PRACTITIONERS' GUIDANCE SERIES – XVI

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President's Remarks

World is seized with very difficult situation due to Corona Virus pandemics. Globally many things have changed and many changes are going to take place. People are undergoing tough time due to job loss, food insecurity and mental ailments.

But majority of rich and middle-class people are living in healthy environment and eating healthy food, except migrant workers, who are undergoing unparalleled misery in the history of mankind. Accidents which take large toll of life have come down drastically. Incidence of diseases like myocardial infarction, stroke and diarrheal diseases have come down considerably. Analysis of data by National agencies will able to give insight about prevalence of diseases and mortality during pandemic period.

Our Country has so far done well during this pandemic. Further in coming days, escalation of cases and deaths is anticipated in view of large number of migration of workers which is a biggest human tragedy. Malnutrition, other infectious diseases and mental health problems may surface. Our Country has potential to invent vaccine and antiviral drug against Corona virus.

Registered Medical Practitioners (RPMs) should take active participation and help Government in tackling this pandemic. Health education about hand washing, social distancing and diet should be carried out for the benefit of public.

Present Practitioners series-XVI has got very useful topics like high resolution CT, MR spectroscopy, life skills for children and hubris syndrome. I am indebted to Editorial Board for bringing out useful booklet for practitioners.

Dr.H.Veerabhadrappa
President

KARNATAKA MEDICAL COUNCIL

Editorial

I take great pleasure to place in your hands the sixteenth Practitioners' Series carrying the write-ups on High resolution computed tomography of the lungs, Burnout syndrome, Life skills for children, and Hubris syndrome.

Computed tomography (CT) of the chest is a very useful chest imaging procedure that provides information to make diagnosis. **Hight-resolution (HR)CT** has been found to be more sensitive and specific in assessing patients with diffuse lung diseases. It helps in making a detailed assessment of pulmonary parenchymal abnormalities. This technique approaches a pathologic disease process by maximizing spatial resolution and facilitates close correlation with pathologic abnormalities. Dr **Balachandiran** has provided a detailed knowledge of normal pulmonary anatomy and an understanding of its alterations in various disease states

MR Spectroscopy and its utilisation in clinical practice: This magnetic resonance non-invasive diagnostic procedure is utilised to measure the biochemical changes in the brain especially in presence of tumours. It helps in the identification of the anatomical site of the tumour. This procedure is utilised to study metabolism in vivo and it provides information on chemical composition of the structure by measuring the levels of different metabolites. In addition it provides biochemical information of the compounds found in brain, prostate, breast and liver.

In the write up on **Life skills for children**, **Dr C R Chandrashekar** has drawn the attention about the child acquiring many life skills during its growing age, and becoming independent. He has stressed the need for the Practitioners to educate the parents who

have to inculcate the life skills to the child. Those skills include thinking, problem solving, decision making, communication, interpersonal skills, empathy, self-awareness, proper management of emotions and stress. The child will develop basic skills involving eating, clothing, sleep and rest, hygiene, time management, social skills, day-to-day organisations, self-protection and avoidance of danger.

World is facing many problems from the action of some individuals who want to be important. These individuals would like to have power and trouble others. This is the main feature of **Hubris syndrome**. It is an extreme and unreasonable feeling of pride and confidence in those individuals. This abuse of power is referred to as Hubris syndrome. Some individuals who are in a position of authority do not act with wisdom, tolerance and sympathy. They treat others with insolence and comp tempt.These symptoms evoked by power usually remit on losing power. Such behaviour is exhibited in persons placed high in the Society.Hubris syndrome is a difficult condition to diagnose. Many persons affected can appear totally normal in their social life. The symptoms of Hubris abate when the person ceases to be in position exercising power

The above four different topics have been described in detail to make the practitioner aware of the conditions they face in their clinical practice. The study of these articles found in this booklet; I am sure will provide necessary knowledge of the conditions. It is hoped it will expand the horizons of their knowledge.

P. S. Shankar
Editor-in-Chief

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HIGH RESOLUTION COMPUTED TOMOGRAPHY OF THE LUNGS

Contributor
G. BALACHANDIRAN

Sectional Editor
P. S. SHANKAR

High resolution computed tomography of the lungs

Introduction

Computed tomography (CT) of the chest can be extremely useful when chest radiographs provide insufficient information to answer important clinical questions about diagnosis, extent of disease, and prognosis. High resolution computed tomography (HRCT) is now widely recognized as more sensitive and specific than chest radiography for the assessment of patients with diffuse lung disease.

