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CLÁUDIA MARA MIRANDA RUSSI

SISTEMA DE OSCILOMETRIA DE IMPULSO, FORÇA RESPIRATÓRIA E PERIFÉRICA EM EX-FUMANTES E INDIVÍDUOS COM DOENÇA PULMONAR OBSTRUTIVA CRÔNICA

IMPULSE OSCILLOMETRY SYSTEM, RESPIRATORY AND PERIPHERAL STRENGTH IN FORMER SMOKERS AND CHRONIC OBSTRUCTIVE PULMONARY DISEASE INDIVIDUALS

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Orientador: Prof. Dr. Rodolfo de Paula Vieira

Co-orientador: Prof. Dr. Ricardo Navarro

Artigo apresentado ao Programa de Pós-Graduação em Bioengenharia da Universidade Brasil, como complementação de créditos necessários par à obtenção do título de Mestre em Bioengenharia.

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Prof.(a) Dr.(a) Francine Maria de Almeida (USP)

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SUMÁRIO

1. INTRODUÇÃO

A doença pulmonar obstrutiva crônica (DPOC) é uma doença respiratória limitante que está relacionada com alta morbidade e mortalidade, caracterizada por limitação crônica do fluxo aéreo, em virtude de doença das pequenas vias aéreas e destruição do parênquima. [1,2] Dispneia e intolerância ao exercício (IE) são comuns em pacientes com DPOC e estão relacionadas com redução da qualidade de vida e aumento da mortalidade. [3,4]. Em pacientes com DPOC, a dispneia e a IE podem resultar de um desequilíbrio da relação carga/capacidade dos músculos respiratórios. A limitação crônica do fluxo aéreo impõe uma carga aos músculos respiratórios (assim como o faz a hiperinsuflação pulmonar) reduzindo a capacidade do diafragma de gerar tensão. Outros fatores podem prejudicar a função muscular respiratória: ativação de proteases, estresse oxidativo, desnutrição, envelhecimento e fatores sistêmicos relacionados com comorbidades. Entretanto, entre os mecanismos que contribuem para a disfunção muscular respiratória, alterações da geometria da parede torácica e da posição do diafragma são os mais comumente reconhecidos e estudados. [2,5]

Como citado anteriormente, um dos fatores que levam ao DPOC é o processo de envelhecimento envolvendo alterações em todo o organismo humano, com declínio em quase todas as funções. O número de idosos no Brasil de 14 milhões estimados em 2002 e com previsão de 32 milhões em 2020 será um dos maiores desafios da saúde pública. O idoso consome mais serviços de saúde com internações hospitalares mais frequentes e tempo de ocupação do leito maior comparado a outras faixas etárias. Em geral, as doenças dos idosos são crônicas e múltiplas, perduram por vários anos, exigem acompanhamento constante, cuidados permanentes, medicação contínua e exames periódicos. [6,5]

Portanto, o presente estudo propõe avaliar a correlação de força de preensão manual com força muscular respiratória, verificando a função e mecânica pulmonar em idosos, contribuindo para melhor qualidade de vida de pacientes portadores de DPOC. Sintomas como dispneia e disfunção muscular esquelética diminuem a tolerância ao exercício e, consequentemente, há maior dificuldade da pessoa em ser autônoma e funcional no seu dia-a-dia. Estas limitações conduzem à necessidade da inclusão das pessoas com DPOC em Programas de Reabilitação Pulmonar.

Pacientes portadores de DPOC na população idosa tem aumentado nos últimos anos, ocasionando o interesse desse estudo para compreender a relação da força muscular de membros superiores com avaliação pela oscilometria e espirometria da capacidade respiratória de portadores de DPOC.

Há um interesse crescente na relação entre a sarcopenia, a força muscular respiratória e a função pulmonar em pacientes com DPOC. Entretanto, há uma avaliação muito limitada da sarcopenia, da força muscular respiratória e da função pulmonar em pessoas idosas sem doença respiratória conhecida.

Há cada vez mais um reconhecimento de uma associação entre força muscular e função pulmonar em pessoas com DPOC. Não se sabe se existe uma relação entre força de preensão e função pulmonar em adultos mais velhos não fumantes. Neste estudo foram encontradas correlações entre a oscilomentria e a espirometria em pacientes DPOC, mas não entre força muscular respiratória e periférica.

