; 22(11): 727 – 732
18. Martinez A, Lisboa C, Jalil J. et al. Selective training of respiratory muscle in patients with chronic heart failure. Rev. Med. Chil. 2001; 129(2): 133 – 139
19. Dall´Ago P, Chiappa GR, Guths H. et al. Inspiratory muscle training in patients with heart failure and inspirátory muscle weakness: a randomized trial. J. Am. Coll. Cardiol. 2006; 47(4): 757 – 763
20. Chiappa GR, Roseguini BT, Vieira PJ. et al. Inspiratory muscle training improves blood flow to resting and exercising limbs in patients with chronic heart failure. J. Am. Coll. Cardiol. 2008; 51(17): 1663-1671

How to cite this article: Žurková P, Dosbaba F, Baťalík L et. al. Inspiratory muscle training and chronic heart failure. Int J Health Sci Res. 2015; 5(4):315-319.

****