

Correlation of Respiratory Oscillometry with CT Image Analysis in a Prospective Cohort of Idiopathic Pulmonary Fibrosis

Supplemental Materials

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Supplemental Table S1. Comparison of the IPF and Healthy Cohort

Data are shown as median (interquartile range). Statistics was performed using the Mann-Whitney U test.

	IPF (n = 89)	Healthy Subjects (n=45)	P-value
Sex (M/F)	60/29	16/29	
Age	70.6 (10.4)	37.5 (15.3)	<0.0001
Height (cm)	168.0 (13.0)	168.0 (11.0)	0.62
Weight (kg)	76.7 (19.3)	67.0 (25.0)	0.006
BMI	27.1 (4.1)	23.7 (6.1)	<0.0001
Smoking Status			
Never smoked	34	45	<0.0001
Ex-smoker < 20 pack years	28	0	
Ex-smoker ≥ 20 pack years	27	0	
FVC (L)	2.5 (1.0)	4.0 (1.3)	<0.0001
%Pred FVC	67.4 (23.1)	97.5 (4.9)	<0.0001
FEV ₁ (L)	2.0 (0.8)	3.3 (0.9)	<0.0001
%Pred FEV ₁	74.6 (24.2)	96.1 (7.1)	<0.0001
FEV ₁ /FVC	80.3 (6.8)	80.7 (4.1)	0.67
R5 (cm H ₂ O·s/L)	3.4 (1.2)	3.1 (1.1)	0.01
%Pred R5	113.6 (36.5)	108 (29.9)	0.038
R19 (cm H ₂ O·s/L)	2.8 (1.0)	3.0 (1.1)	0.23
%Pred R19	98.5 (29.9)	105.8 (30.5)	0.49
R5-19 (cm H ₂ O·s/L)	0.6 (0.6)	0.0 (0.4)	<0.0001
%Pred R5-19	245.1 (409.3)	54.4 (293.2)	0.99
X5 (cm H ₂ O·s/L)	-2.1 (1.1)	-1.0 (0.4)	<0.0001
%Pred X5	171.9 (87.6)	95.7 (35.3)	<0.0001
X5in (cm H ₂ O·s/L)	-2.1 (1.1)	-1.0 (0.4)	<0.0001
X5ex (cm H ₂ O·s/L)	-2.0 (1.4)	-0.9 (0.5)	<0.0001
ΔX5 (cm H ₂ O·s/L)	-0.3 (0.5)	-0.1 (0.2)	<0.0001
AX (cm H ₂ O/L)	12.8 (12.8)	3.1 (2.6)	<0.0001
%Pred AX	413 (408)	133 (94)	<0.0001
Fres (Hz)	21.3 (5)	11.5 (3.7)	<0.0001
%Pred Fres	167 (47)	107 (28)	<0.0001
ReE (cm H ₂ O·s/L)	3.0 (1.2)	2.4 (0.8)	0.001
ReI (cm H ₂ O·s/L)	2.2 (0.8)	2.1 (0.8)	0.123
ReE-ReI (cm H ₂ O·s/L)	0.7 (0.8)	0.5 (0.4)	0.01
(ReE-ReI)/VT (cm H ₂ O·s/L ²)	1.0 (1.0)	0.5 (0.5)	<0.001
XeE (cm H ₂ O·s/L)	-0.3 (0.7)	0.2 (0.4)	<0.001
XeI (cm H ₂ O·s/L)	-0.7 (0.8)	0.1 (0.3)	<0.001
XeE-XeI (cm H ₂ O·s/L)	0.4 (0.6)	0.1 (0.2)	<0.001
(XeE-XeI)/VT (cm H ₂ O·s/ L ²)	0.6 (0.7)	0.1 (0.3)	<0.001

Supplemental Table S2. Comparison of PFT and Osc parameters based on smoking status