Comprobación - Rechazo por parte del colaborador

Gracias por tomarse el tiempo para informar a Archivos de Bronconeumologia de que no es autor colaborador de "Impulse oscillometry system (IOS), respiratory and peripheral strength in former smokers and chronic obstructive pulmonary disease individuals" presentado por Rodolfo Paula Vieira

2. ARTIGO

Impulse oscillometry system (IOS), respiratory and peripheral strength in former smokers and chronic obstructive pulmonary disease individuals

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ABSTRACT

OBJECTIVES: Evaluate whether spirometric and respiratory or peripheral muscle strength may or not correlate with the levels of small airways obstruction evaluated by impulse oscillometry.

METHODS: We evaluated 829 individuals aged >60 years and 19 COPD GOLD II and 20 non-COPD individuals classified by spirometry were evaluated for lung function by spirometry, lung mechanics by IOS (Impulse Oscillometry System), maximum inspiratory (MIP) and expiratory (MEP) pressure by manovacuometer and hand grip strength test.

RESULTS: COPD presented reduced FEV1 (forced expiratory volume in 1 second) and FEV1/FVC (Tifennaud) compared to former smoke group with no changes in FVC (forced vital capacity). In COPD the FEV1 and FEV1/FVC showed a negative correlation with BMI (P<0.05, R=-0.56 and -0.43, respectively). The airway resistance and peripheral airway resistance were reduced in the COPD compared to former smoke group with similar values for proximal airway resistance. The COPD individuals showed a negative moderate correlation between FEV1 and impedance (R=-0,664; P<0.01); airway resistance (R=-0,593, P<0.05) and peripheral airway resistance (R=-0,547, P<0.05) (Table 3). The negative correlation was low in COPD individuals for reactance (R=-0,434, P<0.05) and proximal airway resistance (R=-0,480, P<0.05) (Table 3). These correlations were not found in the former smoke group. Hand grip strength measured in the right arm showed a moderate negative correlation with the maximal inspiratory pressure (Pimax) (R=-0,539, P<0.05) in COPD individuals. There was no correlation between PIMax (maximal expiratory presassure) and PEMax (maximal expiratory preassure) with none of the spirometric or oscillometric parameters ($p>0.05$) in COPD or former smoker's individuals.

CONCLUSIONS: We conclude that the parameters measured by IOS correlate with spirometric parameters in COPD patients but not with respiratory and peripheral muscle strength.

Key words: COPD, muscle strength, impulse oscillometry, lung function, airway obstruction.

INTRODUCTION

Smoking is one of the main risk factors for the development of chronic obstructive pulmonary disease (COPD). Spirometry is the gold standard and primary method to detect the air flow limitation associated with COPD (Kaminsky, 2012). Spirometry involves a forced expiratory manouver and the need of patients' cooperation, which may be difficult especially in elderly patients. The COPD severity is graded by forced expiratory volume measured during the first second (FEV1) and the disease treatment is guided also by clinical symptoms and acute exacerbation risk assessment (Gold update in, 2017). However, some studies have showed that spirometry presente low specificity and sensitivity to changes in the early stages of chronic respiratory disease (Johns et al., 2014).

The multifrequential oscillation techniques, such as impulse oscillometry system (IOS), might be more suitable than spirometry for detecting early stages of respiratory damage. Impulse oscillometry has been used in the clinical practice and as a research tool to measure inspiratory and expiratory flow and pressure during normal tidal breathing over a period of around 30–40 seconds and effort independent. The high frequency oscilation reflects proximal airways resistance and low frequency oscilattions reflects airwas after the eighth airway generation (Michaelson et al., 1975; Winker et al., 2009). The IOS can be useful to identifying early changes in respiratory system of smokers or even former smokers.

There is a decline of lung function and respiratory mechanics due to aging mainly from 50 to 80 years of age with increased airway resistance (Niewoehner and Kleinerman, 1974; Turner, et al., 1968; Winker, et al., 2009).

