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Original Research Article

Evaluation of CT Findings in Different Patients with Idiopathic Pulmonary Fibrosis

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Abstract: ***Background:*** Idiopathic pulmonary fibrosis (IPF) is a chronic disease that progresses over time and is characterized by scar tissue within the lungs in the absence of a particular triggering factor. IPF disease severity has traditionally been characterised using terms such as mild, moderate, or extreme. HRCT provides a correct diagnosis of IPF while preventing histological confirmation and interventional procedures. ***Objective:*** Purpose of the study is to elaborate different HRCT findings in patients with IPF and their correlation with oxygen saturation to determine disease severity. ***Materials and Methods:*** A descriptive cross-sectional study was conducted in a private sector hospital in Gujranwala named "Gondal Medical and Diagnostic Complex". Total 80 patients were engaged in the study. HRCT was performed on Aquillion 64 slice CT scanner with 1.0 or 2.0 mm thick focal segments taken at 2 cm intervals from around the entire chest and then reconstructed. ***Results:*** In this study of 80 patients majority were male (62.5%), while the most common age associated with this disease was 41-50yrs (28.7%), the patients having asthmatic history was 30% and 25% had both smoking and asthma history, 47.5% patients having O_2 saturation between 86-90% while the patients having both smoking and asthma history had shown GGO, RP along with honey combing and indicated disease severity by having worse rate of oxygen desaturation as compared to patients having only RP and GGO with better O2 saturation rate to some extent. So, honey combing with different CT features following asthma history in a patient were noted to have worse oxygen desaturation rate which was a brittle sign of disease severity. ***Conclusions:*** HRCT is a useful tool for estimating disease severity by correlating clinical histories and O2 desaturation rate with HRCT findings without histological verification and invasive procedures.

Key words: GGO, Honey combing, Reticular patterns, O_2 saturation, Asthma, Idiopathic pulmonary fibrosis.

INTRODUCTION

Idiopathic pulmonary fibrosis (IPF) has become a progressive condition that develops over many years and is identified by scar tissue inside the lungs in the absence of specific triggering [1]. Exercise-induced shortness of breath and persistent dry cough are prominent signs. Idiopathic pulmonary fibrosis belongs to class of lung disorders defined as interstitial lung diseases or, most specifically, diffuse parenchymal lung diseases [1]. IPF also defined as cryptogenic fibrosis alveolitis it is one of a class of idiopathic pneumonias that share the clinical characteristics of breathing difficulties, radiographically identifiable diffuse pulmonary infiltrates, and various degrees of inflammation or fibrosis [1, 2]. The clinical condition is extensive, but the majority of patients suffer from elevated dyspnea and pulmonary function loss, but the

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prognosis is low [2, 3]. The overall survival rate from the onset of disease or diagnosis is 2.5-3.5 years [3, 11].

High-resolution chest CT plays a key role in the initial assessment of patients suspected of developing idiopathic pulmonary fibrosis also the findings significantly affect further treatment decisions [4]. The widely accepted HRCT protocol that used to examine the diffuse lung disease.is volumetric acquisition of thin slices (typically ≤1·5 mm) coupled with high frequency reconstruction algorithm [4, 6, 8] Acquisition of Volumetric computed tomography is preferable to non-adjacent imaging because it enhances the identification of patchy disease and the degree of disease delineation, illustrates the spread of disease, enables detection of ancillary effects, promotes the distinction between honeycombing and bronchiectasis in absence of tiny nodules or substantial ground-glass opacification, also optimizes correlation through follow-up images to determine progression or recovery [5, 11].

Long-term survival or reaction to corticosteroid therapy correlates with histological variations. The optimum reaction to steroid was observed in patients with significant disease activity and less fibrosis [6]. To our awareness, open lung biopsy is the most accurate procedure for assessing the activity of the disease [3, 6]. Being functionally heterogeneous, there is a gradual development in certain persons to a sequential failure of lung function resulting in early collapse, while developing more acutely with intervals of significant symptomatic and physiological consistency in others [7, 8] One approach for determining the extent of IPF disease is by staging its severity using information derived from pathological, radiological, and physiological assessments. IPF disease severity has historically been defined using erroneous words such as mild, moderate, or severe, might be early or advance stage. [7]. The 2015 ATS/ERS/JRS/ALAT recommendations conditionally prescribed pirfenidone for the management of patients with IPF due to their potential to decrease functional deterioration and development of the disease with an appropriate protection and efficacy profile [8, 9] HRCT is a crucial part of the assessment of patients at risk of having IPF [10].