HRCT of the chest include detecting lung disease in the presence of normal or equivocal chest radiographic findings. More accurate and detailed assessment of pulmonary parenchymal abnormalities by HRCT allows refinement of differential diagnosis and a more confident diagnosis. Thus HRCT has become a valuable tool for the evaluation of patients with diffuse pulmonary diseases.

What is HRCT?

Conventional computed tomography of the chest examines 7- to 10-mm slices obtained at 10-mm intervals. High-resolution CT examines 1.0- to 1.5-mm slices at 10-mm intervals using a narrow collimation and high-spatial-frequency reconstruction algorithm and illustrates lung parenchymal details better than conventional CT. This technique seeks to maximize spatial resolution and thereby approach a pathologic representation of a disease process. Maximizing spatial resolution allows HRCT findings frequently to correlate closely with pathologic findings.

Scans are done at full inspiration in the supine patient. Prone positioning may be helpful in distinguishing gravity-dependent atelectasis in the dorsal bases seen on supine images from early changes of idiopathic pulmonary fibrosis (IPF).

Expiration images may be helpful in evaluating the mosaic pattern (patchwork of lung regions of varied radiological attenuation) and patients with obstructive lung diseases to show air trapping. If the findings are sufficiently characteristic of a specific diagnosis, HRCT may

obviate a lung biopsy.When a biopsy is needed, HRCT of the chest may guide the selection of the appropriate biopsy procedure and locate optimal sites for biopsy

By use of a dedicated diagnostic algorithm -based on characteristic high-resolution CT scan features coupled with clinical findings can provide either a specific diagnosis or a markedly shortened list of differential diagnoses in a majority of patients presenting with diffuse lung diseases.

Due to its ability to evaluate the lung parenchyma in cross-section, eliminating the superimposition of densities, CT scanning offers a unique opportunity to evaluate lung lesions in exquisite detail.

A detailed knowledge of normal pulmonary anatomy and an understanding of how normal anatomy is altered in disease states are required to appreciate fully HRCT findings in patients with pulmonary disease.

Gross airways anatomy

Airways divide by dichotomous branching with approximately 23 generations of branches identifiable from the trachea to the alveoli. The trachea divides into main bronchi that divide into lobar bronchi. The lobar bronchi divide into segmental bronchi that in turn divide into subsegmental bronchi. These bronchi divide into several generations of smaller bronchi and finally the terminal bronchi are reached.
These terminal bronchi divide into respiratory bronchioles.

Bronchioles differ from the bronchi in that the bronchi contain cartilage and glands in their walls, whereas the bronchioles do not. The bronchioles include two categories: the membranous bronchioles (lobular and terminal) and the respiratory bronchioles.

The lobular bronchioles enter the core of the secondary pulmonary lobule and divide into a number of terminal bronchioles according to the size of the lobule.

These terminal bronchioles represent the most distal purely conducting portion of the tracheobronchial tree; that is they conduct air without being involved in gas exchange.

The terminal bronchioles give rise to the respiratory bronchioles, which are so designated because alveoli bud directly from their walls

Hence, respiratory bronchioles not only are conducting but are also involved in gas exchange.

The respiratory bronchioles give rise to alveolar ducts. In contrast to the respiratory bronchioles where alveoli only rise occasionally from the wall, these alveolar ducts have so many alveoli originating from their wall that there is virtually no wall structure between the alveolar orifices. The alveolar ducts finally lead into the alveolar sacs containing several alveoli.

Adjacent alveoli originating from different air sacs are known to communicate directly with one another through the pores of Kohn. The canals of Lambert communicate distal bronchioles, particularly preterminal bronchioles with alveoli. The secondary pulmonary lobule is a fundamental functional unit of lung structure, and an understanding of lobular anatomy is essential to the interpretation of thin-section high resolution computed tomographic scans of the lung. Thin-section HRCT can show many features of the secondary pulmonary lobule in both normal and abnormal lungs, and many lung diseases produce characteristic abnormalities of lobular anatomy.

The **primary pulmonary lobule** is made of the alveolar ducts, alveolar sacs, and alveoli distal to the last respiratory bronchiole, along with their associated blood vessels, nerves, and connective tissues.

Secondary pulmonary lobule (SPL)-Microanatomy

Airways, pulmonary arteries and veins, lymphatics, and the various components of the pulmonary interstitium are all represented at the level of the secondary lobule.