	Never Smoked	< 20 pack years	≥ 20 pack years	P-value
Sex (M/F)	16/18	20/8	24/3	
Age	69.9 (10.7)	72.4 (9.5)	70.2 (8.7)	0.83
Height (cm)	163 (16.8)	168.5 (10.5)	170.0 (15.5)	0.02
Weight (kg)	70.2 (19.0)	76.2 (16.2)	80.6 (13.5)	0.02
BMI	26.8 (5.6)	27.2 (4.1)	27.4 (3.3)	0.43
FVC (L)	2.2 (0.9)	2.7 (0.8)	2.9 (1.0)	0.03
%Pred FVC	66.3 (32.2)	72.4 (18.2)	66.3 (16.3)	0.69
FEV ₁ (L)	1.8 (0.8)	2.1 (0.8)	2.3 (0.8)	0.02
%Pred FEV ₁	76.1 (32.5)	75.2 (16.6)	70.4 (22.0)	0.47
FEV ₁ /FVC	80.1 (8.1)	81.0 (6.2)	78.4 (6.6)	0.85
TLC (L)	4.0 (1.1)	4.2 (1.3)	4.5 (1.2)	0.10
%Pred TLC	69.6 (23.2)	69.5 (13.6)	65.7 (7.9)	0.70
DLCO (mL/min/mmHg)	10.6 (3.7)	9.2 (6.0)	9.3 (4.8)	0.75
%Pred DLCO	65.4 (23.9)	60.4 (18.4)	56.9 (22.3)	0.13
R5 (cm H ₂ O·s/L)	3.6 (2.0)	3.2 (1.0)	3.5 (0.6)	0.24
%Pred R5	115.0 (29.2)	110.3 (23.1)	119.3 (45.6)	0.26
R19 (cm H ₂ O·s/L)	2.9 (1.1)	2.6 (1.0)	2.7 (0.8)	0.50
%Pred R19	101.0 (22.0)	96.6 (29.0)	101.2 (46.8)	0.10
R5-19 (cm H ₂ O·s/L)	0.7 (0.8)	0.5 (0.6)	0.6 (0.6)	0.24
%Pred R5-19	171.7 (535.0)	264.5 (308.5)	252.3 (280.8)	0.38
X5 (cm H ₂ O·s/L)	-2.4 (1.6)	-1.9 (1.1)	-1.8 (0.9)	0.001
%Pred X5	186.5 (88.1)	141.8 (81.6)	171.4 (71.5)	0.009
X5 _{in} (cm H ₂ O·s/L)	-2.5 (1.3)	-2.0 (1.0)	-1.8 (0.9)	0.001
X5 _{ex} (cm H ₂ O·s/L)	-2.2 (1.7)	-1.7 (1.0)	-1.8 (0.9)	0.005
ΔX5 (cm H ₂ O·s/L)	-0.3 (0.5)	-0.2 (0.4)	-0.2 (0.4)	0.97
AX (cm H ₂ O/L)	16.6 (16.8)	10.3 (9.7)	11.8 (11.7)	0.006
%Pred AX	440.5 (455.8)	338.8 (207.0)	438.4 (335.6)	0.07
Fres (Hz)	22.5 (8.0)	20.1 (5.3)	21.4 (3.0)	0.07
%Pred Fres	177.0 (51.2)	155.3 (39.7)	169.4 (40.1)	0.07
ReE (cm H ₂ O·s/L)	3.3 (1.6)	2.1 (0.8)	2.9 (0.8)	0.36
ReI (cm H ₂ O·s/L)	2.3 (1.0)	2.1 (0.8)	2.1 (0.6)	0.12
ReE-ReI (cm H ₂ O·s/L)	0.7 (0.6)	0.7 (0.9)	0.7 (0.9)	0.78
(ReE-ReI)/VT (cm H ₂ O·s/L ²)	1.0 (1.1)	1.1 (0.9)	0.8 (1.0)	0.41
XeE (cm H ₂ O·s/L)	-0.4 (0.8)	-0.2 (0.5)	-0.2 (0.4)	0.05
XeI (cm H ₂ O·s/L)	-0.8 (0.6)	-0.5 (0.6)	-0.7 (0.7)	0.09
XeE-XeI (cm H ₂ O·s/L)	0.4 (0.4)	0.2 (0.4)	0.4 (0.4)	0.47
(XeE-XeI)/VT (cm H ₂ O·s/L ²)	0.5 (0.9)	0.4 (0.7)	0.6 (0.6)	0.74

Data shown are median (interquartile range). Statistics was performed with One-Way ANOVA.

