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Dysfunctional breathing is more frequent in chronic obstructive pulmonary disease than in asthma and in health

Natalie Law[a], Laurence E. Ruane[a], Kathy Low[a,b], Kais Hamza[c], Philip G. Bardin[a,b,*]

[a] Monash Lung & Sleep, Monash Medical Centre and University, Australia
[b] Hudson Institute, Australia
[c] Statistical Services, Monash University, Melbourne, Australia

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ABSTRACT

Involuntary adaptations of breathing patterns to counter breathlessness may lead to dysfunctional breathing in obstructive lung diseases. However, no studies examining dysfunctional breathing in Chronic Obstructive Pulmonary Disease (COPD) have been reported.

Patients with verified COPD (n = 34), asthma (n = 37) and a healthy control group (n = 41) were recruited. All participants completed the Nijmegen questionnaire for dysfunctional breathing as well as measures of disease activity. Comparisons between groups employed analysis of variance with *post-hoc* Bonferroni analyses and Pearson correlation for associations.

Patients with COPD had significantly higher Nijmegen questionnaire scores than asthmatics (COPD: 23.4 ± 10.6 versus 17.3 ± 10.6, p = 0.016) and healthy individuals (14.3 ± 9.6, p = 0.002). Significantly more patients with COPD had severe dysfunctional breathing with Nijmegen scores > 23 (47%; 16/34) compared to asthma (27%; 10/37) and healthy controls (17%; 7/41) respectively (p = 0.019).

Dysfunctional breathing was detected in ~50% of patients with COPD, more so than in asthma or health. Strategies to reduce abnormal breathing behaviours may have important benefits for treatment of breathlessness in COPD.

1. Introduction

Breathlessness is a cardinal symptom of COPD and patients may instinctively adapt their breathing patterns to reduce this distressing symptom. For example, some patients naturally purse their lips in an attempt to increase upper airway resistance and reduce airway collapse (Cabral et al., 2015). Nonetheless, further involuntary adaptations of breathing patterns may not be beneficial if leading to hyperventilation and other dysfunctional breathing behaviours (Borge et al., 2014). Although dysfunctional breathing may occur frequently and have considerable impact in COPD (Connolly, 2003), there have been limited studies to date.

Dysfunctional breathing is conventionally measured employing the Nijmegen questionnaire using 16 questions on a scale of 0–4 for each question with scores > 23 considered to be indicative of dysfunctional breathing (van Dixhoorn and Duivenvoorden, 1985). The Nijmegen questionnaire has been criticised as being diagnostic of hyperventilation but not reflective of other aspects of dysfunctional breathing (Boulding et al., 2016). However, it has been in use for over 30 years and no suitable replacement has been proposed or attempted. The questionnaire has been validated in asthma (Grammatopoulou et al., 2014) suggesting that it may be useful also in other obstructive lung diseases such as COPD.

Although not intended for this purpose (*i.e.* to measure dysfunctional breathing), other methodologies used to assess COPD disease status may also inadvertently capture facets of breathing dysfunction. For example, the popular and commonly used COPD Assessment Test (CAT) (Jones et al., 2009) includes questions about breathing and breathlessness as part of an overall assessment of COPD disease status. It is unknown if these specific symptoms in CAT may be reflecting dysfunctional breathing practices and if CAT and Nijmegen scores may therefore be correlated through this process. This possibility has not been evaluated.

Accordingly we postulated that dysfunctional breathing might be a frequent abnormality in patients with COPD. The study compared patients with COPD to asthmatic and healthy individuals and examined associations of Nijmegen scores with other COPD and asthma disease severity measures.

* Corresponding author at: Monash Lung & Sleep, Monash Medical Centre, 246 Clayton Road, Melbourne, Australia.
E-mail address: Philip.Bardin@monashhealth.org (P.G. Bardin).

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Table 1
Characteristics of patients enrolled in study.

	COPD (n = 34)	Asthma (n = 37)	Control (n = 41)	p-value
Age (m ± SD)	68.4 ± 11.5	53.7 ± 19.3	56.7 ± 16.7	0.001
Gender (M/F)	13/21	13/24	17/24	0.831
BMI (kg/m^2)	29.6 ± 6.7	27.85 ± 6.1	–	0.223
FEV_1 (% predicted)	61.1 ± 26.2	85.6 ± 24.1	–	0.002
FEV_1/FVC (%)	55.4 ± 17.6	69.4 ± 13.0	–	0.05
Borg score	2.63 ± 2.31.	1.9 ± 1.2	0.57 ± 1.0	< 0.001
CAT score	23.4 ± 7.1	–	–	–
ACQ5 score	–	17.8 ± 1.3	–	–
Nijmegen score	23.4 ± 10.6	17.3 ± 10.6	14.3 ± 9.6	0.001
COPD (GOLD severity classification)				
Mild	13			
Moderate	9			
Severe	8			
Very Severe	4			
Asthma (FEV_1 severity classification)				
Very mild (FEV1 > 80% pred)		10		
Mild (FEV1 60–80% pred)		18		
Moderate (FEV1 45–59% pred)		7		
Severe FEV1 (< 45% pred)		2		

BMI – Body-mass-index; FEV1 – Forced expiratory volume–1 s; FEV1/FVC – Forced expiratory volume–1 s/forced vital capacity; CAT – COPD assessment test; ACQ5 – Asthma control questionnaire-5. COPD Gold – post bronchodilator FEV1 predicted.