The estimation of disease progression over a period and the analysis of disease behaviour is essential for optimal care for patients. HRCT is integral component for IPF diagnostic work-up [4, 8]. High resolution computed tomography makes a definitive diagnosis of IPF, while eliminating the need for histological verification and invasive procedures [8, 10, 11]. The prevalence of Idiopathic pulmonary fibrosis seems to be growing, but it is not clear if this represents improved awareness or a significant rise in incidence. [12, 13] In north America, the prevalence of idiopathic pulmonary fibrosis was estimated to range from 10 to 60 cases per 100,000, however in one study, the prevalence of idiopathic pulmonary fibrosis was 494 cases per 100,000 in 2011 for adults aged 65 years, that was double the prevalence documented ten years earlier [12, 14, 15]. Though its occurrence could be lower in Asia and Latin America, where it was recorded to range between 0·5 to 4·2 cases per 100,000 persons a year [13, 19].

MATERIALS AND METHODS

It is a descriptive cross-sectional study which was performed in a private sector hospital of district Gujranwala named "Gondal Medical and Diagnostic Complex" during my rotation there. This study was conducted in the duration of 3 months during my internship. Total 80 patients were enrolled in the study on the basis of inclusion and exclusion criteria and a data sheet is specifically designed to gather data about the patient's age, gender, smoking history, asthma history and to measure Oxygen (O_2) saturation to analyse that what is the relation between O_2 saturation and disease severity.

Inclusion Criteria

All the patients having shortness of breath as a chief complaint, age above 20 years, mostly patients with smoking and asthma history or at least with one of such history were enrolled for this study. (all the data and history were taken with the consent of the patient and kept confidential throughout the study).

Exclusion Criteria

All the patients below age 20 years were excluded, pregnant females and the patients having contrast reaction history were also excluded from the study.

High resolution computed tomography

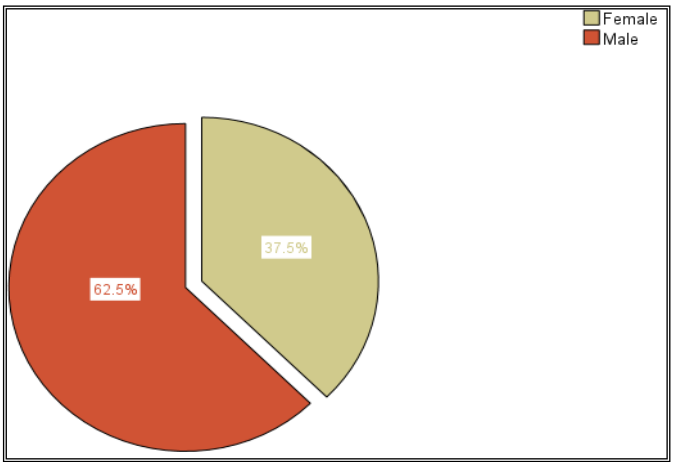
HRCT was performed in every patient registered in the study on AQUILLION computed tomography scanner (64 slice scanner) in the Multislice CT scan department of Gondal medical and diagnostic complex. HRCT was performed with 1.0 or 2.0 mm thick focal segments taken at 2 cm intervals from around the entire chest and then reconstructed. Per patient's scan 25 to 30 CT filter images were gained. A radiologist from the Clinical Centre evaluated the high-resolution computed tomography scans of every patient. Ground glass opacities, reticular pattern, and honey combing were the main evaluating factors in the patient's CT scans of current study to determine how they vary in patients with different histories.

STATISTICAL ANALYSIS

Whole data sheet statistical analysis was performed on statistical package for social sciences (SPSS) version 20.

