Idiopathic pulmonary fibrosis (IPF) on high resolution computed tomographic (HRCT) radiological correlation

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Abstract

Background: Idiopathic pulmonary fibrosis (IPF) is a distinctive type of chronic fibrosing interstitial pneumonia of unknown cause. It is limited to lungs and is associated with histopathological pattern of interstitial inflammation, fibrosis, and honey comb change. Pulmonary function test shows restrictive pattern with reduced lung volume and impaired gas exchange. IPF has poor prognosis with median survival of 2.5 to 3.5 years after the time of diagnosis.

Aims and Objectives: To retrospectively evaluate computed tomographic (CT) images and pulmonary function test results and visual CT scoring test results as predictors of severity of disease.

Material and Method: An observational case series. Using a scoring system, HRCT findings in 100 patients were scored, and different groups were made depending on imaging features and these findings were compared with pulmonary function tests (PFT) results.

Results: Out of 100 patients studied 38 were males, and 62 were females. Average age of the study sample was 65.22 years. FEV1/FVC ratio in females was lower than that in males.

Traction bronchiectasis has statistically significant reduction in FEV1/FVC, FVC and DLCO (diffusion capacity of carbon monoxide) value. Patients with higher scores of interstitial fibrosis has statistically significant reduction in FVC and DLCO value. Patients with disease close to hilum has statistically significant reduction in FVC value. Patients with higher scores of architectural distortion has statistically significant reduction in FEV1/FVC.

Conclusion: HRCT scoring of IPF helps in assessing the clinical severity of the patient's symptoms and can be used to convey it to clinicians.

Key words: IPF, HRCT, Radiological and clinical correlation

Introduction

Idiopathic pulmonary fibrosis (IPF) is a distinctive type of chronic fibrosing interstitial pneumonia of unknown cause. It is limited to lungs and is associated with histopathological pattern of interstitial inflammation, fibrosis, and honey comb change[1]. Pulmonary function test (PFT) shows restrictive pattern with reduced lung volume and impaired gas exchange[2]. IPF has poor prognosis with median survival of 2.5 to 3.5 years after the time of diagnosis[1].

The pathogenesis of IPF is unknown. In the past, it was believed that the earliest histologic abnormality was alveolitis and that this inflammatory process lead to progressive fibrosis. This theory is no longer accepted. The current hypothesis is that the pathogenesis of IPF likely involves several components, including repetitive lung injury, inflammation, exaggerated deposition of collagen and extracellular matrix, recruitment and proliferation of fibroblast, and inappropriate wound healing response[3,4].

Although lung biopsy is required for definitive diagnosis of IPF, it is currently widely accepted that

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a confident diagnosis of IPF can often be made on a combination of clinical and HRCT findings. Joint statement of ATS and ERS concluded that, in absence of open lung biopsy confirmation of UIP, a diagnosis of IPF may be considered likely in presence of four major criteria and three of four minor criteria[1,5-7].

Aims and Objective

To retrospectively evaluate computed tomographic (CT) images and pulmonary function test results and visual CT scoring test results as predictors of severity of disease.

Material and Methods

This is an observational study includes 100 patients who underwent HRCT chest from July 2011 to June 2013. Their HRCT scoring, clinical symptoms and PFT (pulmonary function test) results were compared.

HRCT scanning was done on SIEMENS SOMATOM EMOTION 16 slice machine. Scanning is done at 100 to 160 mAs and 100 to 140 kV, viewed at -1600w,

Imaging findings were graded using a scoring system[8]. In this system lungs are divided into six zones, upper, mid and lower on both sides. Upper zone is considered up to carina (Figure 1), lower zone is below the level of inferior pulmonary veins (Figure 2), and mid zone is in between these two levels.

Score was based on more than 5% of lung parenchyma involvement.

1. Extent of traction bronchiectasis

   Grade O –none, Grade 1 –bronchial dilatation involving bronchi distal to fifth generation bronchi, Grade 2 –bronchial dilatation involving fourth generation bronchi, Grade 3 - bronchial dilatation involving bronchi proximal to third generation bronchi.

2. Architectural distortion

   Grade O- none,Grade 1 – present.

3. Interstitial fibrosis

   Grade O – none, Grade 1 – ground glass attenuation without reticulation, Grade 2 - ground glass attenuation with fine reticular opacity, Grade 3 – reticular opacity and microcyst less than 3 mm in diameter,Grade 4

   – coarse reticular opacity and cyst more than 3 mm in diameter.

4. Extent of disease close to hilum

   Grade O - none, Grade 1 - abnormal parenchyma distal to fifth generation bronchi, Grade 2 - abnormal parenchyma distal to fourth generation bronchi, Grade 3 - abnormal parenchyma proximal to fourth generation bronchi.

