CLINICAL SCIENCE

Shwachman-Kulczycki score still useful to monitor cystic fibrosis severity

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INTRODUCTION: The Shwachman-Kulczycki score was the first scoring system used in cystic fibrosis to assess disease severity. Despite its subjectivity, it is still widely used.

OBJECTIVE: To study correlations among forced expiratory volume in one second (FEV_1), chest radiography, chest computed tomography, 6-minute walk test, and Shwachman-Kulczycki score in patients with cystic fibrosis and to test whether the Shwachman-Kulczycki score is still useful in monitoring the severity of the disease.

METHODS: A cross-sectional prospective study was performed to analyze the correlations (Spearman). Patients with clinically stable cystic fibrosis, aged 3-21 years, were included.

RESULTS: 43 patients, 19F/24M, mean age 10.5 $\pm$ 4.7 years, with a median Shwachman-Kulczycki score of 70 were studied. The median Brasfield and Bhalla scores were 17 and 10, respectively. The mean Z score for the 6-minute walk test was -1.1 ± 1.106 and the mean FEV_1 was 59 $\pm$ 26 (as percentage of predicted values). The following significant correlations versus the Shwachman-Kulczycki score were found: FEV_1 ($r = 0.76$), 6-minute walk test ($r = 0.71$), chest radiography ($r = 0.71$) and chest computed tomography ($r = -0.78$). When patients were divided according to FEV_1, a statistically significantly correlation with the Shwachman-Kulczycki score was found only in patients with $FEV_1 < 70\%$ ($r = 0.67$).

CONCLUSIONS: The Shwachman-Kulczycki score remains an useful tool for monitoring the severity of cystic fibrosis, adequately reflecting the functional impairment and chest radiography and tomography changes, especially in patients with greater impairment of lung function. When assessing patients with mild lung disease its limitations should be considered and its usefulness in such patients should be evaluated in larger populations.

KEYWORDS: Chest radiography; Six minute walk test; Spirometry; Chest tomography; Clinical status.

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INTRODUCTION

Cystic fibrosis (CF) is the most common autosomal recessive hereditary disease in the Caucasian population. It is characterized by suppurative chronic obstructive pulmonary disease, pancreatic insufficiency, multifocal biliary cirrhosis and electrolyte loss in sweat. In men, CF is also associated with infertility due to obstructive azospermia.[1-3]

Disease progression is assessed through tests of pulmonary function, chest radiography and tomography, and clinical data. However, the scores used to assess disease severity in CF were developed some time ago and may not meet current needs.[4]

The Shwachman-Kulczycki (SK) score, published in 1958, was the first score to assess the severity of CF.[5] It was developed based on a study which monitored 105 patients for 5 years, exposing the need for a system to evaluate the severity of this disease, and to provide a perception of the overall clinical status of the patient. This score is based on clinical and radiological evaluation and represented a milestone in the history of CF. Since its publication many other scoring systems for different aspects of CF have been developed, mainly radiological, functional and clinical scores. However, the SK score is still the most widely used score, despite its subjectivity, lack of systematic application and its failure to consider the lung function test.

In this study we investigated the correlation between the SK score and other current parameters used to evaluate CF severity, such as forced expiratory volume in 1 second (FEV_1), 6-minute walk test (6-MWT), chest radiography (CXR) and chest computed tomography (CT). Our aim was to evaluate the current usefulness of the SK score in view of

the fact that a greater number of patients are now being detected at earlier stages of disease and thus present a milder version of the disease than patients in later stages.

MATERIALS AND METHODS

This was a cross-sectional prospective study. Data from clinical charts, radiological documents (CXR and CT), 6-MWT and spirometry of 43 patients with cystic fibrosis aged between 3 and 21 years and treated at the Cystic Fibrosis Center of Instituto da Criança – Hospital das Clínicas (São Paulo, Brazil) between June 2006 and August 2008 were analyzed. The diagnosis of CF was made according to established criteria.[6] Only patients with stable disease were included in this study. Exclusion criteria were pulmonary exacerbation[7] in the month preceding the tests or a chest CT carried out in the previous year. Spirometry, chest radiography and CT and the 6-MWT were all carried out on the same morning.

Of the 114 patients followed up at our CF clinic who were eligible for inclusion during the period of the study, 43 fulfilled all inclusion criteria and therefore comprise a convenience sample.

Shwachman-Kulczycki score

The SK score was calculated by two pediatric pulmonologists with expertise in CF. The SK score is divided into four domains—namely, general activity; physical examination; nutrition; and radiological findings; each having five possible subscores, according to the degree of impairment. The scores of the four domains are summed to obtain the final score, from which the condition of the patient is categorized as excellent (86-100), good (71-85), average (56-70), poor (41-55) or severe ($\leq$40).