Table-1: Distribution based on Gender

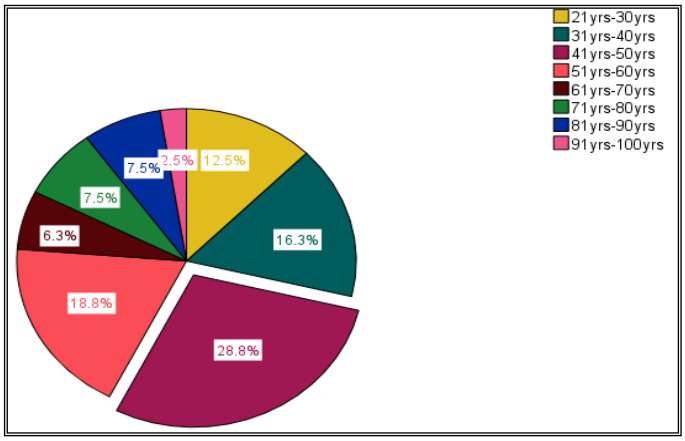
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	30	37.5	37.5	37.5
	Male	50	62.5	62.5	100.0
	Total	80	100.0	100.0	



Graph-1: Shows the distribution of study population according to gender

Table-2: Distribution based on Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	21yrs-30yrs	10	12.5	12.5	12.5
	31yrs-40yrs	13	16.3	16.3	28.7
	41yrs-50yrs	23	28.7	28.7	57.5
	51yrs-60yrs	15	18.8	18.8	76.3
	61yrs-70yrs	5	6.3	6.3	82.5
	71yrs-80yrs	6	7.5	7.5	90.0
	81yrs-90yrs	6	7.5	7.5	97.5
	91yrs-100yrs	2	2.5	2.5	100.0
	Total	80	100.0	100.0	

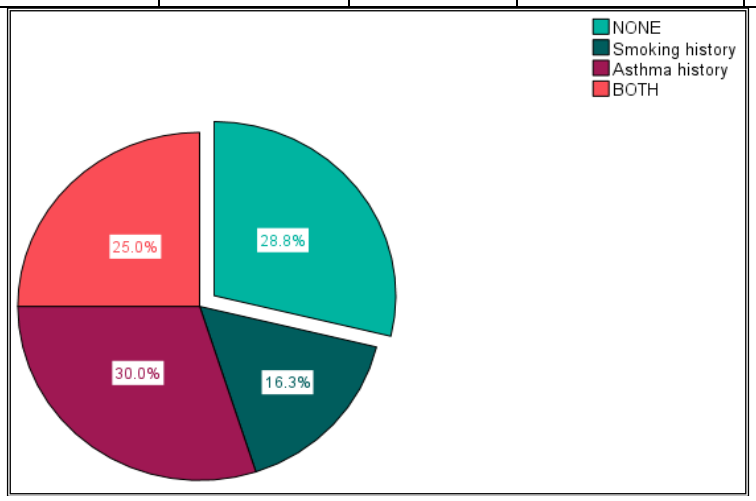


Graph-2: Shows the distribution based on age

Table-3: Distribution according to the history of Patients

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NONE	23	28.7	28.7	28.7
	Smoking history	13	16.3	16.3	45.0
	Asthma history	24	30.0	30.0	75.0
	BOTH	20	25.0	25.0	100.0