2. Methods

A cross-sectional study was conducted in Monash Lung & Sleep, Monash Medical Centre, Melbourne, Australia. Monash Health Research Ethics Committee approved studies.

Three groups were evaluated. Patients with COPD and asthma were randomly recruited from respiratory clinics in the hospital. Monash Medical Centre is a tertiary care teaching hospital and the clinic populations reflect more severe COPD and asthma. Milder disease is usually managed in General Practice and these patients could not be recruited in the current studies. The healthy control group was recruited from relatives or friends of patients visiting the hospital. Patients with asthma had verified disease as per GINA guidelines (Reddel et al., 2015) (n = 37) or COPD (n = 34) based on GOLD criteria (Seemungal and Wedzicha, 2015). The healthy control group comprised individuals without respiratory symptoms or previous evidence of any lung disease (n = 41). Since this group had no symptoms or evidence of any respiratory disease approval was not obtained to conduct spirometry in this group.

Patients in the COPD group were older, had a smoking history of > 10 pack years and COPD severity as indicated in Table 1. Severity of asthma based on FEV_1 is also shown in Table 1. Both the asthmatics and healthy volunteers were non-smokers or had a history of < 10 pack years. Other baseline characteristics are shown in Table 1.

All participants completed the Nijmegen questionnaire (van Dixhoorn and Duivenvoorden, 1985) and Modified Borg Dyspnoea Scale (Seemungal and Wedzicha, 2015). In addition the COPD group also completed the CAT questionnaire and patients in the asthma group completed the Asthma Control Questionnaire-5 (ACQ5) (Juniper et al., 2005).

Data were normally distributed and comparisons between groups were done using analysis of variance and *post-hoc* Bonferroni analyses. Associations between Nijmegen scores and other scores were examined using Pearson correlation.

3. Results

Patients with COPD were older and had lower FEV_1 measurements (Table 1). COPD severity tended to be moderate to severe based on spirometry (FEV_1 61.1 ± 26.2% predicted). Asthmatic patients had a spectrum of mild and moderate to severe disease (Table 1). If severity was based on GINA Guidelines (Reddel et al., 2015) (assessed by treatment needed to control asthma), approximately equal numbers of patients were in the moderate and severe categories and none were mild (data not shown). Borg scores were significantly higher in the COPD and asthmatic groups than in healthy subjects ($p < 0.001$).

Significant differences ($p < 0.001$) in Nijmegen scores were noted between the three study groups (Fig. 1). *Post-hoc* analyses found that patients with COPD had significantly higher scores than asthmatics (COPD: 23.4 ± 10.6 versus 17.3 ± 10.6, $p = 0.016$) and versus healthy individuals (14.3 ± 9.6, $p = 0.002$). There were no significant differences in Nijmegen scores between asthmatics and healthy volunteers. Significantly more patients with COPD had Nijmegen scores > 23 (47%; 16/34) compared to patients with asthma (27%; 10/37) and healthy controls (17%; 7/41) respectively ($p = 0.019$). To assess the contribution of the four questions about breathlessness contained in the Nijmegen questionnaire, sub-scores in COPD, asthma and controls were compared *post-hoc*. Sub-scores did not appear to govern overall Nijmegen scores in COPD versus asthma. In healthy controls breathlessness sub-scores were lower as was to be expected from lower total scores in

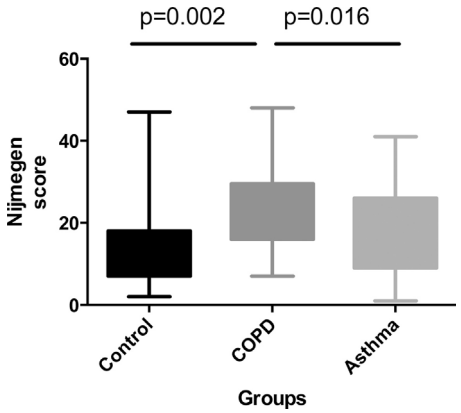

Fig. 1. Box-and-whisker plots showing Nijmegen scores in patients with COPD, asthma and healthy control subjects. There were significant differences between COPD and asthma and between COPD and healthy controls. Analysis was performed employing ANOVA and Bonferroni post-hoc testing.