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RESEARCH LETTERS

Reference values for maximum respiratory pressures in patients with type 2 diabetes mellitus

Dear Editor,

In Brazil there are few published studies on the reference values of maximal respiratory pressures. The first publication was written by Camelo Jr et al.,[1] who, in 1985, was a pioneer in the field by suggesting maximal inspiratory (MIP) and expiratory (MEP) pressure values for the Brazilian adult population. A few years later, Neder et al.[2] proposed predicted values of MIP and MEP, which were later questioned by Parreira et al.[3] These authors reported different results in subsequent studies, suggesting that the use of the predictive values published by Neder et al.[2] were not applicable to the target population. More recently, Costa et al.[4] recommended new equations for the determination of MIP and MEP, and proposed that their findings could contribute to the study by Neder et al.[2] by predicting, in particular, inspiratory muscle strength.

The previous studies[1–4] that formulated the predicted values for the Brazilian population used an aneroid manometer to measure respiratory muscle strength. Only one single Brazilian study[5] recently reported the reference values using a digital manometer. It is worth mentioning that currently the digital manometer is widely used in the clinical practice of respiratory therapy, and most importantly, the predicted values formulated with the equations developed with the aneroid manometer do not always match the results obtained with a digital manometer. In addition, the interpretation of the pulmonary function of a given individual is based on data comparisons obtained with healthy subjects, and do not take into account the effects of specific disfunctions the patients may have. As there are no specific equations for people with certain diseases, the results may not always correspond to those observed in clinical practice.

Given the lack of reference equations for patients with type 2 diabetes mellitus (DM2), in addition to the fact that there has only been one single publication conducted with a digital manometer, the objective of this study was to compare, in a population of patients with DM2, the MIP and MEP values obtained with a digital manometer against the values predicted by the equations proposed for the healthy Brazilian population, which were based on evaluations conducted with an aneroid manometer. Additionally, this study proposes new equations to determine the predicted values of MIP and MEP for patients with DM2 based on evaluations of the respiratory muscle strength conducted with a digital manometer. The hypothesis of this study was that the values obtained in patients with DM2 with a digital manometer differ from the values provided for the healthy population which were based on evaluations conduced with an aneroid manometer, and that new equations should therefore be formulated.

The values of MIP and MEP were measured in 219 patients with DM2, aged under 75, living in the urban area of Ijuí/Brazil, with calibrated digital manometer MVD-300 (Microhard System, Globalmed, Porto Alegre, Brazil). All participants underwent at least six, technically acceptable, efforts of maximum inspiration and expiration. For data analysis, the highest value was recorded, as long as there is not more than 10 percent of difference compared to the second highest value.

Among the patients studied, 64.8 percent were female, average age of 61.4 ± 9.5 years old and body mass index of 30.9 ± 5.9 kg/m^2. The average time of DM2 diagnosis was 7.4 ± 6.7 years, ranging from 0.5 to 40 years and the average fasting blood glucose was 126.4 ± 53.1 mg/dL, with minimum value of 55.0 mg/dL and maximum of 219.0 mg/dL. The average of maximal respiratory pressures achieved and predicted in male and female are recorded in Table 1.

When comparing the difference between the predicted and achieved values of MIP and MEP, there was a statistically significant difference between them, in both sexes. In post hoc Bonferroni analysis, in men, the value predicted by Costa et al.[4] is higher than PImax achieved by patients ($p < 0.0001$) and it is higher than equation values predicted by Neder et al.[2] ($p < 0.0001$). The Neder et al.[2] values were similar to those achieved by the patients ($p > 0.05$). In women it was found that the value predicted by Costa et al.[4] equation was statistically lower than that achieved by patients ($p < 0.0001$). The values predicted by Neder et al.[2] equation are closer to the value found in the test, but they are significantly different when compared to the scores obtained by the patients ($p = 0.021$) (Table 1).

