Pursed Lips Breathing (PLB) In Chronic Obstructive Pulmonary Disease (COPD)

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Abstract
Pursed lips breathing in patients with chronic obstructive pulmonary disease often gives immediate symptomatic relief from dyspnea by a mechanism that is not well understood. We studied six adult COPD patients using pursed lips breathing and recorded the following parameters (a) subjective relief from dyspnea graded from mild to maximal. (b) breathing pattern including respiratory rate, tidal volume and total expiration time, (c) specific airways conductance, (d) airway pressures, (e) lung volumes including functional residual capacity, (f) volume of trapped gas. Our study confirms that pursed lips breathing in COPD patients gives (a) symptomatic relief from dyspnea, (b) the breathing pattern is more efficient, (c) airway pressures are increased, (d) there is a significant drop in functional residual capacity during PLB.

Key Words: *Obstructive lung disease, emphysema, breathing pattern.*

Chronic Obstructive Pulmonary Disease (COPD) comprises those conditions accompanied by chronic or recurrent obstruction to airflow within the lungs.[1] It is the single most prevalent cause of disability in the working population of the USA,[2] with a mortality of 32/100,000 afflicting 10 million Americans and ranking as the 6th leading cause of death and the 8th leading cause of morbidity in the country. Patients with this disease have a limited ventilatory reserve and irreversible changes in lung parenchyma and airways. Thus effective forms of therapy are limited for what may prove to be a long drawn out disease.[3] The patients respond by leaning forwards, compressing their abdominal muscles and deploying the pursed lips breathing.[4]

Pursed lips breathing, frequently seen as a spontaneous untaught practice in COPD patients is a breathing pattern to achieve prolongation in expiration through pursed lips.[5] It has been described as the whistling expirium, i.e. expiring with lips pursed like in whistling- as one intends to extinguish the flame of a burning candle from a greater distance.[6]

This maneuver often gives immediate symptomatic relief from dyspnea in most patients with emphysema.[7] Since the mechanism of relief is not well understood, we undertook this study to elucidate the physiological basis of this improvement.

Material and methods

Patient selection - Six patients of emphysema who fulfilled the following criteria were selected:

a. they were ambulatory and clinically stable at the time of the study.
b. they had moderate to severe non-reversible obstructive ventilatory impairment ($FEV_1$65%)
c. they attended the pulmonary rehabilitation program at Queens Hospital Center where they had been taught the PLB technique.
d. they were willing to sign an informed consent.

The patient data is summarized in Table 1.

Patient evaluation - A detailed histoty was elicited and a physical examination carried out on all patients. Patients with cardiovascular complications (congestive heart failure, angina, etc.) were excluded from the study. Vital statistics (including age, height and weight) were recorded. The patients' functional disability was classified according to the standard dsypnea index:

Class 1: Dyspnea only on more strenuous exertion than normally required.
Class 2: Some restriction in activities. Shortness of breath on stair climbing or on an incline

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Table 1. Patient Data

Age (yrs)	Sex	Ht. ('')	Wt. (pds)	FEV_1 % Pred	FVC % Pred	DLCO SB % Pred	Arterial blood gas Room Air		
							pH	pCO_2	pO_2
83	M	64	136	65	103	50	7.40	38.0	75.0
50	F	61	114	15	32	70	7.40	45.0	67.0
66	M	66	160	32	49	38	7.40	41.0	67.6
55	F	64	139	31	52	57	7.40	50.0	43.5
59	M	71	173	35	47	70	7.40	38.0	74.1
70	M	66	124	56	43	72	7.40	41.8	71.5

N.B. FEV_1 - Forced expiratory volume in 1 second
FVC - Forced vital capacity
DLCO - Diffusion capacity for carbon monoxide

but not on level walking.

Class 3: Dyspnea during activities of daily living, but not at rest. The patient can manage without assistance from others.

Class 4: Dyspnea produces dependence on others for some essential activities of daily living such as bathing or dressing. Patient is not dyspneic at rest.

Class 5: Dyspnea at rest.

