Rev Port Pneumol. 2010;16(6):887-891

revista portuguesa de
PNEUMOLOGIA
portuguese journal of pulmonology
www.revportpneumol.org

ORIGINAL ARTICLE

Effects of arm bracing posture on respiratory muscle strength and pulmonary function in patients with chronic obstructive pulmonary disease

V. Cavalheri,[a,b] C.A. Camillo,[a] A.F. Brunetto,[a,c,#] V.S. Probst,[a,c] E.M. Cipulo Ramos,[b] and F. Pitta[a,*]

[a]*Laboratório de Pesquisa em Fisioterapia Pulmonar (LFIP), Departamento de Fisioterapia, Universidade Estadual de Londrina, Paraná, Brazil*
[b]*Programa de Mestrado em Fisioterapia, Departamento de Fisioterapia, UNESP - Universidade Estadual Paulista, Presidente Prudente, SP, Brazil*
[c]*Departamento de Fisioterapia, Universidade do Norte do Paraná (UNOPAR), Londrina, Paraná, Brazil*
[#]*In memoriam*

Received November 12, 2009; accepted May 21, 2010

KEYWORDS
Upper limb;
Respiratory muscles;
Pulmonary function test;
Chronic obstructive pulmonary disease

Abstract
Objective: To analyze the effect of arm bracing posture on respiratory muscle strength and pulmonary function in patients with Chronic Obstructive Pulmonary Disease (COPD).
Methods: 20 patients with COPD (11 male; 67 ± 8 years; BMI 24 ± 3 kg · m^{-2}) were submitted to assessments of Maximal Inspiratory and Expiratory Pressures (MIP and MEP, respectively) and spirometry with and without arm bracing in a random order. The assessment with arm bracing was done on standing position and the height of the support was adjusted at the level of the ulnar styloid process with elbow flexion and trunk anterior inclination of 30 degrees promoting weight discharge in the upper limbs. Assessment without arm bracing was also performed on standing position, however with the arms relaxed alongside the body. The time interval between assessments was one week.
Results: MIP, MEP and maximal voluntary ventilation (MVV) were higher with arm bracing than without arm bracing (MIP 64 ± 22 cmH_2O *versus* 54 ± 24 cmH_2O, P = ,00001; MEP 104 ± 37 cmH_2O *versus* 92 ± 37 cmH_2O, P = .00001, and MVV 42 ± 20 L/min *versus* 38 ± 20 L/min, P = .003). Other variables did not show statistical significant difference.
Conclusion: The arm bracing posture resulted in higher capacity to generate force and endurance of the respiratory muscles in patients with COPD.

*Corresponding author.
E-mail: fabiopitta@uol.com.br (F. Pitta).

PALAVRAS-CHAVE
Extremidade superior;
Músculos respiratórios;
Espirometria;
Doença pulmonar obstrutiva crônica

Efeitos do apoio dos membros superiores sobre a força muscular respiratória e função pulmonar de pacientes com doença pulmonar obstrutiva crônica

Resumo

Objetivo: Analisar o efeito do apoio de membros superiores sobre a força muscular respiratória e função pulmonar de pacientes com Doença Pulmonar Obstrutiva Crônica (DPOC).

Métodos: Vinte pacientes com DPOC (11 homens) com idade de 67 ± 8 anos e IMC 24 ± 3 $Kg \cdot m^{-2}$, foram submetidos a avaliações de Pressão Inspiratória e Expiratória Máximas (PImax e PEmax, respectivamente) e espirometria com e sem apoio dos membros superiores em ordem aleatória. A avaliação com apoio dos membros superiores foi realizada em posição ortostática, com o apoio dos membros superiores na altura do processo estilóide da ulna, flexão de cotovelos e tronco inclinado à frente, ambos em aproximadamente 30 graus, de modo a promover descarga de peso em membros superiores. A avaliação sem apoio de membros superiores foi realizada também em posição ortostática, porém com os membros superiores relaxados ao lado do corpo. O intervalo entre as avaliações foi de uma semana.

Resultados: A PImax, PEmax e Ventilação Voluntária Máxima (VVM) foram maiores com a utilização do apoio do que sem o apoio (PImax 64 ± 22 cmH_2O *versus* 54 ± 24 cmH_2O, p = 0,00001; PEmax 104 ± 37 cmH_2O *versus* 92 ± 37 cmH_2O, p = 0,00001 e VVM 42 ± 20 L/min *versus* 38 ± 20 L/min, p = 0,003). As demais variáveis não apresentaram diferenças estatisticamente significantes.

Conclusão: O apoio de membros superiores resultou em maior capacidade de gerar força e *endurance* dos músculos respiratórios em pacientes com DPOC.