Besides the lung fucntion drop, there is an overall decline in skeletal muscle mass, strength and function documented also in respiratory muscle (Ohara et al., 2018; Summerhill et al., 2007). Hand grip strength and maximal static inspiratory and expiratory pressure (MIP and MEP) are recommended as simple tool to measure peripheral and respiratory muscle strength (Ohara et al., 2018; Cruz-Jentoft et al., 2010).

There is increasing interest in the possible correlations of IOS and spirometry, respiratory and peripheral muscle strength in elderly with COPD and healthy subjects. This study aimed to evaluate the relationship of grip strength and lung function and lung mechanics in elderlies' former smokers versus elderlies with COPD.

METHODS

Participants

This was a prospective study conducted in elderly individuals into 2017. We evaluated 829 individuals aged >60 years and 19 COPD GOLD II and 20 non-COPD individuals classified by spirometry were included. COPD were defined by a spirometric result of forced expiratory volume in 1 second (FEV_1)/forced vital capacity (FVC) <0.7 (Gold update in, 2017). The inclusion criteria were as follow: individuals with COPD classified with a degree of airflow limitation defined by FEV_1>50% and ≤80% as GOLD 2 (Gold update in, 2017) and non COPD individual matched by age and BMI; sedentary; clinically stable with no change in medication in the last 3 months. A convenience sample of eligible patients were notified in advance about the objectives and procedures of the study and after its approval and signed an informed consent they became part of effective research. This study was approved by the Ethics Committee in Research (53344616.6.0000.5511) of the Brazil University, Sao Paulo, Brazil.

Exclusion criteria were met if any participant was unable to meet all of the inclusion criteria, had any contraindication to performing spirometry according to the ATS (American Toracic Society) guidelines or any other test required for participation in the study (Celli et al., 2015) Individuals with history of smoking habit in the last six months, subjects with restrictive spirometric pattern ([FEV1/FVC] ≥0.70 and FVC <80% of predicted) or who refused to participate in the study were also excluded.

Study design

Individuals were evaluated at the “Casa do Idoso” in Sao Jose dos Campos, Sao Paulo, Brazil, by a first interview conducted to obtain personal data, body mass index (kg/m^2), smoking history, and spirometry. The participants of this study were evaluated by impulse oscillometry, maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP) and hand grip test. Individuals were instructed not to use pharmacological agents such as anesthetics, analgesics, antidepressants, as well as caffeine-based substances and/or alcohol during the last 12 hours preceding the test. Tests were performed in the morning (from 8 to 9 am) with controlled temperature (24°C) and relative humidity (from 50 to 60%).

Spirometry and impulse oscillometry were performed to measure pulmonar function by using Jaeger Masterscreen pulmonary function instrument (Masterscreen IOS, Erich Jaeger, Hoechberg, Germany) in strict accordance with the American Thoracic Society/European Society of Respiratory Diseases guidelines (ATS/ERS, 2012). The reference values for spirometry were specific for the Brazilian population. Total respiratory impedance [Z5] %pred, R5, R20, R5-R20, (R5-R20) % R5, and reactance parameter X5, Fres, and Ax were recorded by impulse oscillometry as described previously (Impulse oscillometry system as an alternative diagnostic method for chronic obstructive pulmonary disease (Wei et al., 2017).

Maximal inspiratory (MIP) and expiratory pressure (MEP) were measured by a pressure transducer (MVD-300 V.1.1 Microhard System, Globalmed, Porto Alegre, Brazil). MIP was measured after maximal inspiration effort from residual volume and MEP was measured after residual volume effort from total lung capacity, both against an occluded airway with a minor air leak (2mm). The highest pressure of six measurements (3 for MIP and 3 for MPE) was used for analysis (ATS/ERS, 2012).

Hand grip strength were measured by a calibrated handheld dynamometer (Jamar®, Sammons Preston Rolyan, Boilingbrook, IL, USA) in a supine position. The participants were instructed to sit down with their elbows flexed in an angle of 90° and three attempts were performed with both hands. The maximum grip recorded value in Newton was used for analysis (Kim et al., 2018; Mathiowetz et al., 1984).