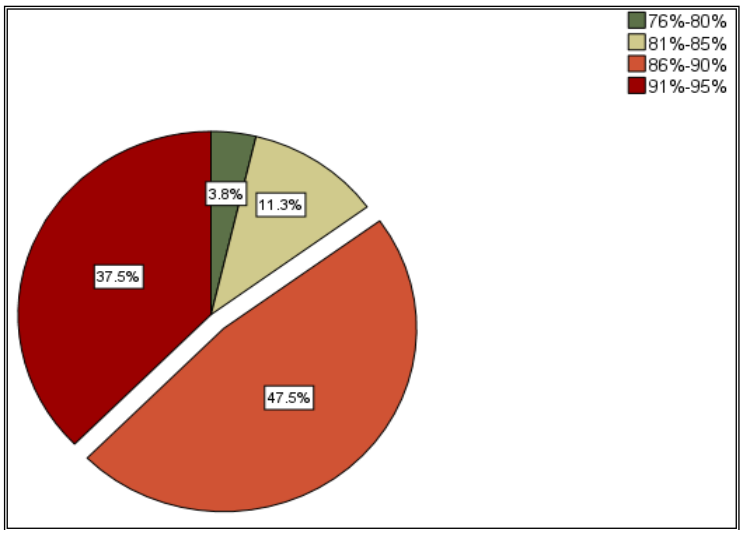
	Total	80	100.0	100.0	



Graph-3: Distribution according to the history of patient

Table-4: Distribution according to variation in O2 Saturation

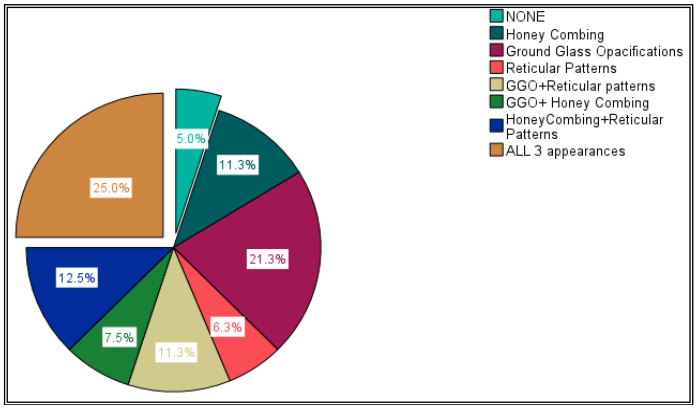
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	76%-80%	3	3.8	3.8	3.8
	81%-85%	9	11.3	11.3	15.0
	86%-90%	38	47.5	47.5	62.5
	91%-95%	30	37.5	37.5	100.0
	Total	80	100.0	100.0	



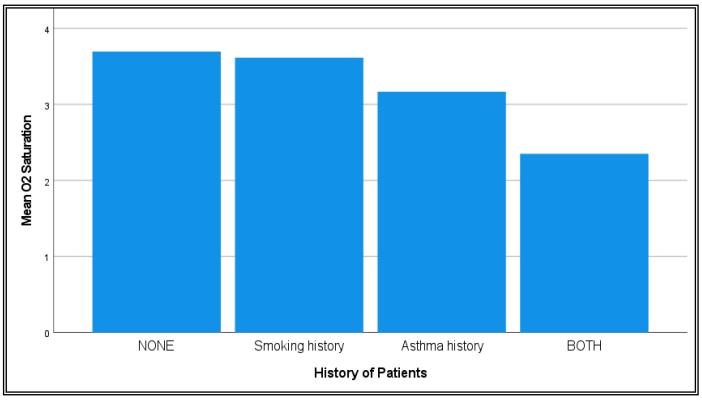
Graph-4: Shows distribution according to the variation in O_2 saturation

Table-5: Distribution based on Appearances on HRCT Scan

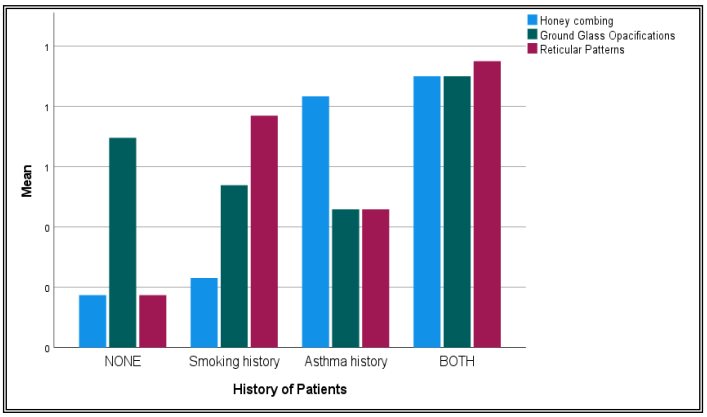
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NONE	4	5.0	5.0	5.0
	Honey Combing	9	11.3	11.3	16.3
	Ground Glass Opacifications	17	21.3	21.3	37.5
	Reticular Patterns	5	6.3	6.3	43.8
	GGO+ Reticular patterns	9	11.3	11.3	55.0
	GGO+ Honey Combing	6	7.5	7.5	62.5
	Honey Combing+ Reticular Patterns	10	12.5	12.5	75.0
	ALL 3 appearances	20	25.0	25.0	100.0
	Total	80	100.0	100.0	