Introduction

Gravity force and length variations observed in respiratory muscles according to several postures of the human body determine activity differences of these muscles.[1] For example: Banzett et al.[2] showed that arm bracing posture with anterior trunk inclination (forward-lean position) results in higher ventilatory capacity in normal subjects. As an explication, Solway et al.[3] suggest that lean forward position plus arm bracing posture enables arm and shoulder girdle muscles to act more effectively as breathing accessory muscles. Due to produced tension-muscle length relation, the forward-lean position increases the diaphragmatic fibers length, improving its function, and even reducing dyspnea sensation in patients with Chronic Obstructive Pulmonary Disease (COPD).[4]

Improvement of respiratory muscles function may increase exercise tolerance and agility of activities of daily living (ADL).[5] Individuals with COPD when submitted to walking tests, improve their oxygen saturation, ventilatory capacity and reduce their dyspnea perception when they use a rollator (which provides support for the arms),[3,6,7] apart from a more efficient walk.[6] Abovementioned studies[3,6,7] suggest that higher variables with the arm bracing posture occurred due to improvement in efficienty of the respiratory muscles; nevertheless, these studies did not assess whether there is difference on the respiratory muscles' capacity to generate force when arms are supported. In such case, the objective of this study was to assess the effects of arm bracing posture on respiratory muscle strength and pulmonary function in patients with COPD on the standing position.

Material and methods

In a convenient sample, 20 patients with COPD were recruited. All individuals were clinically stable, between 55 and 85 years old and classified as GOLD II-IV.[8] Exclusion criteria were: patients who could not stay on the determined postures (stand up position and arm bracing posture) or patients who had an exacerbation between the first and second assessments. The study was approved by the local ethical committee of Universidade Estadual de Londrina. All patients signed a written informed consent which was obtained before starting the assessments.

Patients were submitted to spirometry and maximal respiratory pressure assessments with and without arm bracing in a random order (concealment allocation) with 1-week interval between the two measurement moments. Assessment without arm bracing was performed on standing position with the arms relaxed alongside the body. In the assessment with arm bracing, the height of the support was adjusted at the level of the ulnar styloid process with elbow flexion and trunk anterior inclination of 30 degrees (forward-lean position) promoting weight discharge in the upper limbs.[6]

Spirometry: Lung function test was performed with the Pony FX (COSMED SRL, Rome, Italy) according to American Thoracic Society/European Respiratory Society recommendations.[9] Normal values were proposed by Knudson et al.[10] Patients were instructed for the postures (with and without arm bracing) and performed three maneuvers of slow vital capacity (SVC), three forced vital capacity (FVC) maneuvers and three maximal voluntary ventilation (MVV) maneuvers. For a better accuracy of SVC data [expired volume (VE) and inspiratory time / total time relation (Ti/Ttot)], individuals had to rest for 2 minutes, before and between the maneuvers, while remaining on the ideal test posture.

Maximal respiratory pressures: A digital manuovacuometer (MVD-500 V.1.1, Microhard System, Globalmed, Porto Alegre, Brazil) was used, whereas for data analysis the AQDADOS 4 (LYNX) was utilized. Individuals were instructed concerning the postures (with and without arm bracing) and performed ten maximal inspiratory pressures (MIP) maneuvers and ten maximal expiratory pressures (MEP) maneuvers.[11] MIP was measured near residual volume and MEP near total lung capacity.[12] The predictive values were those of Neder et al.[13] The two technically best results which presented a reproducibility equal or under 5% were analyzed and the best of them was taken.[14]

For statistical analysis, the Shapiro Wilk test was performed to evaluate data distribution. As studied variables (MIP, MEP, SVC, FVC, MVV, FEV_1, Ti/Ttot and VE) presented normal distribution, *student t test* was used for differences between with and without arm bracing postures. For all statistical analysis, *P* values < .05 were considered as significant.

Table 1 Baseline characteristics

Characteristics	
Gender (M/W)	11/9
Age, years	62 ± 11
Weight, kg	1.62 ± 0.1
Height, m	24 ± 3
BMI, kg · m^{-2}	67 ± 8
FEV_1, %pred)	39.2 ± 16

BMI indicates body mass index; FEV_1, forced expiratory volume in the first second; M, men; W, women.
Data are presented as mean ± standard deviation, except gender.

Table 2 Differences between variables with and without arm bracing

	Arm bracing	No arm bracing	***P*** value
MIP (cmH_2O)	64 ± 22	54 ± 24	.00001
MEP (cmH_2O)	104 ± 37	92 ± 37	.00001
SVC (L)	1.84 ± 0.5	1.75 ± 0.5	.09
FVC (L)	1.84 ± 0.6	1.75 ± 0.6	.07
VE (L/MIN)	9.8 ± 2.6	10 ± 3.6	.56
FEV_1 (L)	1 ± 0.5	0.95 ± 0.5	.18
MVV (L/min)	42 ± 20	38 ± 20	.003

FEV_1 indicates forced expiratory volume in the first second; FVC, forced vital capacity; MEP, maximal expiratory pressure; MIP, maximal inspiratory pressure; MVV, maximal voluntary ventilation; SVC, slow vital capacity; VE, expired volume.
Data are presented as mean ± standard deviation.