As the patients studied were using PLB routinely, their subjective improvement in dyspnea using this breathing pattern was recorded on a six point scale:

Grade 0: No improvement
Grade I: Barely perceptible improvement
Grade II: Mild improvement
Grade III: Moderate improvement
Grade IV: Good improvement
Grade V: Tremendous improvement

Pulmonary function testing - All measurements were made with the patients in the sitting position. Each patient had baseline spirometric measurements done within the preceding six months. On each subject, a reduced treadmill exercise tolerance established moderate to severe dyspnea after 6 minutes of walking. To begin with, respiratory rates were measured during normal breathing and PLB. Using a metronome (Seth-Thomas), the patients practiced breathing normally at the same rate they employed during PLB. Airway pressures were then measured using a respiratory amplifier (Hewlett-Packard) during normal breathing and pursed lips breathing. The rest of the measurements were done with the patients breathing in a special lightweight face mask with a soft inflatable plastic gasket over the nose and face without hindering in the pursed lips breathing maneuver. The mask dead space was found to be 65ml. It had low resistance inhalation and exhalation valves. Static lung volumes (including slow vital capacity, residual volume, functional residual capacity, total lung capacity, and expiratory reserve volume), forced expiratory volume in one second (FEV_1), and diffusion capacity (DLco) were

Table 2. Spirometric & Plethysmographic Measurements in Patient Groups

Breathing Pattern	Range & Mean	Respiratory Rate/min	T_E in sec.	FRC/L	RA cm of H_2O	S_{GAW}	Subjective Improvement
NPLB	Range	9-24	1.41-3.08	3.43-4.95	.05-.68	-.21-.117	No change
	Mean	19	2.04	3.78	.26	.07	
T.F.B.	Range	7-13	1.73-2.65	3.59-5.20	-	-	No change
	Mean	13	2.37	4.09	-		
P.L.B.	Range	7-21	1.80-5.16	3.34-4.56	2.13-10	0.23-0.76	2-mild 3-moderate
	Mean	14	3.23	3.61	5.64	.05	1-maximal

N.B.: NPLB - Non-pursed lips breathing
TFB - Timed frequency breathing
PLB - Pursed lips breathing
T_E - Total expiratory time per breath
FRC - Functional residual capacity
R_A - Airway Resistance
S_{GAW} - Specific airways conductance

measured during the normal breathing pattern, PLB and timed frequency breathing. These measurements were made with the GOULD 5000 IV. These tests were then repeated, in addition to airways resistance, using the GOULD M800 Automated Transmural Breathing Pressure Volume plethysmograph. According to the recommendations of Shore et al, the frequency of panting in the plethysmographic measurements was kept low (less than 1 Htz) and the cheeks supported by tightly fitting mask.[8] (Table 2).

Flow volume/time curve analysis - Tracings obtained from the plethysmograph and computerized spirometer were analyzed to get the tidal volume (Vt)., total time per breath (Tt), total inspiratory time (Ti), the total expiratory time (Te) and the frequency of breathing (fb).

Statistic methods - The double-tailed Student t-test was used in all statistical comparisons. A value of p 0.01 was considered to represent statistical significance.

Results

In our study, two patients indicated grade III (moderate) improvement with PLB, three indicated grade IV (very good improvement) and one grade V (tremendous improvement). We observed that the worse the dyspnea, the greater the benefit derived.

It was found that the PLB maneuver resulted in a mean fall in breathing frequency by 5 breaths/minute (range 1.9-11.3). There was prolongation in expiration time by an average of 1.19 seconds i.e. a 60% increase in Te. A marked increase in airway pressures from 0.26 cm of water during normal breathing to 4.8 cm during PLB was noted (Fig. 1). A slight fall in the specific airways conductance occured with pursed

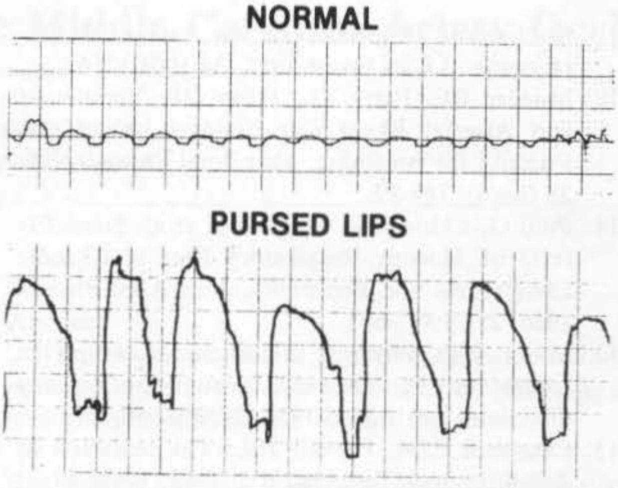

Figure 1. Airway pressures in normal and pursed lips breathing.