And overall impression about lung involvement was made whether homogenous or heterogeneous involvement of the lung. Predominant distribution of the lung involvement was determined, whether symmetric or asymmetric, upper, mid or lower zone predominance, or peripheral dependent densities, or peribroncho vascular involvement[9,10].

Results

Using a scoring system, HRCT findings in 100 patients were scored, and different groups were made depending on imaging features. And these findings were compared with PFT results. Out of 100 patients studied 38 were males, and 62 were females. With mean age of male being 66.21 years and that of females being 64.61. Average age of the study sample was 65.22 years. FEV1/FVC ratio in females was lower than that in males. The average ratio in males being 118.4 and that in the females being 113.5 and the ratio for the sample being 115.4. These changes can be physiological between the two genders. Even the same trend was seen in FVC calculation, 55.0 for male, 51.9 for females and combined values being 53.1.

Traction bronchiectasis was graded from 0 to 3 grades, and each lobe of lung was graded using this grading. Total traction bronchiectasis score was calculated by adding score of all the six lobes of both lungs. Total score was grouped in two groups, one being <=6, and other >6. Finding included that group with score <=6, had 64 patients, where as other group had 36 patients. Patients in <=6 group had 117.9 as average FEV1/FVC ratio, and >6 group had 110.8 as average ratio. The difference between these two groups is statistically significant with p value being 0.0001.

FVC value in <=6 group was 61.69, and that in >6 group was 37.9. The difference in this case was statistically significant, with p value being 0.0001. DLCO value in <=6 was 37.75 and in >6 group was 27.07. This difference is also statistically significant with p value <0.0001. This means that patients in >6 group, meaning advance stage of disease had significant decrease in FEV1/FVC, FVC and DLCO level.

Architectural distortion was graded as "0" or "1", depending on whether distortion present or absent. Total score of both lung was divided in two groups of <=3 and >3. The group <=3 had 48 patients, and other group of >3 had 52 patients. Patients in <=3 group had mean FEV1/FVC ratio of 117.7 and patients in group >3 had 113.2. This difference in FEV1/FVC ratio of both groups is statistically significant, with p value being 0.0042. Whereas FVC values of both groups is not statistically significant with p value being 0.4.

DLCO value in <3 was 38.25 and in >3 group was 33.24. This difference is also statistically significant with p value 0.02. Interstitial fibrosis was graded from 0 to 4 grades and depending on total score, two groups of <=12 and >12 were made. In the <=12 group 34 patients were there, and in >12 group 66 patients were there. FEV1/FVC ratio in group <= 12 is 117.0 and in group >12 is 114.5. This difference in both groups is statistically insignificant with p value being 0.13. Whereas FVC in <=12 group is 61.69 and in group >12 is 48.72. These differences in both these groups were statistically significant, p value being 0.0003. This means that in patients with advanced changes of interstitial fibrosis has decreased FVC value.

DLCO value in <=12 was 38.79 and in >12 group was 33.06. This difference is also statistically significant with p value 0.006. Disease close to hilum was graded from "0" to grade "3". And total lung score was divided in two groups of <=6 and >6. Total number of patients in <=6 group are 34 and those in >6 group is 66. FEV1/FVC ratio in group <=6 was 116.7 and in >6 group is 114.7 with p value of 0.22. Whereas FVC values in <=6 group was 66.7 and that in >6 group was 46.1. This finding is statistically significant as p value for this finding is <0.0001. This suggests that in patients in whom disease is located more close to hilum, there is significant reduction of FVC value.

Table 1. Comparison of HRCT scoring of IPF and PFT results

Parameter			Age		FEV1/FVC		FVC		DLCO	
		N	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Male	38	66.2	10.4	118.5	8.1	55.1	19.4	33.8	10.6
	Female	62	64.6	12.7	118.5	7.1	51.9	15.9	37	6.5
	Combined	100	65.2	11.8	115.5	7.9	53.1	17.3	35.7	8.5
	P Value		0.T51		0.0019		0.38		0.13	
Traction Bronchiectasis	≤ 6	64			117.9	7.6	61.7	14.1	37.7	7.5
	>6	36			110.8	6	37.9	11	27	6.6
	Combined	100			115.4	7.9	53.1	17.3	35.7	8.5
	P Value				0.0001		0.0001		0.0001	
Architectural distortion	≤ 3	48			117.7	7.2	54.7	14.6	38.3	9.4
	>3	52			113.3	7.9	51.7	19.6	33.2	6.7
	combined	100			115.4	7.9	53.1	17.3	35.7	8.5
	P Value				0.0042		0.4		0.02	
Interstitial fibrosis	≤ 12	48			117	7.3	61.7	13.2	38.8	5.5
	>12	52			114.5	8	48.7	17.6	33	9.8
	Combined	100			115.4	7.9	53.1	17.3	35.7	8.5
	P value				0.13		0.0003		0.006	
Disease close to Hlium	≤ 6	34			116.7	8.9	66.8	11.3	37.9	5
	>6	66			114.7	7.3	46.1	15.7	33.9	10.4
	Combined	100			115.4	7.9	53.1	17.3	35.7	8.5
	P value				0.22		<0.0001		0.06	