Results

Twenty patients were submitted to the assessments and there were no exclusions. The baseline characteristics are presented on Table 1.

The mean MIP of the group (without arm bracing) shows a characteristic of inspiratory muscle weakness (MIP below 70% predict)[15] whereas man MEP was normal (100 ± 38% predict). When patients performed with arm bracing mean MIP was 72 ± 23% predict, not characterizing inspiratory muscle weakness anymore.

MIP values were higher with arm bracing than without arm bracing (64 ± 22 cmH_2O with arm bracing *versus* 54 ± 24 cmH_2O without arm bracing; *P* = .00001) (Table 2). Relative Difference Mean (RDM) of MIP with and without arm bracing (*RDM%* = [MIP with arm bracing — MIP without arm bracing] / MIP with arm bracing) was 26%. Seventeen out of the twenty individuals (85%) had higher inspiratory muscle strength with the arm bracing posture.

Likewise MIP, MEP was also higher when patients were assessed on arm bracing posture (104 ± 37 cmH_2O with arm bracing *versus* 92 ± 37 cmH_2O without arm bracing; *P* = .00001) (Table 2). Eighteen of the twenty individuals (90%) had higher expiratory muscle strength with the arm bracing posture. RDM of MEP with and without arm bracing (*RDM%* = [MEP with arm bracing — MEP without arm bracing]/MEP with arm bracing) was 15%.

MVV values followed the same pattern as maximal respiratory pressures, *i.e.*, higher when patients were assessed on arm bracing posture (42 ± 20 L/min with arm bracing *versus* 38 ± 20 L/min without arm bracing; *P* = .003) (Table 2). RDM of MVV with and without arm bracing (*RDM%* = [MVV with arm bracing — MVV without arm bracing]/MVV with arm bracing) was 15%.

For the remaining variables (SVC, FVC, VE, FEV_1 e TI/Ttot) there were no significant differences between values with and without arm bracing (SVC *P* = .09; FVC *P* = .07; VE *P* = .56; FEV_1 *P* = .18 and Ti/Ttot *P* = .70).

Discussion

The present study showed that arm bracing posture enables respiratory muscles to a better capacity to generate maximal force and endurance in patients with COPD. For the first time, respiratory muscle strength and pulmonary function of individuals with COPD were assessed on standing position plus arm bracing. Adoption of similar posture has already been used in studies with patients with COPD walking with a rollator.[3,6] In these studies there was an increase in 6-minute walking distance and oxygen saturation, an increase in ventilatory capacity and/or walking efficiency in individuals with COPD, specially in those more severe disease.

The forward-lean position for dyspnea relief (anterior trunk inclination and arm bracing) has been reported as a posture that improves diaphragmatic function[6] by reducing abdominal muscle tension[16] and providing arm and shoulder girdle muscles to act more effectively as breathing accessory muscles.[3,17] Kera and Maruyama[1] mention that pectoralis major and minor (muscles that lift the rib cage up) and serratus anterior are easily activated when arms are supported. Moreover, these authors described that the behavior adopted by individuals with COPD when feeling dyspnea (anterior trunk inclination plus arm bracing posture) is not related just to the increase of these inspiration accessory muscles activity, but it is also related to expiratory muscles either, as the external oblique abdominis. These researchers mentioned a higher activity of these muscles, as much on expiratory effort as on inspiratory effort, when arms were supported. The higher capacity to generate inspiratory and expiratoy force has great importance to patients with COPD, and both (inspiratory and expiratory muscles) are involved on this weakness.[18]

MEP findings in this study contrast with observations done by O'Neill and McCarthy.[4] These researchers measured maximal respiratory pressures of patients with COPD and healthy individuals at five different postures, including forward-lean position (sitting), and they did not find significant differences among MEP values on these positions. However, they did not evaluate arm bracing posture on standing position.

Concerning MVV, the present results were similar to those from Solway et al.[3] and Probst et al.,[6] also in patients with COPD, which showed higher MVV values with the arms supported. This is explainable because the MVV maneuver is specific to evaluate respiratory muscle weakness,[19] one of the main characteristics in individuals with COPD. Since these patients perform higher maximal respiratory pressures with arm bracing posture it might be expected that they can perform higher MVV either.