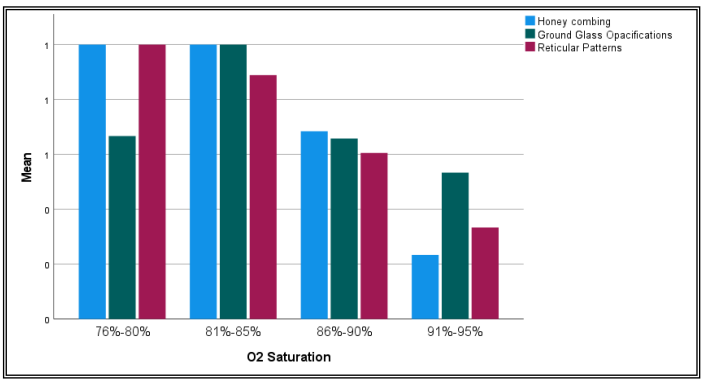
Graph-5: Shows distribution based on appearances on HRCT scan



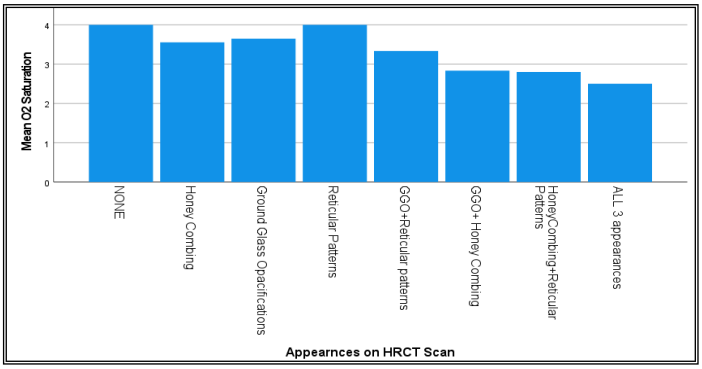
Graph-6: Shows Simple Bar Mean of O_2 saturation affected by the history of patient



Graph-7: Shows the Simple Bar Mean of Different CT features like Honey Combing, GGO, and RP influenced by history of patients



Graph-8: Shows the Simple Bar Mean Chart of Correlation between different CT features like Honey Combing, GGO, and RP with O_2 Saturation.



Graph-9: Shows that O_2 Saturation rate is significantly varies in the patients based on HRCT features. (Note: Patients with all three appearances showed worse O2 saturation)

RESULTS

In this research study total 80 patients were selected on the basis of Inclusion criteria from which 50 (62.5%) were male patients whereas 30 (37.5%) were female patients. (Tab.1) The majority of the patients associated with the disease were male in comparison to females (Graph-1).

According to this study analysis 21.5% patients belong to age group 21-30yrs, 16.3% patients belong to 31-40yrs of age, 28.7% patients belong to age group of 41-50yrs, 18.8% linked with age group 51-60yrs, 6.3% patients belong to 61-70yrs of age, 7.5% patients lie in the age group 71-80yrs, similarly 7.5% patients are linked with age group 81-90yrs of age and only 2.5% patients belong to the age group 91-100yrs (Tab.2). The most frequent age group associated with the IPF disease was 41-50yrs, accounting for 28.7% population of the study (Graph-2).

If the history of the patient is taken into concern, then we concluded that out of 80 patients 28.7% had no history like smoking and asthma. 16.3% patients had smoking history, 30% have Asthma history and 25% patients were those who had both smoking as well as asthma history. (Tab.3) Oxygen saturation was measured in all the 80 patients from which 3 patients (3.8%) had O2 saturation between the ranges 76%-80%, About 9 out of 80 (11.3%) patients was measured O2 between 81%-85%. Mostly patients 38 out of 80 (47.5%) patients had O2 saturation range between 86%-90%. And 30 out of 80 (37.5%) patients were in between the range 91%-95%. (Tab.4) the bar mean chart of oxygen saturation according to history of patients indicated that the patients have no history like smoking and asthma had almost normal level of oxygen saturation as compared to the patients having smoking history and asthma history even the patients had only smoking history were also had better O_2 saturation than asthma patients and the frequency of patients having both these histories had comparatively lower level of oxygen (O_2) saturation. (Graph-6) The results made on features appeared on CT scan of these patients indicated that (4 out of 80, 5%) patients were normal, (9 out of 80, 11.3%) had honey combing, (17 out of 80, 21.3%) patients had ground glass opacifications, (5 out of 80, 6.3%) patients had reticular patterns, (9 out of 80, 11.3%) patients had ground glass opacities along with mild reticular patterns, (6 out of 80, 7.5%) patients had ground glass opacities with honey combing, (10 out of 80, 12.5%) patients had reticular patterns along with the appearance of honey combing, and about (20 out of 80, 25%) patients were having GGO and reticular patterns along with the moderate honey combing. (Tab.5) according to the (Graph-5) mostly patients 25% engaged in the study had all three appearances.