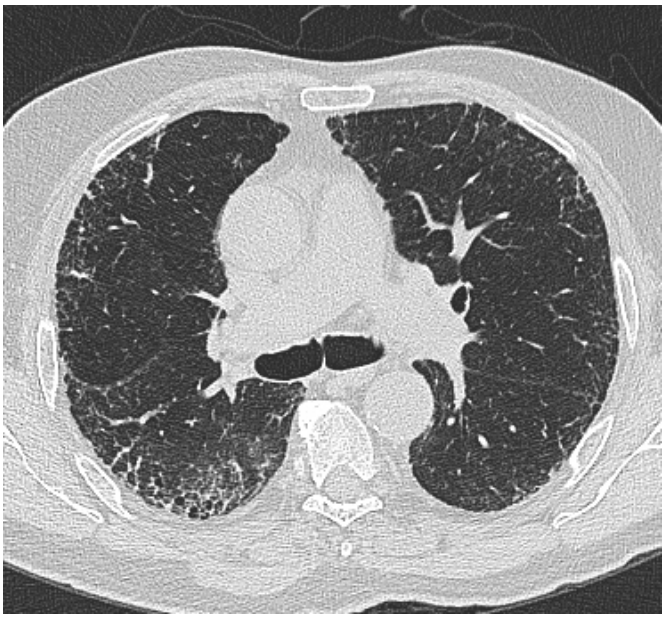

Figure 1. Upper zone: HRCT above the level of carina

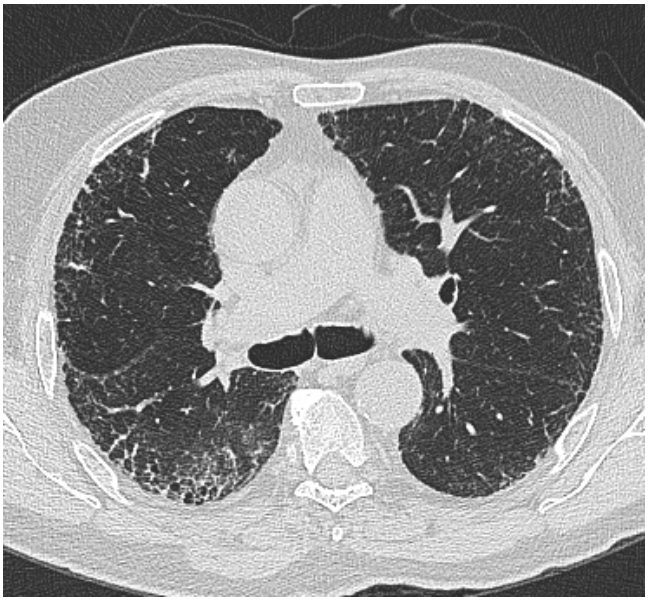

Figure 2. Lower zone: HRCT below the level of inferior pulmonary veins

Discussion

HRCT has become a central component of the diagnostic evaluation of patients with suspected IPF and guidelines for HRCT evaluation have been generated. Scans considered consistent with IPF were significantly more likely to show honeycombing, traction bronchiectasis and bronchiolectasis, and lower lobe volume loss, and less likely to show ground glass attenuation, decreased attenuation, mosaic attenuation, and centrilobular nodules than scans not consistent with IPF. In this study 100 patients were studied with females being more affected than the males which are comparable to previous study by Charlene D. Fell, Fernando J et al[11]. Male's age is higher than the female's and females are affected more severely than the males. Obstructive and restrictive features are more in females than males. However no significant difference between males and females in gas exchange across the lungs. The traction bronchiectasis severity was less observed and patients with higher scores of traction bronchiectasis were severely affected even for CO gas diffusion[12,13].

Architectural distortion and close to hilum patterns patients did not have significant diffusion of CO differences between the low and high scores groups. Interstitial fibrosis pattern high score patients show reduced diffusion of CO suggesting lesser ability to gas exchange across the lungs[14-18]. Overall patients with high scores of traction bronchiectasis and interstitial fibrosis have significantly reduced gas exchange across the lungs. Hence the HRCT scoring of the severity of IPF gives more reliable results in terms of patient's clinical symptoms and easy to compare the progression and can be incorporated into the clinical practice.

Conclusion:

In conclusion patients with higher scores of traction bronchiectasis has statistically significant reduction in FEV1/FVC, FVC and DLCO value . Patients with higher scores of interstitial fibrosis has statistically significant reduction in FVC and DLCO value. Patients with disease close to hilum has statistically significant reduction in FVC value. Patients with higher scores of architectural distortion has statistically significant reduction in FEV1/FVC.