Pulmonary Function Test

Spirometry was performed at the pulmonary function laboratory of Instituto da Criança in patients over 6 years, following the recommendations of the American Thoracic Society (ATS)[8] and using a master screen spirometer (Multispiro Creative Biomedics) (Natick, MA, United States). The following spirometric parameters were evaluated: forced vital capacity, FEV_1 and forced expiratory flow between 25 and 75% of vital capacity as a percentage of predicted values. The equations of Polgar and Promadhat[9] were used as a reference for subjects up to 17 years of age, and the equation of Knudson et al.[10] was used for patients aged between 18 and 21 years. The severity of the ventilatory obstruction was classified according to ATS criteria.[8]

Patients were divided into two groups according to FEV_1: $< 70\%$ and $\geq 70\%$. Patients with $FEV_1 \geq 70\%$ were considered as having mild lung disease.

Chest Radiography

The Brasfield score,[11] which considers 5 categories scored from 0 to 5—namely, air trapping, linear markings, nodular cystic lesions, large lesions and general severity, was used to evaluate CXR changes. The demerit points were then summed and subtracted from 25 to obtain the final score. Chest roentgenograms showing more severe changes received a lower score.

Chest CT Scan

The Bhalla score was used for tomographic analysis.[12] This score was calculated using nine categories—namely, severity of bronchiectasis, peribronchial thickening, extent of bronchiectasis, extent of mucus plugging, saculations or abscesses, generation of bronchial divisions involved, number of bullae, emphysema and collapse or consolidation. These categories were scored from 0 to 3, with a higher score indicating greater structural damage.

Scanning was performed with a GE LightSpeed Ultra CT Scanner (Minneapolis, USA). Thin-section CT scans were obtained using a beam current automatically adjusted by the machine (70-100 mA), an exposure time of 0.5 seconds, a beam potential of 120 kV from lung apex to lung base at 10 mm intervals using 1.25 mm thick single slices, non-volumetric and a field of view of 15-40 cm. All scans were reconstructed with a high spatial frequency algorithm (bone) and printed with window settings appropriate for the imaging of pulmonary parenchyma (window width -600 HU; window level 1.500 HU).

The radiographic and tomographic scores were calculated independently by three radiologists (two pediatric radiologists and a chest radiologist), who were blinded to the clinical and functional characteristics of the patients. The final score was the average of the three radiologists' scores.

Six-Minute Walk Test

All 6-MWTs were done using a 30 m lap, on a flat, hard surface, according to the ATS guidelines.[13] The patients were asked to walk for 6 minutes up and down the measured lap at their best pace, but not to run. Two tests were performed on the same day with an interval of at least 30 min and after all clinical variables had returned to their basal values. The distance was measured in meters and the test with the greatest distance was selected. The values were transformed into Z scores based on Geiger et al. data,[14] using the following formula: value found – normal value/standard deviation.

Statistical Analysis

Data were expressed as number of cases, mean and standard deviation or median. Linear regression (Spearman's correlation coefficient) was used for analysis of correlations between the tests, calculated by the GraphPadPrism 5 program. The significance level considered was $p < 0.05$.

This study was approved by the human ethics committee of Hospital das Clínicas – Medical School of University of

Table 1 - Characteristics of the patients (24 men, 19 women) with cystic fibrosis (n = 43).

Characteristics	M $\pm$ SD	R
Age (years)	10.5 $\pm$ 4.7	3.1-20.9
BMI-Z	-0.7 $\pm$ 1.2	-2.9-2.1
Z-6-MWT *	-1.1 $\pm$ 1.1	-4.07-0.6
FVC (% predicted)*	70.4 $\pm$ 25.9	20.4-126
FEV_1 (% predicted)*	59.2 $\pm$ 26	13.3-134.0
$FEF_{25-75\%}$ (% predicted)*	47.4 $\pm$ 35.8	4.8-172.4
Bhalla score (median)	10.0	2.3-19
Brasfield score (median)	17.0	6-23.7
Shwachman-Kulczycki score (median)	70	40-95

*n = 34.
BMI-Z = Z score of body mass index; $FEF_{25-75\%}$ = forced expiratory flow between 25 and 75% of vital capacity; FEV_1 = forced expiratory volume in 1 second, FVC = forced vital capacity; Z-6-MWT = Z score of 6-minute walk test.

