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Correlation between the Brody score and lung function using an ultra-low-dose CT protocol without anesthesia in children with cystic fibrosis

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TO THE EDITOR,

Cystic Fibrosis (CF) is a multisystemic disease; however, the extent of pulmonary impairment is decisive for the course of the disease and survival.[1,2] Lung function tests are crucial to assess the progression and severity of lung disease.[2,3] Studies have shown that the forced expiratory volume in the first second (FEV_1) is also a relevant index in the early detection of pulmonary exacerbations, improving the survival of patients with CF.[4]

The progression of CF lung disease is associated with a decline in FEV_1.[2] Although the lung parenchyma remains largely intact for much of the course of the disease, Brody et al. (2005) demonstrated that patients with normal FEV_1 already had structural changes upon chest computed tomography (CT).[5-7]

Early methods of predicting lung involvement in CF patients are essential to target treatment and prevent loss of lung function and respiratory failure. Chest CTs show findings that can assist in predicting the progression of lung disease, such as the presence of bronchiectasis and obstructive changes in the lung parenchyma.[8] In addition, chest CT scans in children currently adopt low doses of radiation, often without the need for anesthesia, which implies greater ease in acquiring images and less exposure to radiation and possible complications resulting from anesthesia.

In order to track pulmonary changes before clinical symptoms become apparent, the evaluation of new strategies is essential. Spirometry is used for monitoring, but FEV_1 often remains normal in advanced stages of lung disease. Thus, the aim of this study was to determine the correlation between the Brody score and lung function in subjects with CF.

This retrospective, cross-sectional study included all CF patients aged over five years old, with available chest CT scans, who were assisted in the outpatient CF Clinic of the São Lucas Hospital (HSL) Pulmonology Service between July and November 2020. Subjects in which the period between pulmonary function testing and chest CT was longer than three months were excluded.

The diagnosis of patients with CF was confirmed according to the CF Foundation Consensus Report.[1] Demographic and clinical data and information on genetic mutations (mild - classes III to VI, and severe - classes I and II) and lung function (% predicted FEV_1) were collected from physical and electronic medical records. The spirometry test was performed according to the recommendations of the American Thoracic Society and European Respiratory Society.

The Brody score was evaluated by chest CT scans using an ultra-low radiation dose, without anesthesia. CT scans were obtained in all patients in supine position, in both the expiratory and inspiratory phases, from the lung apex to below the costophrenic angles. Chest CT was performed using a CT 16 multislice scanner (LightSpeed VCT; GE Healthcare, Milwaukee, WI, USA) according to the following protocol: collimation of 1.25 mm, Gantry rotation of 0.5 s, 80 kV, and 30 mAs; without anesthesia.[9] The Brody score is calculated based on four parameters: diameter and extent of bronchiectasis, thickening of the peribronchial wall, air trapping, and the extent of lung parenchyma impairment.[10]

All statistical analyses were performed using the Statistical Package for the Social Sciences software, version 20.0, for Windows (SPSS Inc., Chicago, IL, USA). Categorical variables were described as absolute and relative, while continuous variables as median and interquartile range. The categorical variables were analyzed through the Chi-square test. Spearman's correlation coefficient was calculated to evaluate the association of lung impairment by the Brody score and FEV_1. P-values below 0.05 were considered significant. This study was approved by the Research Ethics Committee of the Pontifícia Universidade Católica do Rio Grande do Sul, Brazil (CAAE No. 49692115.7.0000.5336).

A total of 25 subjects were included, with a median age of 7 years [interquartile range: 5.1 – 15.1]; there was a predominance of males (n = 15; 60%). Ten (40%) subjects were homozygous for F508del, 10 (40%) were heterozygous for F508del, and five (20%) carried other CFTR mutations. The median % predicted FEV_1 was 81 [54.5 - 105.0], and 19 (76%) subjects had bronchiectasis upon chest CT.

A moderate positive correlation was observed between the Brody score and age ($r = 0.42$, $p = 0.034$), while a negative correlation was observed between FEV_1 and age ($r = -0.57$, $p = 0.006$), indicating that the severity of the Brody score is associated with the progression of lung disease over the years.

Figure 1 shows the correlation between the Brody score and FEV_1, adjusted by age ($r = -0.582$, $p = 0.006$). Five (31.2%) subjects aged 12 years or less presented Brody

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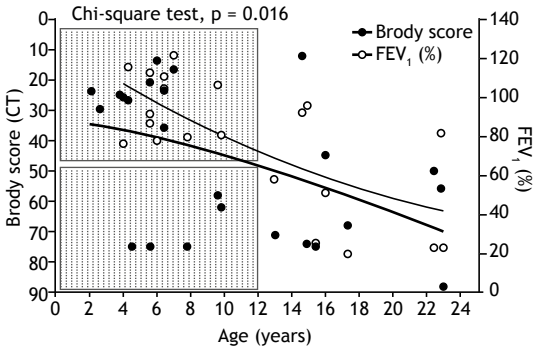

Figure 1. Brody score and FEV_1 by age in patients attended at the CF Reference Center at HSL-PUC. CT = Computed tomography; FEV_1 = Forced expiratory volume in the first second.

scores above 50, showing early and relevant pulmonary alterations by chest CT. In contrast, none of the patients aged 12 years or less showed a significant change in % predicted FEV_1 (Brody score vs. FEV_1, p = 0.016).

Our findings revealed high Brody scores in young patients who did not yet exhibit reduced lung function, highlighting the importance of early interventions to reduce future damage. In addition, the sample showed a high prevalence of bronchiectasis in childhood and adolescence. A significant correlation between the Brody score and FEV_1, adjusted by age, was found in this study. Furthermore, five patients with preserved lung function already presented lung impairment when evaluated by the Brody score, performed by chest CT. These findings are important, particularly at the preschool age, when the child is unable to perform spirometry.

Relevant findings of lung disease on chest CT were present in CF patients with mild to moderate disease, according to FEV_1 parameters. Although bronchiectasis was present in most CT scans, in only half of the cases (20%) was the Brody score above 50, a sign of advancing lung disease.

This study had some limitations. First, it is a retrospective, cross-sectional study. Second, it was performed on a small sample size; and third, it was carried out in a single center. However, only some studies have explored the use of the Brody score in ultra-low-dose chest CT without anesthesia for the early assessment of pulmonary involvement in children with cystic fibrosis. The Brody score measured by chest CT provided advantages, such as the early detection of pulmonary impairment. This scoring system is a simple method that can be performed without anesthesia, using an ultra-low CT radiation dose, which is safer and more effective.

In conclusion, the present study showed a positive correlation between the Brody score and lung function in CF subjects. Moreover, these results indicate that chest CT could assess and detect early structural changes related to lung disease progression. However, more studies with larger sample sizes are needed to elucidate the potential of chest CT as an early detector of lung disease.

AUTHOR CONTRIBUTIONS

SC: study conception, methodology, visualization, writing of the original draft, and review and editing. FF and LAP: study conception, methodology, visualization, and review and editing. MPP and LCSM: study methodology, visualization, and review and editing. All authors approved the final version of the manuscript for publication.

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