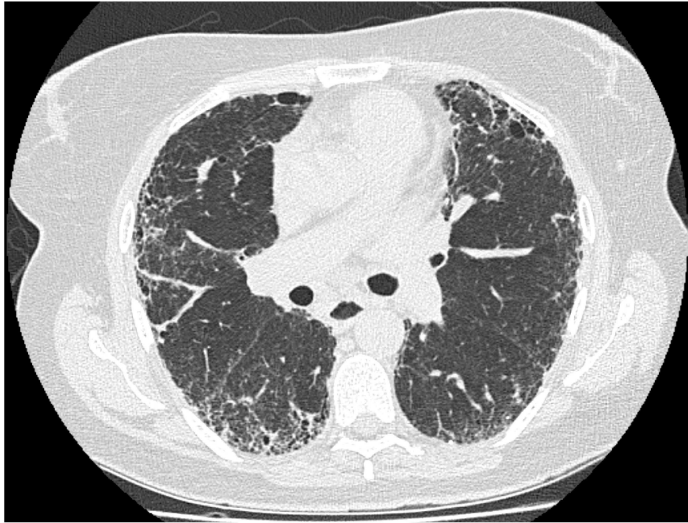
Supplemental Table S3. Summary of Automated Lung Texture CT Analyses

	(n=26)
TLC_{CT} (L)	3.5 ± 1.1
PVV	5.3 ± 2.4
% Normal volume	76.9 ± 15.9
ILD extent	20.8 ± 16.3
% Ground glass	15.6 ± 13.3
% Reticular	4.9 ± 4.2
% Honeycomb	0.3 ± 0.4

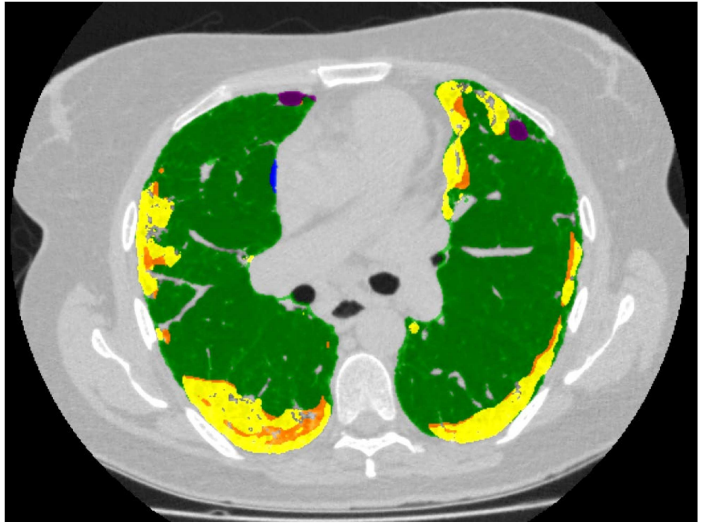
Data are shown as mean ± standard deviation. ILD extent = sum of %ground glass, %reticular and %honeycomb; PVV = pulmonary vessel volume; TLC_{CT} = total lung capacity measured by computed tomography.

Supplemental Figure S1. Example of high resolution CT scan images in patient with IPF analyzed with the Lung Texture Analysis. (A) Single axial non-contrast image in lung windows demonstrates subpleural ground glass opacity, reticulation, traction bronchiectasis, and mild honeycombing. (B) Automated quantitative CT segments the lung from the chest and identifies normal (green), ground glass (yellow), reticular (orange), and honeycomb (purple) textures.

A



B



Supplemental Figure S2. Correlations between Conventional PFTs and CT-derived Metrics

The coefficient of determination, R^2 was derived using polynomial with 2 degrees regression. Similar observations (not shown) were made using linear and exponential regression.

	%FVC	FVC	%FEV₁	FEV₁	%TLC	TLC	%DLCO	DLCO
TLC_{CT}	0.244	0.663	0.535	0.628	0.460	0.628	0.000	0.091
PVV	0.117	0.247	0.077	0.171	0.598	0.479	0.092	0.252
ILD Extent	0.180	0.258	0.159	0.216	0.715	0.385	0.089	0.149
% Ground Glass	0.244	0.305	0.204	0.270	0.811	0.338	0.095	0.099
% Reticular	0.004	0.011	0.000	0.001	0.148	0.306	0.079	0.180
% Honeycomb	0.000	0.000	0.000	0.027	0.000	0.000	0.322	0.267

ILD extent = sum of %ground glass, %reticular and %honeycomb; PVV = pulmonary vessel volume; TLC_{CT} = total lung capacity measured by computed tomography.