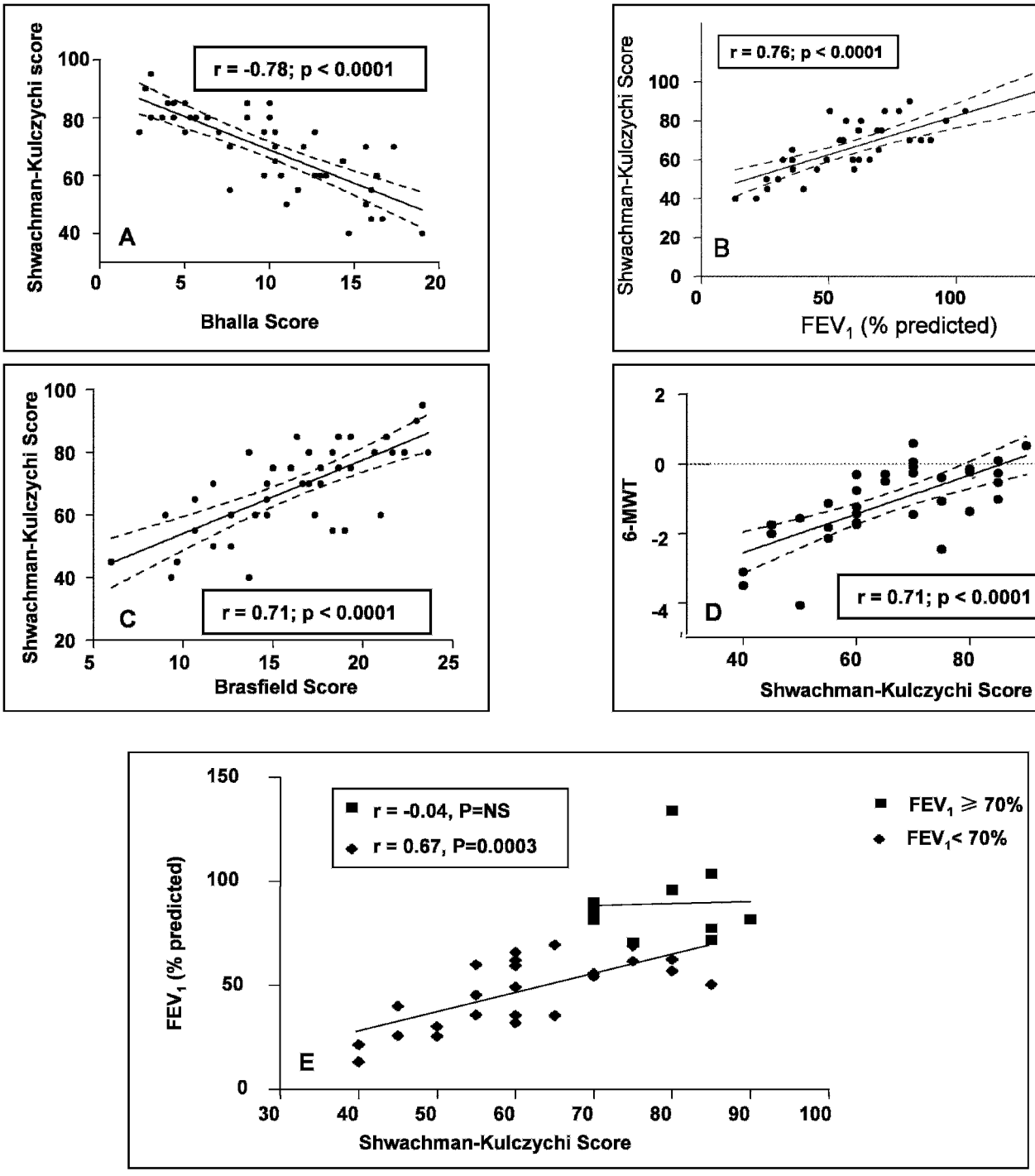

Figure 1 - (A) Correlation between the Bhalla score and the Shwachman-Kulczycki score; (B) correlation between FEV_1 and Shwachman-Kulczycki score; (C) correlation between the Brasfield score and Shwachman-Kulczycki score; (D) correlation between the 6-MWT and Shwachman-Kulczycki score; (E) correlation between $FEV_1 < 70\%$ and $\geq 70\%$ and the Shwachman-Kulczycki Score. FEV_1 = forced expiratory volume in 1 second; 6-MWT = 6-minute walk test.

São Paulo, Brazil. Written informed consent was obtained from all subjects or their parents.

RESULTS

Forty-three patients were studied, 19 female and 24 male, mean age 10.5 ± 4.7 years. The characteristics of the patients are listed in Table 1. Patients' average body mass index (BMI) was 16.5 ± 2.4 and their BMI Z score was –0.7 ± 1.2. Pulmonary function tests showed that 11 children had mild obstructive lung disease ($FEV_1 \geq 70\%$) or normal FEV_1 ($FEV_1 \geq 80\%$), seven moderate (FEV_1 = 60-69%), five moderately severe (FEV_1 = 50-59%), six severe (FEV_1 = 35-49%) and five very severe ($FEV_1 \leq 35\%$) disease.