Secondary lobules are marginated by the connective-tissue interlobular septa, which extend inward from the pleural surface. The interlobular septa are part of the peripheral interstitial fibre system which extends over the surface of the lung beneath the visceral pleura and envelopes the lung in a fibrous sac from which the connective-tissue

septa penetrate the lung parenchyma. Pulmonary veins and lymphatics lie within this connective-tissue.

Secondary pulmonary lobules measures between 1 and 2.5 cm across. They are polyhedral in shape bounded by fibrous septa (the interlobularsepta) which are themselves continuous with the peribronchovascularinterstitium (axial connective tissue) and pleura (peripheral connective tissue).The **secondary pulmonary lobule** refers to the smallest anatomic unit of lung structure.and contains a variable number of acini.Each lobule contains a up to a dozenacini and 30-50 primary pulmonary lobules.Each secondary pulmonary lobule is supplied by a terminal bronchiole and a pulmonary artery branch. They are drained by pulmonary veins which form in at the periphery of the lobule and pass though the interlobular septa. Within the secondary lobule, separating adjacent acini is a much less pronounced network of supporting connective tissue which forms the intralobular septa.

The secondary pulmonary lobule has three principal components (Fig. 1)

* The interlobular septa that marginate the lobule and that contain the pulmonary veins and lymphatics surrounded by connective tissue.

*The centrilobular region containing the bronchiolar branches that supply the lobule, their accompanying pulmonary arteries and adjacent to them supporting connective tissue and lymph vessels.

*The lobular lung parenchyma is the part of the secondary lobule surrounding the lobular core and contained within the interlobular septa. It consists of functioning lung grouped in 3–12 acini that contain alveoli (organised in alveolar ducts and sacs) and their associated pulmonary capillary bed together with their supplying small respiratory airways and arterioles and with draining veins. This parenchyma is supported by connective tissue stroma.

The **pulmonary acinus** is (Fig.2) smaller than the secondary lobule. It is defined as the portion of lung distal to a terminal bronchiole (the last purely conducting airway) and is supplied by a first-order respiratory bronchiole or bronchioles.Each secondary pulmonary lobule

contains 3-12 acini, and adjacent acini are separated by incomplete intralobularseptae. Acini are usually described as ranging from 6 to 10 mm in diameter.

The substance of the secondary lobule, which surrounds the centrilobular region and is contained within the interlobular septa, consists of functioning lung parenchyma—namely, alveoli and the associated pulmonary capillary bed supplied by small airways and branches of the pulmonary arteries, veins, and lymphatics. This parenchyma is supported by a connective-tissue stroma, a fine network of very thin fibres within the alveolar septa termed the "septal fibers"