The bar mean chart between the patient history and the evaluated CT appearances showed that the patients who were having both smoking as well as asthma histories had shown all three CT features (more worse findings) as compared to other patients and Honey combing was mostly associated with asthmatic patients as compared to smokers (Graph-7) and the bar mean chart with oxygen saturation showed that the patients having worse oxygen saturation rate had most commonly shown honey combing with any other associated CT feature as compared to patients nearly having normal O_2 saturation rate. (Graph-8) All the patients having different CT findings were associated with different O2 saturation rate demonstrated in (Graph-9).

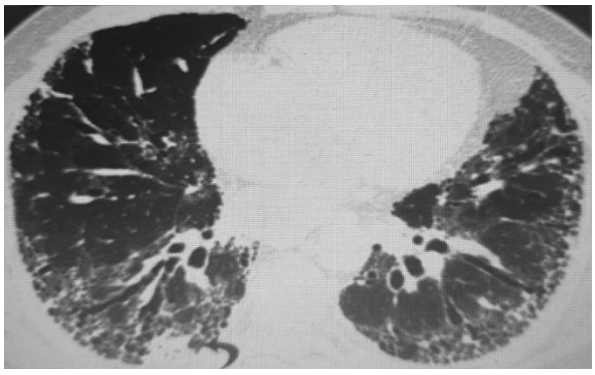


Fig-1: Demonstrate severe IPF in 69 years old patient by subpleural honeycombing, exclusive reticulation, and architectural distortion. An irregular nodule is seen at subpleural region indicated area of severe fibrosis in the right sided lung. (Curved arrow)

Fig-2: HRCT of chest demonstrates the severe IPF in 43 years old patient by showing severe honeycombing in left sided lung following patchy ground glass opacifications.

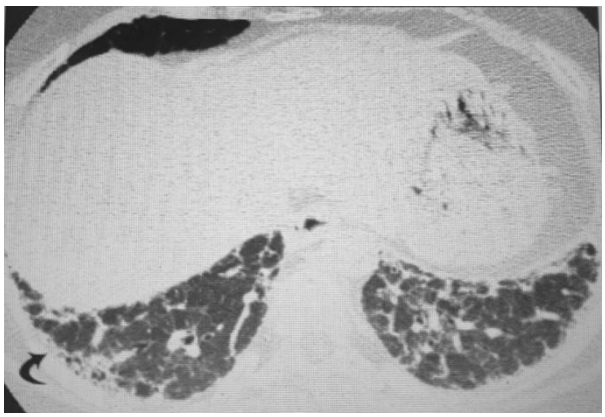


Fig-3: HRCT of chest demonstrating IPF in 73 years old female patient by showing mild reticulation as well as ground glass opacifications at subpleural region. (curved arrow)

DISSCUSSION

Idiopathic pulmonary fibrosis is difficult to diagnose because the progression of this disease in the individual patient varies greatly but early detection is required for IPF because it is extremely progressive and proved to be fatal in late stages of the disease if not detected and treated in earlier stages of disease [13, 21]. High-resolution chest CT plays a key role in the initial assessment of patients suspected of developing idiopathic pulmonary fibrosis also the findings significantly affect further treatment decisions [4, 11]. The primary intention of this study was to see how different patterns of IPF on HRCT scan were related to patients having different physical and clinical histories and demonstrating that which age, gender and the history of the patient is more prone to the IPF disease based on different CT patterns. So that the patients have suspected IPF can be evaluated and treated earlier before the fatal stage of disease based on their history and CT findings. 80 patients were enrolled in this study based on inclusion criteria of the study and Oxygen saturation of all the selected patients were measured by pulse oximeter before or after the HRCT procedure.

Some of the salient findings arises from our study. One of which predicted that the ratio of the male patients (62.5%) associated with the disease is greater than the female patients (37.5%) and this result is supported by the work of Marshall et al. carried out in 2018 in which the mortality rate was analyzed in different countries in the patients having lung disease and the male ratio of mortality rate was comparatively high in every country from which data was collected [16, 17, 22]. Esposito et al. in 2015 and Baumgartner et al. in 1997 also concluded in their study that the incidence of IPF in men is higher than women [23, 24].