The mean distance walked was 596 ± 69 m and the Z score of the 6-MWT was −1.1 ± 1.106.

For all patients the correlations between the SK score and Brasfield and Bhalla scores were calculated. In 34 patients aged > 6 years it was possible to calculate the correlations between SK score and FEV_1 and between SK score and Z-6-MWT. A significant correlation between all parameters was observed (Figures 1A-D).

When patients were divided into two groups according to FEV_1 (< 70% and ≥ 70%), a statistically significantly correlation was found between FEV_1 and the SK score only in patients with $FEV_1 < 70\%$ (Figure 1E).

DISCUSSION

In this study, the SK score correlated strongly and significantly with FEV_1, chest radiography and tomography and with the 6-MWT. The significant correlations between the SK score and chest CT, and between the SK score and 6-MWT, are novel findings reported in this study.

Previous studies showed strong correlations between the SK score and pulmonary function tests (r values ranging from 0.63 to 0.72 for FEV_1).[15-17]

Similar to our findings and despite having a better FEV_1, two retrospective studies in patients with CF in Brazil also found significant correlations between the SK score and FEV_1 ($r = 0.5$ and 0.75).[18,19]

To test if a strong correlation still exists between FEV_1 and the SK score for the severity of lung function impairment, patients were divided according to the degree of pulmonary involvement indicated by FEV_1. The correlation between FEV_1 and the SK score was significant only in patients with $FEV_1 < 70\%$ ($r = 0.67$, $p = 0.0003$), whereas in patients with $FEV_1 \geq 70\%$ no correlation with the SK score was found ($r = -0.04$).

One previous study tested a correlation between the 6-MWT and the SK score in 16 children with CF, aged 11 ± 1.9 years, with an FEV_1 of 63.1±21%, SK score of 69.4 ± 16 and 6-MWT of 598.2 ± 56.8 m.[20] Despite the similar characteristics of their patients to those of our study, no significant correlation was found, possibly owing to the smaller number of patients in their study than in ours. Another study also found no significant correlation between the 6-MWT and the SK score but in that study adolescents and adults with CF were evaluated,[21] which might account for the lack of correlation, because age is one of the sources of the 6-MWT variations, as reported in other studies.[14,22,23]

Although reference values for 6-MWT in Brazilian children have recently been published[22] we decided to use those of Geiger et al.[14] because our sample comprised patients up to 21 years old and the Brazilian data only included patients aged < 12 years. Nevertheless, the Brazilian data on reference values for the 6-MWT strongly correlated with the data of Geiger et al. ($r = 0.87$).

Correlations between the SK score and chest radiography have been observed since the late 1970s. Brasfield et al.[11]observed a significant correlation between the SK score and chest radiography ($r = 0.82$, $p < 0001$), while evaluating 643 chest radiographs of 118 patients with CF. Note that the correlation they found is higher than that found in our study ($r = 0.71$). Freire et al.[19] while evaluating 40 children with CF also found a significant correlation between the SK score and the Brasfield score ($r = 0.62$). The highest correlation observed in our study was between the SK score and CT ($r = -0.78$, $p < 0.001$). This correlation has not been previously described.

One limitation of our study is that it was cross-sectional, which precludes a longitudinal evaluation. Despite the high correlation found in our study between the SK score and both imaging and functional pulmonary data, it was not possible to assess whether or not the parameters (CXR, CT, FEV_1, 6-MWT and SK score) changed in a similar way.

The SK clinical score is criticized because it depends on the subjective clinical estimation of the examiner and lacks a domain that evaluates pulmonary function. Some authors even claim that because the SK score was developed in an era when patients were detected later and thus presented more severe disease, it is unlikely to be sufficiently sensitive to describe the spectrum of clinical features of milder disease; this is a great limitation of the SK clinical score in comparison with other evaluations. Our data indicate that the SK score may be more reliable in assessing the severity of CF in patients with greater impairment of lung function, reinforcing this limitation. However, it strongly correlated with other important outcome measurements currently used, such as radiographic and tomographic scores and the 6-MWT. Another limitation of the SK score is that its development was based on pediatric patients and some of the domains are specifically focused on children. Nevertheless, it is still used in many CF clinics and studies, even in older patients.[18,19,24]

CONCLUSION

In conclusion, the SK score remains a useful and simple tool for monitoring the severity of CF, adequately reflecting the functional impairment and chest radiography and tomography changes, especially in patients with greater impairment of lung function. When assessing patients with mild lung disease its limitations should be considered and its usefulness in such patients should be evaluated in larger populations.

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