Statistical analysis

Data were analysed by using SigmaStat 5.0 software (California, USA). Normality of the data was evaluated by the Kolmogorov-Smirnov test. The data were submitted to a t test for a comparison between the groups and Spearman test interpreted according to Hinkle et. al. (2003): negligible 0.0 - 0.3; low 0.3 - 0.5; moderate 0.5-0.7; high 0.7 - 0.9; very high 0.9 - 1.0). Significance values were adjusted to 5% ($p < 0.05$). The graphs will be compiled using GraphPad Prism 5.0 software (California, USA).

RESULTS

Patients selection, inclusion and exclusion

A total of 829 individuals were screened over 48 months of which 790 were excluded: 90 individuals with asthma; 63 were current smokers, 153 were GOLD 1, 3 or 4, 180 did not complete all exams and 324 were healthy individuals, of which 20 were used in the control group. The 39 eligible individual consented to take part in the study (Figure 1). Patient characteristics are recorded in table 1.

Maximal Inspiratory Pressure (MIP) and Maximal Expiratory Pressure (MEP) and Hand Grip Strength

There was no statistically difference in age, body mass index (BMI), maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP) and hand grip strength in both arm between groups. COPD patients and former smokers presented a percentage of 70.58% and 57.89%, respectively, of individuals with MIP bellow the reference values. COPD patients and former smokers presented a percentage of 35.29% and 5.26%, respectively, of individuals with weakness in the hand grip strength test (Table 1). In COPD patients there was negative correlation between age and MIP (P<0.05, R=-0.58) (Figure 2). The MIP was significantly correlated with MEP in former smokers group with a trend for COPD individuals (R=-0,530, P=0.019 and R=-0,462, P=0.05, respectivelly) (Figure 3). In both groups the hand grip strength measured in the left arm showed a high correlation with hand grip strength measured in the right arm (R=0,959, P<0.0001, for former smoke group and R=0,899, P<0.0001 for COPD group). Hand grip strength measured in the right arm showed a moderate negative correlation with the maximal inspiratory pressure (MIP) (R=-0,539, P<0.05) (Figure 4) and a moderate positive correlation with the maximal expiratory pressure (MEP) (R=0,586, P<0.05) in COPD individuals (Figure 5).

Lung Function and Mechanics

COPD individuals presented reduced FEV1 (Figure 6) and FEV1/FVC (figure 7) compared to former smokers group (p<0.001, Table 2). The airway resistance (resistance at 5 Hz [R5]) and peripheral airway resistance (R5-R20) were increased in former smokers compared to COPD individuals (p<0.05 and p<0.01, respectivelly, Table 2) (Figure 8). There was no statistically difference in impedance, reactance and proximal airway resistance (resistance at 20 Hz [R20]) between groups (Table 2). However, the COPD individuals showed a negative correlation between FEV1 and FEV1/FVC and BMI (P<0.05, R=-0.56 and -0.43, respectively). The COPD individuals showed a negative moderate correlation between FEV1 and impedance (R=-0,664; P<0.01), airway resistance at 5 Hz (R=-0,593, P<0.05), and peripheral airway resistance (R5-R20; R=-0,547, P<0.05) (Table 3). The negative correlation was low in COPD individuals for reactance (R=-0,434, P<0.05) and proximal airway resistance (R=-0,480, P<0.05) (Table 3) (Figure 9). These correlations were not found in the former smoke group.

DISCUSSION

Oscillometry is a technique to measure the impedance that comprises airway resistance and reactance. The multifrequential oscillation waves which are transmitted along the tracheobronchial tree typically by 5 and 20 Hz allow to measure the total airway resistance (at 5 Hz), the proximal airway resistance (at 20 Hz) and the peripheral airway resistance (R5-R20) (Winkler et al., 2009). In the current study, oscillometry detected increased airway resistance in former smokers compared to COPD subjects.

There is also a reduced muscle mass and strength of respiratory muscles. Previous studies demonstrated that in health subjects MIP decreased significantly after 55 years of age (Black & Hyatt, 1969, Bahat et al., 2014; Pessoa et al. 2014). In addition, it has been extensively reported that the functional alterations caused by aging such as sarcopenia, mainly in sedentary individuals, contributes to the decrease in respiratory and peripheral muscle strength (Goodparster et al, 2006, Holmes et al, 2017). In the present study no diferences were found in the respiratory strength between COPD (GOLD 2) and former smokers. However average 70% of COPD and 54% of former-smokers individuals presented values below the reference values for maximal inspiratory pressure considering age and sex (Pessoa et al, 2014).

