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Review Article

An Overview of Idiopathic Pulmonary Fibrosis

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ABSTRACT

Interstitial lung disorders encompass a wide array of diseases that lead to inflammation and scarring (fibrosis) of the lung parenchyma. Among these, idiopathic pulmonary fibrosis (IPF) is the most common form of idiopathic interstitial pneumonia and is the primary focus of this review. IPF is a progressive and currently incurable condition, typically presenting with chronic and worsening shortness of breath, often accompanied by a dry cough, crackling sounds at the lung bases during auscultation, and clubbing of the fingers. Although the exact cause remains unknown, it is believed that repeated injury to alveolar epithelial cells initiates an abnormal healing response, resulting in fibrosis. Accurate diagnosis of IPF requires a multidisciplinary approach, integrating clinical evaluation with radiological and histopathological findings. High-resolution computed tomography (HRCT) plays a vital role in the diagnostic process.

INTRODUCTION

The progressive respiratory condition known as pulmonary fibrosis (PF) is marked by thickening and scarring of the lung lining, which results in an irreversible decrease of oxygen transport and exchange capacity.Lung tissue stiffens with scarring, making breathing harder for the lungs to expand and contract. Breathing becomes more difficult when this occurs because the bloodstream receives less oxygen. A person has increasing weakness and dyspnea as their PF worsens. Damage to lung tissue caused by PF finally leads to death because the injured tissue cannot be repaired to its original state. Idiopathic pulmonary fibrosis is the term used to describe PF for which an etiology is not clearly known (IPF). The most prevalent form of diffuse parenchymal lung disease is IPF, a chronic illness that leads to the destruction of the tiny interstitial spaces in the lungs. Previously believed to be primarily a proinflammatory illness, IPF is now recognized to be the outcome of an abnormal wound-healing cascade coupled with irreversible fibro

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proliferative processes.[1] IPF causes moderate-to-severe episodes of coughing, increases lung recoil, and reduces lung volume, which makes breathing harder. Fatigue, sudden weight loss, a dry cough lasting thirty days, rales or rhonchi, chest pain, palpitations, sore muscles and joints, and clubbing of the fingers and toes are some of the symptoms[2,3,4] Numerous comorbidities, such as heart failure, pulmonary hypertension (PH), and respiratory failure, arise as IPF worsens. Lung parenchyma, which is mechanically connected to pulmonary capillaries in the alveoli, experiences inflammation and fibrotic alterations due to IPF. As a result, the capillaries in the impacted alveoli are damaged, losing their capacity to exchange oxygen and bring blood that is rich in oxygen into the systemic circulation. High-resolution CT scans show a pied or patchy appearance and honeycombing when fibrotic alterations have occurred, which are highly indicative of IPF[5]

Epidemiology

IPF usually presents after the fifth or sixth decade of life and is common with older age. There is a global distribution, and the incidence appears to be increasing. This could be related to an aging population or increased recognition.[6] Prevalence in the United States is estimated to range from 10 to 60 cases per 100,000.[7]

Risk Factors

Lung tissue scarring linked to IPF can result from a wide range of chemical and environmental causes. Additional risks include age (PF is more common in middle aged and environmental older persons),work (e.g., mining , farming, construction), long- term exposure to tobacco smoke, viruses, emphysema, and chronic lung disease (CLD). There seems to be a hereditary component to some forms of PF. Most of the time, the cause is never found.

Pathophysiology

The exact mechanisms of the development of IPF remain largely unknown.It has long been believed that a chronic inflammatory process injured the lung and modulates fibro genesis, leading to end-stage fibrotic scarring and pulmonary fibrosis. This model of inflammation driven fibro genesis has been questioned. Inflammation is not a prominent histopathological finding in usual interstitial pneumonia (UIP), and there is little evidence of prominent inflammation in early disease. In 2001, selman et al. Proposed that IPF is the result of an aberrant wound healing process following repetitive epithelial injury [8] . Targeted injury of alveolar epithelial cells (ACEs) consistently induces pulmonary fibrosis in experimental models. Pathologic examination of UIP tissues reveals diagnostic lesions known as 'fibroblastic foci' (dense collections of my fibroblasts and scar tissue). The ACEs adjacent to these fibroblasts foci often remain hyper plastic and abnormal rather than undergoing appropriate repair [9]. Several animal models have demonstrated similar defects [10,11,12,13,14]. Lung fibroblasts from patients with fibrotic lung diseases differ from normal lung fibroblasts regarding proliferation, rate of collagen production and differentiation into my fibroblasts [15,16]. Several pathways results in accumulation of fibroblasts and my fibroblasts with in fibrotic lungs including expansion of resident Mesenchymal cells, epithelial to mesenchymal transition (EMT), and differentiation of circulating precursors called fibrocytes [17,18]. Myofibroblasts cause basement membrane disruption and promote ACE apoptosis , eventually resulting in excessive deposition of extracellular matrix, destruction of alveolar-

capillary units and formation of cystic fibrotic spaces[19] . This is one proposed machanism of IPF pathogenesis derived from animal models although there is no animal model that resembles the pathologic changes seen in human IPF.