Statistically insignificant reduction in FVC value is seen in patients with higher score of architectural distortion. Statistically insignificant reduction in FEV1/FVC values is seen in interstitial fibrosis and disease close to hilum.

Limitation of study:

Cases which were included in this study were diagnosed cases of IPF with said imaging features, so many early IPF cases in which diagnosis was in doubt, or had other differential diagnosis in consideration were excluded from the study.

As this is a retrospective study, HRCT and PFT was

not done at same time, in some cases both the examinations were done three to four weeks apart. However this will not change interpretation to great extent, as IPF is a chronic long standing disorder.

This is an observational study, and only HRCT finding and PFT results were compared at a certain point in the disease processes, the progression of the disease cannot be predicted.

DLCO is more accurate in measuring interstitial involvement and gas exchange across the alveolar membrane. But in many cases it was difficult to measure, as patients could not hold breath for 10 sec, which is minimum time required for measurement of DLCO.

References

1. *Richard Webb W, Nestor LM, David P, Naidich High Resolution CT of the lung. Fourth Edition, Lippincott, Williams and Wilkins A Wolters Kluwer business, 530 Walnut Street, Philadelphia PA, 19106 USA.*
2. *Antoni Xaubet, Carles Agustí, Patricio Luburich, Pulmonary Function Tests and CT Scan in the Management of Idiopathic Pulmonary Fibrosis. American Journal Of Respiratory And Critical Care Medicine. 1998;158*
3. *Thin-Section CT of the Secondary Pulmonary Lobule: The 2004 Fleischner Lecture Radiology. May 2006;239(2).*
4. *Robert M. Strieter. Pathogenesis and natural history of usual interstitial pneumonia: The whole story or the last chapter of a long novel Chest 2005; 128:526S-532S.*
5. *Baskaran Sundaram, Barry H. Accuracy of High-Resolution CT in the Diagnosis of Diffuse Lung Disease: Effect of Predominance and Distribution of Findings.2008, AJR; 191:1032– 1039.*
6. *Hiroaki Arakawa, Koichi Honma. Honeycomb Lung: History and Current Concepts. AJR 2011; 196:773 –782.*
7. *David A. Lynch, J. David Godwin , High-Resolution Computed Tomography in Idiopathic Pulmonary Fibrosis Diagnosis and Prognosis. American Journal Of Respiratory and Critical Care Medicine. 2005;172 :488-493.*
8. *Hiromitsu Sumikawa, Takeshi Johkoh Computed Tomography Findings in Pathological Usual Interstitial Pneumonia Relationship to Survival. American Journal Of Respiratory And Critical Care Medicine. 2008;177: 433-39.*
9. *Ruppel GL. Manual Of Pulmonary Function Testing. 7th edition. USA: Mosby publications; 1997*
10. *Steven D. Nathan; Oksana A. Shlobin,Pulmonary Hypertension and Pulmonary Function Testing in Idiopathic Pulmonary Fibrosis. Chest.2007; 131:657-63.*
11. *Charlene D. Fell, Fernando J. Martinez, Lyrica X. Liu, Susan Murray, MeiLan K. Han et al.Clinical Predictors of a Diagnosis of Idiopathic Pulmonary Fibrosis. Am J Respir Crit Care Med 2010;81:832–7.*
12. *Fernando J. Martinez,Kevin Flaherty. Pulmonary Function Testing in Idiopathic Interstitial Pneumonias. Proceedings Of the American Thoracic Society. 2006; 3 : 315-21.*
13. *Shigeki Misumi, David A.Idiopathic Pulmonary Fibrosis/Usual Interstitial Pneumonia.Lynch Proceedings Of the American Thoracic Society. 2006;3: 307-14.*
14. *Carolina Althoff Souza, Nestor L. Müller,Idiopathic Pulmonary Fibrosis: Spectrum of High-Resolution CT Findings. AJR 2005; 185:1531–9.*
15. *Alan C. Best, Jiangfeng Meng, Idiopathic Pulmonary Fibrosis: Physiologic Tests, Quantitative CT Indexes, and CT Visual Scores as Predictors of Mortality. Radiology. March 2008;246:*
16. *Chen N, Yang ZG, Yu JQ. Idiopathic pulmonary fibrosis: correlation between helical CT findings and pulmonary function test results. PMID: 14981827 [PubMed - indexed for MEDLINE]*
17. *Denial Hanson, Richard H Winterbauer, Changes in Pulmonary Function Test Results After 1 Year of Therapy as Predictors of Survival in Patients With Idiopathic Pulmonary Fibrosis. Chest 1995; 108 ;305-10*
18. *Bourke SJ.Interstitial lung diseases: progress and problem. Postgrad Med J 2006; 82:494– 9.*

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