In elderly people the hand grip strength is used as an important functional marker of maintenance of functional independence and quality of life and reduced levels of grip strength can predict disability or mortality (Ganna & Ingelsson, 2015). The grip strength less than 26 kg in men and less than 16 kg in women aged 65 and older are considered “weak”. (Alley et al, 2014).

Two previous meta-analyses provided the reference values for grip strength in the general population (Bohannon et al., 2006, Bohannon et al., 2007). In our study 35.29% of COPD patients and 5.26% of former smokers presented a weakness in hand grip strength based on age and sex. A recent study reported that the risk for mortality from COPD was higher per 5 kg lower in grip strength (Celis-Morales et al, 2018).

With increasing age there is a decrease in pulmonar function with a decrease in forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC), and forced expiratory flow decrease (Janssens et al., 1999 and Janssens, 2005).

Interestingly former smokers showed increased airway resistance and peripheral airway resistance compared to COPD group. The forced expiratory volume in the first second is not the best tool to access small airway resistance. For these analyses the preference variable is the maximal expiratory flow (25-75%) especially for evaluation of asthmatic patients as the disease since, during the initial blow, the chokepoint is central and MEF is mostly unaffected by peripheral airway resistance. This forms the basis of using mid or late expiratory flows (MEF 25-75) as an index of peripheral/small airway disease. However, this too is shown to be inadequate.

Respiratory impedance is the sum of all forces which oppose the generated impulse. Impedance measured at any frequency is the ratio of the difference in pressure and changes in the flow at that frequency. Depending on the region where the pressure is measured, the impedance varies. For example, pressure difference at the mouth and in the alveoli gives impedance of the airways and the difference at the mouth, and pleural pressures give a total impedance of the lung. In IOS, the pressure measured at the mouth is compared to atmospheric pressure, which is the pressure outside the chest wall. This defined as respiratory system Zrs and includes the in-phase (real) component which is the resistive component (Rrs) and an out-of-phase (imaginary) component which is a reactive component (Xrs). Simply put, Rrs can be viewed as the energy dissipation whereas Xrs as energy storage. Since IOS measures input impedance, abnormalities of chest wall and skeletal muscles will also be reflected in the measurement.

CONCLUSIONS

We conclude that the parameters measured by IOS correlate with spirometric parameters in COPD patients but not with respiratory and peripheral muscle strength.

DISCLOSURE

The authors report no conflicts of interest in this work.

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AUTHOR CONTRIBUTIONS STATEMENT

CMMR, ACTA, MARBR, LAC, ASR, TCG, RMF, SMMS, RA, RSN, CRF, RPV, contributed performing the experiments and analysis. CMMR, ACTA, RSN, CRF, RPV have written the manuscript and critically revised the manuscript and performed the statistical analysis. RPV have designed the study. All authors have reviewed and approved the final version of the manuscript prior to submission.

COMPETING FINANCIAL INTERESTS

All authors declare do not have any competing financial interests related to this publication.

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Figure Legends

Figure 1: Flowchart for the recruitment into the study.

Figura 2: Correlation between age and maximal inspiratory pressure.

Figura 3: Correlation between maximal inspiratory pressure and maximal expiratory pressure between former smokers and COPD individuals.

Figura 4: Correlation between hand grip strength measured in the right arm and maximal inspiratory pressure in COPD individuals.

Figura 5: Correlation between hand grip strength measured in the right arm and maximal expiratory pressure in COPD individuals.

Figura 6: Correlation between forced expiratory volume between former smokers and COPD individuals.

Figura 7: Correlation FEV1/FCV between former smokers and COPD individuals.

Figura 8: Correlation between air resistance between former smokers and COPD individuals.

Figura 9: Correlation between FEV1, FEV1/FCV, R5, R20 in COPD individuals.

Table legends

Table 1: Baseline characteristics of COPD and former smokers' elderly individuals.

Table 2: Lung Function tests of COPD and former smokers.

Table 3: Correlation between FEV1 and demographic, oscillometric and strength parameters in COPD and former smokers.