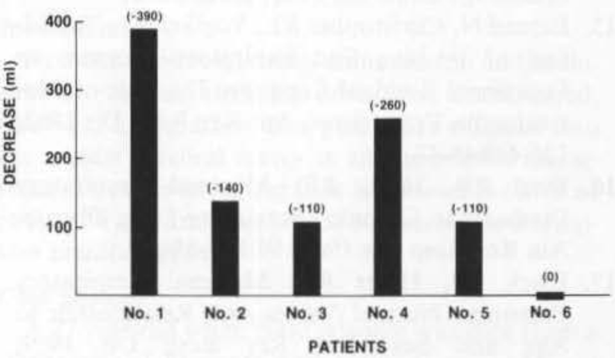

Figure 2. Decrease in functional residual capacity in patients using pursed lips breathing.

lips. There was a fall of 170cc in the FRC and 223cc in the TLC when patients used pursed lips to breathe.

Timed frequency breathing did not result in subjective improvement in dyspnea in any patient. There was a mean rise of 135cc in the FRC with this breathing pattern. The total expiratory time increased by a mean of 0.69 sec/breath.

Discussion

In COPD, particularly emphysema, there is a decrease in static recoil pressure causing a collapse of airways early in expiration.[9] By resorting to PLB, patients voluntarily impose an expiratory resistance which is reflected as back pressure in the bronchioles.[5] This is substantiated by a rise in airway pressures in our study. The back pressure reduces the collapse of airways, thereby allowing a greater volume of air to be expelled during the process of expiration. This is corroborated by a fall in FRC (Fig. 2). This mechanism of benefit is further strengthened by the results of an earlier study,[4] in which we followed 180 mechanically ventilated patients during the weaning phase. We observed a marked clinical deterioration when the mode of ventilation was

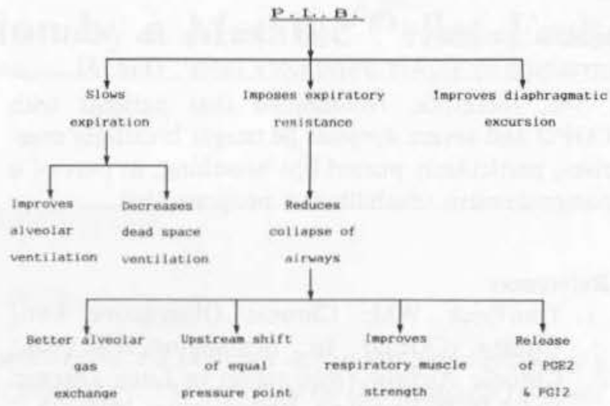

Figure 3. Pursed lips breathing - physiological effects.

changed from intermittent mandatory ventilation (IMV) at zero rate to that of a T-tube setup. We found out that the peak airway pressures were greater on IMV at zero rate compared to peak airway pressures on T-piece. This rise in airway pressures is comparable to that introduced by PLB. A similar explanation for the mechanism of benefit derived by PLB came from Ingram and Schilder. They found that the greatest benefit in PLB was seen in patients who had the greatest decrease in non-elastic transpulmonary resistance. This led them to postulate that PLB may provide symptomatic relief by preventing collapse of larger bronchi.[5]

In the opinion of Barach, restoration of the patency of the bronchial passageway abolishes the obviously burdensome contraction of the girdle muscles of the neck and shoulder which is perceived as immediate symptomatic relief; the diaphragm simultaneously takes over the bellows responsible for ventilating the lungs.[7]

Another aspect of PLB that merits discussion is its effects on the respiratory rate.[10] Thomas et al had patients breathe with slow respiratory rates comparable to those achieved with PLB.[3] They found a comparable decline in $paCO_2$ in both groups, i.e. those with PLB and timed frequency breathing (TFB). However, the beneficial effects of PLB occur almost instantaneously - certainly much before the arterial blood gases show any improvement. In our study, patients deploying the TFB did not derive any beneficial effects in their sensation of dyspnea. These findings are similar to those of Paul et at[11].

Additionally, in our group one patient did not show any slowing of respiratory rate with PLB. However, he experienced a grade III (moderate) improvement in his dyspnea using this breathing pattern.

Other explanations include an improvement in the muscle length/tension inappropriateness,[5,12-14] release of bronchodilators like $PGE_2 \& I_2$ in response to positive-end-expiratory pressure distension of the lungs,[15] the improved muscle strength by breathing against resistance [16,17] or decrease in work of breathing by slower inspiratory rates[18] (Fig. 3).

We, therefore, recommend that patients with COPD and severe dyspnea be taught breathing exercises, particularly pursed lips breathing, as part of a comprehensive rehabilitation program.[19,20]

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