Regarding the MEP, the values proposed by Costa et al.[4] equation showed equivalent numbers to those achieved by patients, with no significant difference between the sexes ($p > 0.05$). On the other hand, the Neder et al.[2] equation shows a considerably higher predicted value than the value achieved by patients, for both sexes ($p < 0.0001$). There was a significant difference between the values predicted by both Costa et al.[4] and Neder et al.[2] equations ($p < 0.001$) (Table 1).

Table 1 Absolute value and percentage reached the inspiratory and the expiratory maximal pressures achieved and predicted according to the equations of Neder et al.[2] and Costa et al.[4]

Respiratory pressure	Gender	Measure	Pressure predicted by Neder et al.[2]	Pressure predicted by Costa et al.[4]	Maximum pressure achieved	*p* value
Inspiratory	Male	cmH_2O	−107.9 ± 13.1	−153.7 ± 11.0	−93.1 ± 41.8	<0.0001[a]
	(*n* = 77)	%	86.3	60.5		
	Female	cmH_2O	−79.3 ± 15.5	−46.5 ± 4.4	−72.5 ± 27.7	<0.0001[a]
	(*n* = 142)	%	91.4	155.9		
Expiratory	Male	cmH_2O	173.7 ± 41.2	103.5 ± 11.2	101.2 ± 30.9	<0.0001[a]
	(*n* = 77)	%	58.3	97.8		
	Female	cmH_2O	116.9 ± 29.5	78.3 ± 6.6	76.9 ± 27.9	<0.0001[a]
	(*n* = 142)	%	65.8	98.2		

cmH_2O: centimeters of water; %: percentage reached.
[a] ANOVA repeated measures with post-hoc Bonferroni.

Table 2 Description of predictive equations for the maximum respiratory pressure for patients with diabetes mellitus type 2 from digital manovacuometry.

Equations formulated for	Men	Women
Maximal inspiratory pressures	204.959 − 1.772 (age)	110.660 − 0.633 (age)
Maximal expiratory pressures	118.972 − 1.148 (age) + 0.657 (body mass)	111.236 − 0.570 (age)

Regression analyzes were made for men and women.

The Pearson correlation coefficient was used to determine which variables best explained the maximal respiratory pressures values. For men, negative correlations were observed between MIP and age ($r = -0.374$; $p = 0.001$) and between MEP and age ($r = -0.379$; $p = 0.001$) and positive correlations between MEP and body mass ($r = 0.340$; $p = 0.003$). For women, there was a negative correlation between MIP and age ($r = -0.216$; $p = 0.021$) and MEP and age ($r = -0.192$; $p = 0.027$).

Based on the linear regression model, gender, age and body mass were considered predictor variables to determine the MEP for men. Table 2 describes the equations for MIP and MEP which have been proposed for patients with DM2 from the digital manometer. The equations obtained the following coefficients of determination (R^2) and standard error of the estimate (SEE) for men: MIP ($R^2 = 14.0$, SEE = 39.1); MEP ($R^2 = 21.9$, SEE = 27.7) and for women: MIP ($R^2 = 4.7$; EPE = 27.1) MEP ($R^2 = 3.7$; EPE = 27.5). There is no collinearity between predictor variables MEP in men (tolerance:0.966; inflation factor of variance:1.035).

To the best of our knowledge, it is the first study to propose equations to obtain reference values for patients with DM2 of the population, and the second one to establish reference values for the maximal respiratory pressures from digital manometer measuring. Thus, the results of this study may contribute to the prediction of maximal respiratory pressures in patients with DM2, in particular, measurements by digital manometer. It is important to point out that further studies with patients from different regions of Brazil and with different characteristics are still needed, so that they can formulate new tables or equations for determining the maximal respiratory pressures in patients with DM2.

Authorship

Fontela PC participated in the conception, design, analysis and interpretation of data and article.

Kuhn LA participated in the analysis and interpretation of data and article.

Winkelmann ER participated in all stages of the study.

Conflict of interest

We declare no conflicts of scientific interest in this study.