Figura 1

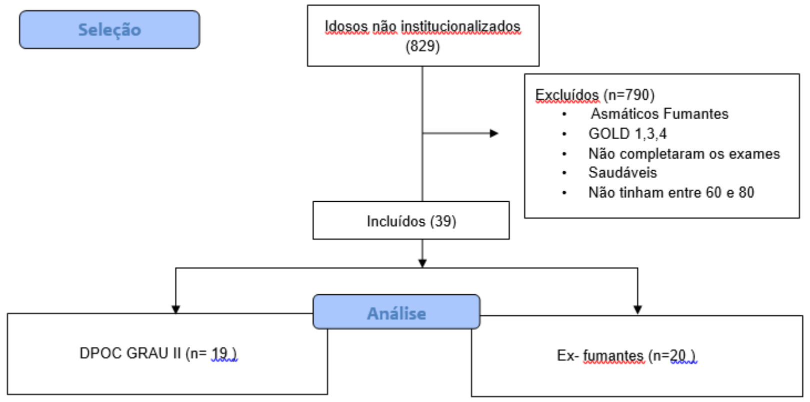
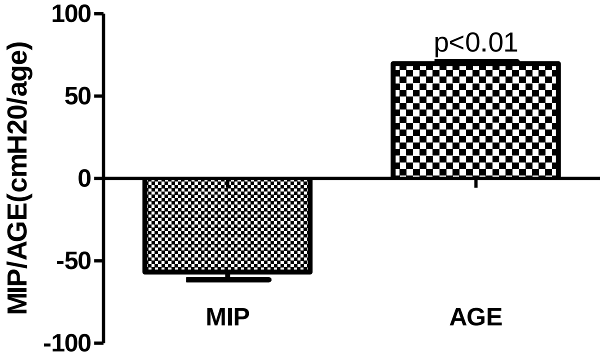


Figura 2



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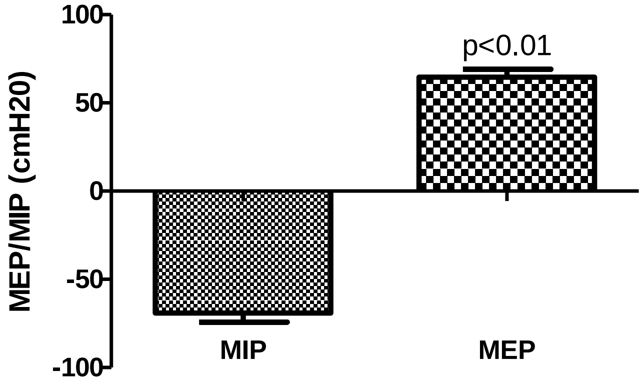

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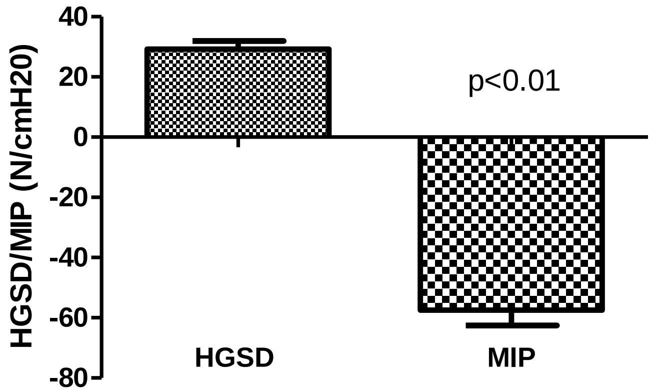

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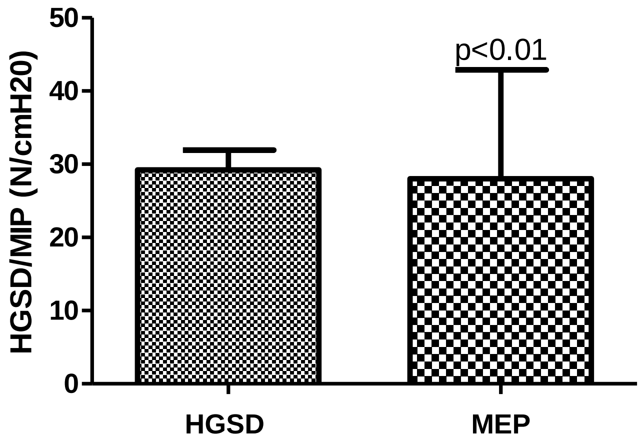