The higher capacity of respiratory muscles to generate force and endurance at the arm bracing posture explains, at least in part, the findings of previous studies which demonstrated the use of wheeled walking aids as generating increase in walking distance, oxygen saturation, dyspnea, ventilatory capacity and walk efficiency in individuals with COPD.[3,6,7] This can be a hypothesis to explain the dyspnea relief in these individuals when they remain with their arms stabilized.[4,16,17]

A limitation of the present study is that it does not have electromyographyc data to prove a higher muscular activity at the arm bracing posture. Kera and Maruyama[1] showed data of a higher abdominal muscle activity at the arm bracing posture, but it is known that a lot of other muscles are involved on inspiratory and expiratory movements, such as some shoulder girdle and rib cage muscles. This can be the topic for future studies.

Results of the present study demonstrated that arm bracing posture on standing position resulted in higher values of maximal respiratory pressures and respiratory muscle endurance in patients with COPD, without volume, flow and lung capacity changes. The effects of arm bracing posture on respiratory muscle function (as shown in this study) points out to the fundamental importance of this posture on rehabilitation programs of individuals with COPD. Therefore, we suggest a more frequent use of this posture as a coadjuvant strategy for physical training in these patients.

Finantial support

CNPq —Brazil.

Conflict of interest

Authors declare they don't have any conflict of interest.

Acknowledgements

The authors would like to thank the physiotherapist Demétria Kovelis (Laboratório de Pesquisa em Fisioterapia Pulmonar, Universidade Estadual de Londrina, Paraná, Brazil) for helping with the assessments.

References

1. Kera T, Maruyama H. The effect of posture on respiratory activity of the abdominal muscles. J Physiol Anthropol Appl Human Sci. 2005;24(4):259-65.
2. Banzett RB, Topulos GP, Leith DE, Nations CS. Bracing arms increases the capacity for sustained hyperpnea. Am Rev Respir Dis. 1988;138(1):106-9.
3. Solway S, Brooks D, Lau L, Goldstein R. The short-term effect of a rolator on functional exercise capacity among individuals with severe COPD. Chest. 2002;122:56-65.
4. O'Neill S, McCarthy DS. Postural relief of Dyspnoea in severe chronic airflow limitation: relationship to respiratory muscle strength. Thorax. 1983;38:595-600.
5. Reid WD, Samrai B. Respiratory muscle training for patients with COPD. Physical Therapy. 1995;11(75);996-1005.
6. Probst VS, Troosters T, Coosemans I, Spruit MA, Pitta Fde, Decramer M, et al. Mechanisms of improvement in exercise capacity using a rollator in patients with COPD. Chest. 2004;126:1102-7.
7. Honeyman P, Barr P, Stubbing DG. Effect of a walking aid on disability, oxygenation and breathlessness in patients with chronic airflow limitation. J Cardiopulm Rehabil. 1996;16:63-7.
8. Rabe KF, Hurd S, Anzueto A, Barnes PJ, Buist SA, Calverley P, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir Crit Care Med. 2007;176(6):532-55.
9. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, et al. Standardisation of spirometry. Eur Respir J 2005; 26(2):319-38.

10. Knudson RJ, Lebowitz MD, Holberg CJ, Burrows B. Changes in the normal maximal expiratory flow-volume curve with growth and aging. Am Rev Respir Dis. 1983;127;725-34.
11. Fiz JA, Montserrat JM, Picado C, Plaza V, Agusti-Vidal A. How many manoeuvres should be done to measure maximal inspiratory mouth pressures in patients with chronic airflow obstruction? Thorax. 1989;44:419-21.
12. Black LF, Hyatt RE. Maximal respiratory pressures: normal values and relationship to age and sex. Am Rev Respir Dis. 1969;99:696-702.
13. Neder JA, Andreoni S, Lerario MC, Nery LE. Reference values for lung function tests: Maximal respiratory pressures and voluntary ventilation. Braz J Med Biol Res. 1999;32:719-27.
14. Rodrigues F, Barbara C. Maximal respiratory pressures: proposition for a protocol of assessment. Rev Port Pneumol. 2000;4:297-307.
15. Dall'Ago P, Chiappa GRS, Guths H, Stein R, Ribeiro JP. Inspiratory muscle training in patients with heart failure and inspiratory muscle weakness: a randomized trial. JACC. 2006; 47:757-63.
16. Alvan L, Barach MD. Chronic obstructive lung disease: postural relief of dyspnea. Arch Phys Med Rehabil. 1974;55: 494-504.
17. Sharp JT, Drutz WS, Moisan T, Foster J, Machnach W. Postural relief of dyspnea in chronic obstructive pulmonary disease. Am Rev Respir Dis. 1980;122:201-11.
18. Decramer M, Albier M. The respiratory muscles: cellular and molecular physiology. Eur Respir J. 1997;10:1943-5.
19. American Thoratic Society/European Respiratory Society. ATS/ERS Statement on respiratory muscle testing. Am J Respir Crit Care Med. 2002;166;518-624.