In our study the age between 41-50 years then 51-60 years is commonly associated with IPF disease as shown in (Tab.2) when the study started it was an assumption that the smokers and the patients who had any history of lung disease specifically asthma are more prone to the development of IPF as compared to a non-smoker and non-asthma patients [24, 25] so the history of every patient was noted prior to the HRCT scan which proved this assumption correct as the results indicated that the patients with no history (28.7%) were having less prognosis while the patients with smoking history (16.3%), asthma history (30%) and with both these histories (25%) were greater in frequency and more commonly detected with IPF. The study of Baumgartner et al. in 1997 supported our findings as they concluded in their case control study that the smokers (either they are current smokers or formal smokers) associated with 60% higher risk of developing Idiopathic pulmonary fibrosis as compared to non-smokers as their results indicated that out of 248 selected IPF cases 137 were former smokers, 42 were current smokers while only 69 patients were identified as non-smokers. So, 72.18% population of the study who had diagnosed with IPF was identified as having smoking history [18, 26].

Similarly, Asthma is found to be the most common predictor of IPF as the chronic asthma triggers tissue damage of the lung airways (fibrosis), which can lead to airway obstruction. The patients with presence of any lung disease such asthma shows the worst symptoms and clinical findings [25, 27].

The previous study performed by Rusanov et al. in 2008 also determined the low oxygen saturation rate in the patients with any of the lung disease such as asthma, emphysema, and Idiopathic pulmonary fibrosis. The oxygen saturation rate varies according to the disease severity from person to person [20, 28] and it reinforced the results of our research study in which 3 patients were detected having O_2 saturation less than 80%, whereas 9 patients having O_2 saturation less than 85% appeared with worst CT findings (all three appearances include reticular pattern, GGO,

honeycombing) indicating disease severity (least stable). While 38 patients having O_2 saturation between 86%-90% were less severe with moderate findings and 30 patients were diagnosed earlier having nearly stable rate of O_2 saturation between 91%-95% with most commonly reticular pattern and ground glass opacities in their CT scan. These patients who had O2 saturation between 91-95% were nearly stable as compared to patients who had worse rate of desaturation.

All those 12 patients detected with O_2 saturation less than 85% had all three CT findings while those patients whose HRCT showed honeycombing in their lungs were recorded with severe symptoms and oxygen desaturation. Gupta et al. in 2017 also found by his study that the O2 desaturation in 6-minute walk test was a significant predictor of IPF severity in patients having severe IPF disease [29] and Akira et al. in 1993 and 2003 concluded by his research that the patients had honeycombing in their CT scan were noted having irreversible disease as they showed no response to any treatment while patients detected with GGO and RP were having reversible disease as they were responded a little too low doses of corticosteroids [20, 30] which strongly acknowledged our study in which the patients with honey combing showed more worse O2 desaturation and disease severity.

CONCLUSION

High resolution computed tomography makes a definitive diagnosis of IPF by correlating the smoking habit and clinical history of the patients with HRCT findings. Evaluating extent of O_2 desaturation and correlating it with the HRCT findings is also helpful tool for estimating disease severity and can save many lives in early stages of disease without histological verification and invasive procedures.

RECOMMENDATIONS

By taking the following study into concern it is highly recommended that smoking should be avoided, and legal actions should be implemented by the government so that underage children can be prevented from smoking as it is the major risk factor of many fatal lung diseases.

Ethical considerations

The rules and regulations proposed by the Ethical Committee of the Universe. The majority site of Gujranwala had been followed when the study was conducted, and the privacy of the study subjects was kept confidential.

Privacy rights and informed consent

Informed written consent was received from all research subjects. Participants were kept confidential throughout the current investigation. Participants had been assured that everything about them that would be mentioned in the study would be private and all the participants had right to drawn out their consent at any time. There were no drawbacks or hazards involved with the research protocol.

Financial assistance

There was no financial help was acquired in this study.

Data confidentiality

All details and data analysis had been kept private and protected. All of the patient-related material utilized throughout the research was gathered with their approval, and they were reassured before starting the study that keeping anything about them would be kept anonymous in the entire study or even in every publication.

Disputes of interest

The writer ensured that there is no dispute of interest throughout the research study.

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