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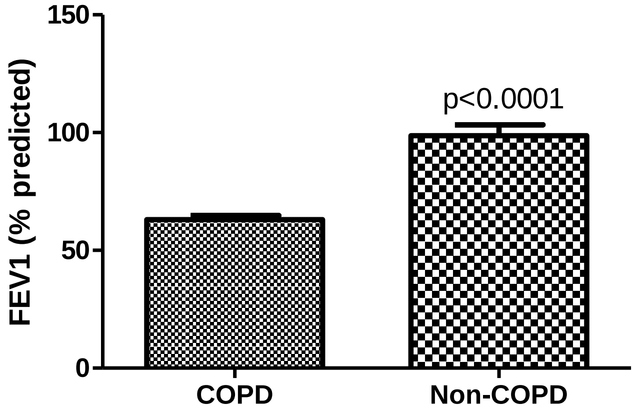

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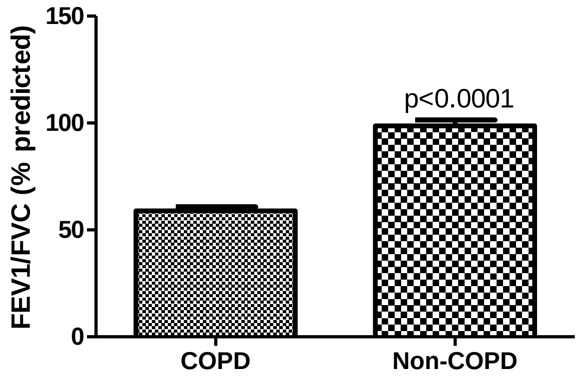

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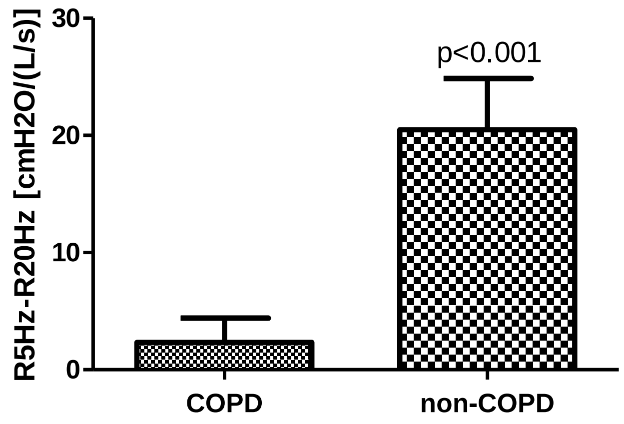
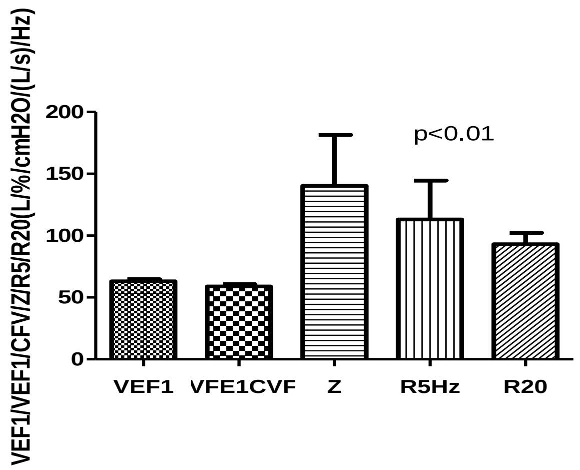


Figura 9



Tables

Table 1. Baseline characteristics of COPD and former smokers' elderly individuals.