Complications

- Pulmonary hypertension
- Thromboembolic disease
- Adverse effects of medications
- Superimposed lung infections
- Acute coronary syndrome
- Hypoxic respiratory failure

DIAGNOSIS

IPF is often a diagnosis of exclusion and requires a multidisciplinary approach, usually involving a pulmonologist, pathologist, and radiologist to rule out other known causes of IPF or similar diseases. A thorough patient history and physical examination must be obtained, along with radiologic studies and lung biopsy with or without broncho alveolar lavage, to rule out alternative diagnoses .

During the physical examination, the physician listens carefully to the lungs to detect and assess any atypical sounds. If there are any unusual lung findings, a number of tests or procedures may be conducted.

- Chest x-ray----- This test can reveal lung scar tissue that is typical of PF and may be used as a baseline or for following the disease course and / or treatment progress. If the x-ray is normal, further tests may be needed to explain the presence of IPF signs and symptoms or rules out a respiratory condition.

- Echocardiogram---- sound waves are used to visualise the heart and it's function. This test can produce real-time still images of the heart's structures and vedios of heart function, including the amount of pressure in the right ventricle.[20]

- Pulmonary/ lung function test----- The patient exhales quickly and forcefully through a tube connected to a machine, wich measures how much air the lung can retain and how quickly air moves in and out.

- Oximetry---- A sensor is clamped onto one finger to measure blood oxygen saturation.This is an easy and accurate way to monitor the course of disease

- Exercise stress test --- An excercise treadmill or stationary bike may be used to monitor lung function in an active patient

- Bronchoscopy ----This procedure is used obtain very small lung tissue samples

- Bronchoalveolar lavage--- A salt solution is injected into air sacs in the lung and immediately auctioned out for analysis

- Surgical biopsy---Surgical instruments and a small camera are inserted through several small incision between ribs.The surgeon is able to view the lungs on a vedio monitor while collecting tissue specimens.[21]

Treatment

Pulmonary function tests every 3 to 6 months should be performed based on symptoms and the disease’s progression. However, serial chest imaging is not always necessary. Tools like GAP (gender, age physiology) score issue points for the male gender, advanced age, forced vital capacity, and diffusing capacity or transfer factor of the lung for carbon monoxide and can be used to assess long-term prognosis, with a high GAP score

indicating worse mortality. This is mainly used when considering a patient for a lung transplant referral.[22][23][24] It is also important to assess the patient's functional status objectively and screen for hypoxic respiratory failure. Most Interstitial Lung Disease specialty centers use the 6-minute walk test to accomplish both. There are two antifibrotic agents approved for use in IPF. These are pirfenidone and nintedanib (tyrosine kinase inhibitors). Both drugs have been shown to slow the disease progression but not significantly impact mortality. For this reason, early initiation of therapy is recommended. Further studies have also shown decreased exacerbations of IPF with these drugs. Serial monitoring of liver function tests is recommended while on either drug. The most common side effect reported with nintedanib is diarrhea and with pirfenidone rash, photosensitivity, and gastrointestinal discomfort. Gastrointestinal side effects are the most common reason for discontinuing both drugs.[25] Recommended supportive measures include tobacco cessation, oxygen supplementation, and control of gastroesophageal reflux with proton pump inhibitors. Influenza and pneumococcal vaccination are recommended. Corticosteroids, immunosuppressant like azathioprine, and N-acetyl cysteine, have been used in the past, but now the recommendation is against the use of these agents in IPF following the publication of the PANTHER-IPF trial.[26] Referral for a lung transplant is recommended early in the course of the disease, especially in a patient with a progressive decline in lung function. Survival benefit has been shown for patients with IPF who undergo a lung transplant.[27] IPF is mainly confined to the lungs, and other organ involvement has not been seen. The progression of the disease is variable in patients. Some patients remain stable for several years after diagnosis, some patients decline rapidly after diagnosis, and some patients have periodic exacerbations during their course, which leads to declining lung function and increased mortality. Baseline lung function at diagnosis, the presence of comorbidities (especially co-existing emphysema and pulmonary hypertension), smoking history, low body mass index, and older age are associated with a worse prognosis. Acute can occur in IPF, which can lead to rapid decline. Factors like heart failure must be excluded, and potential infections and thromboembolic disease must also be considered and promptly treated when an acute exacerbation is suspected. Imaging during acute exacerbations may show ground-glass opacities and consolidations.[28]

CONCLUSION

In conclusion, idiopathic pulmonary fibrosis and other fibrotic lung disorders pose a significant therapeutic challenge to medical professionals. Patients who appear with chronic, worsening shortness of breath should be treated with a high index of suspicion because there are currently no clinically available biomarkers for diagnosis. For diagnosis, HRCT may be adequate, and not all patients need a surgical lung biopsy. For professional advice, patients should be directed to an ILD centre. As of right now, the only medication that has been shown to be effective is pirfenidone. Improving quality of life through symptom relief, disease-specific information, support, and early palliative care conversation should be the main goal of ongoing care for people with IPF.

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