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P. Caitano Fontela[a], L.A. Kuhn[b], E.R. Winkelmann[c,*]

[a] *Postgraduate Program Ciências Pneumológicas, Universidade Federal do Rio Grande do Sul – UFRGS, Porto Alegre, RS, Brazil*
[b] *Department of Ciências da Vida, Universidade Regional do Noroeste do Estado do Rio Grande do Sul – UNIJUÍ, Ijuí, RS, Brazil*
[c] *Master's Degree Program Atenção Integral à Saúde, Department of Ciências da Vida, Universidade Regional do Noroeste do Estado do Rio Grande do Sul – UNIJUÍ, Ijuí, RS, Brazil*

* Corresponding author.
E-mail address: elianew@unijui.edu.br (E.R. Winkelmann).

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Study of CT-guided core needle biopsy in patients with interstitial lung diseases: Diagnostic yield and complications

Dear Editor,

In the study of lung lesions, tissue samples necessary for a pathomorphological assessment may be obtained by different techniques: surgical, bronchoscopic and percutaneous methods (like computed tomography (CT) guided transthoracic needle biopsy (TTNB) by fine-needle aspiration biopsy (FNAB) or by core-needle biopsy (CNB)).[1] The decision to perform FNAB or CNB is multifactorial and highly operator dependent. The diagnostic accuracy of FNAB is almost as good as CNB in the diagnosis of malignant lesions, especially if onsite cytopathological evaluation is available.[2] However, for diagnosis of benign lesions CNB is preferred, with a diagnostic yield of 52–91%, when compared to 20–50% with FNAB, for definitive diagnosis of benign lesions.[3] Although CT-guided CNB has been shown to be an accurate means of diagnosing lung malignancies, there is relatively little information about its utility in diagnosing benign conditions.[4] Previous series of lung CNB have included benign diagnosis but have not provided details of the histological features,[4] and there are no studies specifically addressing interstitial lung diseases (ILD). The aim of this work is to evaluate the use of CT-guided CNB in patients with suspected ILD: diagnostic yield for the different types of ILD, factors that influence it and complications.

All patients followed in our ILD outpatient clinic with suspected ILD, who underwent CT-guided CNB between 08/2010 and 02/2015, were consecutively recruited into this prospective study. All cases were discussed in a multidisciplinary meeting before being proposed to CT-guided CNB. Before the procedure, risks and possible complications were explained to each patient and informed consent was obtained. The procedure was performed by an interventional radiologist. All cases were performed using the Philips 16-slice spiral CT (120 kV, 250 mA and a 3-mm thickness; Philips Healthcare, Andover, MA, USA) for imaging guidance. The biopsy tool used was an automated biopsy gun (Magnum™, Bard Biopsy Systems, AZ, USA) with an 18 or 20-gauge needle. The patient lay on the CT table and the puncture point and access routine were determined by CT scan to a desired area of diseased lung. Following local

Table 1 Patients characteristics (CT, computed tomography; FNAB, fine-needle aspiration biopsy; EBUS-TBNA, endobronchial ultrasound transbronchial needle aspiration).

	n = 22	%
Smoking status		
Non-smoker	6	27.3
Former smoker	10	45.4
Current smoker	6	27.3
Comorbidities		
Cardiovascular risk factors	12	54.5
Heart failure	6	27.3
COPD	5	22.7
Ischemic heart disease	3	13.6
Malignancy	2	9.1
Asthma	1	4.5
Valvular disease	1	4.5
CT features		
Ground glass opacities	14	63.6
Nodules	8	36.4
Septal thickening	6	27.3
Consolidation	5	22.7
Honeycombing	5	22.7
Traction bronchiectasis	4	18.2
Emphysema	3	13.6
Previous diagnostic procedures		
Fiberoptic bronchoscopy with bronchoalveolar lavage	16	72.7
Fiberoptic bronchoscopy with transbronchial biopsy	2	9.1
FNAB	4	18.2
EBUS TBNA	2	9.1