	COPD (GOLD 2) group (n=20)	Former Smokers (n=19)	P value
Age (yr)	69.8 ± 4.7	71 ± 4.9	0.45
Gender (M/F)	13/6	4/14	
BMI (Kg/ m2)	27.6±4.3	27.1±6.1	0.64
MIP (cmH2O)	-58.8±23.4	-69±25.4	0.20
MEP (cmH2O)	61.7±28.9	68.9±21	0.39
MIP below the reference value (%)	70.58	57.89	
HGS-R (Kg)	28.9±12.4	30.6±11.7	0.95
HGS-L (Kg)	29.5±13.1	29.3±10.9	0.79
Weak HGS (%) **(<26 kg in men and <16 kg in women)**	35.29	5.26	-

Abbreviations: BMI, body mass index; MIP, maximal inspiratory pressure; MEP, maximal expiratory pressure; HGS-R, hand grip strength right arm; HGS-L, hand grip strength left arm. Data are presented as mean±standard deviation.

Table 2. Lung Function tests of COPD and former smokers.

	COPD (GOLD 2) group (n=19)	Former Smokers (n=20)	Teste-t/ Wilcoxon P value
FEV1 (L)	61.4 (59.7-73.2)	97.3 (79-107)	<0.001
FVC (L)	102.73±16.07	100.8 (87-121.5)	0.932
FEV1/FVC (%)	61.7 (56.3-63,8)	99.7 (92.1-105.1)	<0.001
Z (KPa/L/s)	80.2 (68.3-110.7)	116.5 (86-152.9)	0.057
X	138.9 (94.4-235.3)	156.4 (105.3-241.3)	0.692
R5 (KPa/L/s)	76.8 (67.8-108.4)	112.6 (85.2-152.4)	0.039
R20 (KPa/L/s)	73 (63.1-92.6)	86.7 (69.1-116.6)	0.136
R5-R20 (KPa/L/s)	4.7 (1.7-9.3)	25.2 (5.9-35.3)	0.009

Abbreviations: FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity; Z, impedance; X, reactance; R5, airway resistance at 5 Hz; R20, proximal airway resistance at 20 Hz; R5-R20, peripheral airway resistance. Data are presented as median and interquartile range.

	COPD group FEV1		Former smoker group FEV1	
	Pearson/ Spearman r (p)	Teste-t/ Wilcoxon p (TE)	Pearson/ Spearman r (p)	Teste-t/ Wilcoxon p (TE)
Age (years)	-0.10	0.68	0.28	0.23
BMI (N/ m2)	-0.56	0.01	0.10	0.66
Z (KPa/L/s)	-0.66	0.003	0.01	0.95
X (KPa/L/s)	-0.43	0.07	-0.12	0.61
R5 (KPa/L/s)	-0.59	0.01	-0,04	0,84
R20 KPa/L/s)	-0.48	0.04	-0.06	0.77
R5-R20	-0.54	0.02	0.02	0.90
MIP (cmH2O)	0.15	0.55	-0.23	0.31
MEP (cmH2O)	-0.43	0.07	0.28	0.23
HGS-R (Kg)	0.11	0.65	-0.06	0.79

Abbreviations: BMI, body mass index; Z, impedance; X, reactance; R5, airway resistance at 5 Hz; R20, proximal airway resistance at 20 Hz; R5-R20, peripheral airway resistance; MIP, maximal inspiratory pressure; MEP, maximal expiratory pressure; HGS-R, hand grip strength right arm. Data are presented as median and interquartile range.

Table 3. Correlation between FEV1 and demographic, oscillometric and strength parameters in COPD and former smokers.

3. CONSIDERAÇÕES FINAIS

A pesquisa iniciou-se em 2017 com a avaliação de 829 idosos que frequentavam a Casa do Idoso de São José dos Campos, São Paulo. Foram realizados exames de espirometria, oscilometria, IMC, força de preensão palmar e exame de sangue. Sendo que o presente estudo não utilizou o exame de sangue.

A pretensão inicial era analisar a força muscular de membros superiores por meio da dinamometria e correlacionar com oscilometria e espirometria pulmonar em idosos com DPOC grau I, em 80 idosos entre 60 e 80 anos de idade, de ambos os sexos.

O número de idosos com DPOC grau I não atingiu um número satisfatório para o desenvolvimento da pesquisa, portanto foi realizada uma análise dos resultados constando que DPOC grau 2 apresentou um número suficiente para correlacionar os dados, como foi apresentação nos resultados.

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