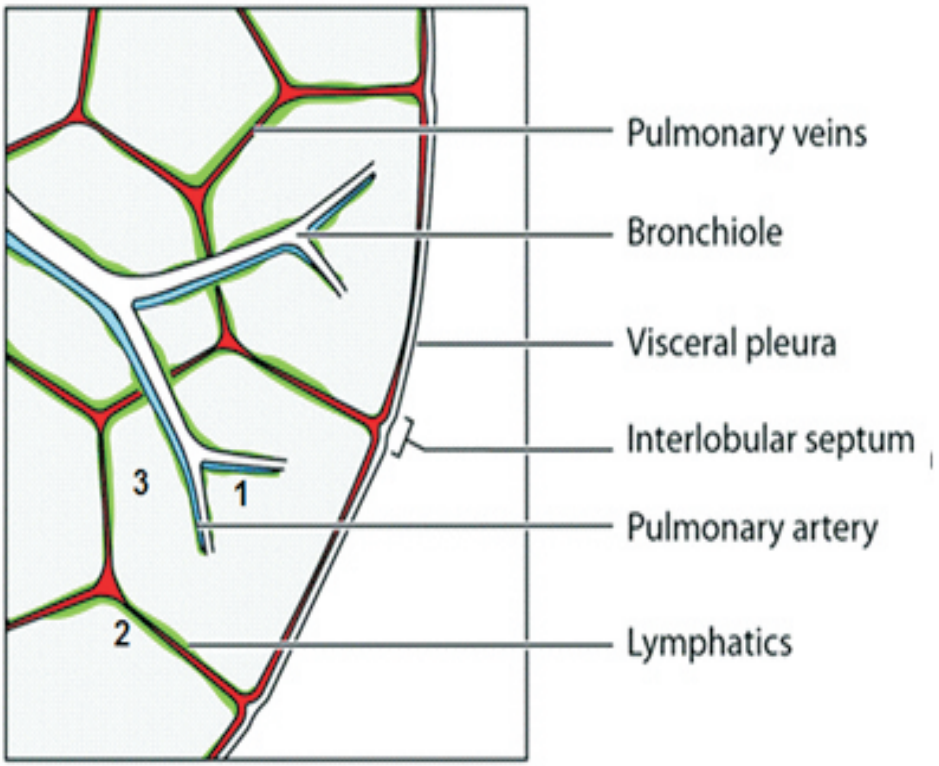


Fig.1- HRCT appearances of major components of a secondary pulmonary lobule
1-Centrilobular area; 2-Perilymphatic area; 3-Lobular parenchyma

Note; SPL-Borders of lobule are interlobular septa. At centre of each lobule is a bronchiole (white) and a branch of pulmonary artery (blue). Pulmonary vein (red) run in interlobular septa. Lymphatics (green) are found in interlobular septa and in central and axialinterstitium that surrounds broncho-vascular bundles.

Specific important anatomic details

1. The interlobular septae

The interlobular septae are located betweensecondary pulmonary lobules and are continuous with both the subpleuralinterstitium (peripheral connective tissue) and the peribronchovascularinterstitium (axial connective tissue) as well as the more delicate intralobular septa.

These septae are composed of connective tissues within which run the pulmonary veins and lymphatics which drain towards the pleura. A second set of lymphatics runs along with arteries and drains centrally. The interlobular septa are incomplete allowing for communication between adjacent secondary pulmonary lobules (Canals of Lambert and pores of Kohn).

The intralobular septae are delicate strands of connective tissue separating adjacent pulmonary acini and primary pulmonary lobules. They are continuous with the interlobular septae which surround and define the secondary pulmonary lobules.

2. Lung interstitium

The lung is supported by a network of connective tissue fibres referred to as the lung interstitium. The interstitium has three components that communicate freely: (1) the peripheral connective tissue, (2) the axial connective tissue, and (3) the parenchymal connective tissue.

The peripheral connective tissue includes the sub-pleural space and the lung septa. The septa are fibrous strands that penetrate deeply as incomplete partitions from the subpleural space into the lung not only

between lung segments and subsegments but also between secondary pulmonary lobules and acini So the pleura is in anatomic continuity with the different lung septa including the interlobular septa and the septa between the acini.

The axial connective tissue is a system of fibres that originates at the hilum, surrounds the bronchovascular structures and extends peripherally. It terminates at the centre of the acini in the form of a fibrous network that follows the wall of the alveolar ducts and sacs. The alveoli are formed in the meshes of this fibrous network.The peribronchovascularinterstitium refers to the connective-tissue sheath that encloses the bronchi, pulmonaryarteries, and lymphatic vessels. It extends from the hilar regions through to the lung peripheries.

There are many diseases that could affect peribronchovascularinterstitiumeg Sarcoidosis,silicosis,pulmonary odema,etc.

3. Lymphatics

There are two lymphatic systems: 1. a central network, that runs along the bronchovascular bundle towards the centre of the lobule and 2. a peripheral network, that is located within the interlobular septa and along the pleural linings

4. Central lobular area:

Central lobular area is the central part of the secondary pulmonary lobule. The centrilobular region comprises the central portion of the secondary pulmonary lobule, consisting of the pulmonary artery, bronchiole and surrounding lung interstitium.It is usually the site of diseases, that enter the lung through the airways (i.e. hypersensitivity pneumonitis, respiratory bronchiolitis, centrilobular emphysema). Therefore, the bronchiolar disease that produces an enhancement of the centrilobular structure occurs when there is thickening of the bronchiolar wall or filling of the bronchiolar lumen. Centrilobular patterns include: (a) nodules; (b) tree-in-bud pattern; (c) thickening of the peribronchovascular peripheral interstitium; and (d) areas of low attenuation without visible walls (emphysema).

5. Perilymphatic area:

Perilympatic areais the peripheral part of the secundary lobule.It containsthe interlobular septa that marginate the lobule and contain the pulmonary veins and lymphatics surrounded by connective tissue.It is usually the site of diseases, that are located in the lymphatics of in the interlobular septa (i.e. sarcoid, lymphangitic carcinomatosis, pulmonary oedema). These diseases are usually also located in the central network of lymphatics that surround the bronchovascular bundle.

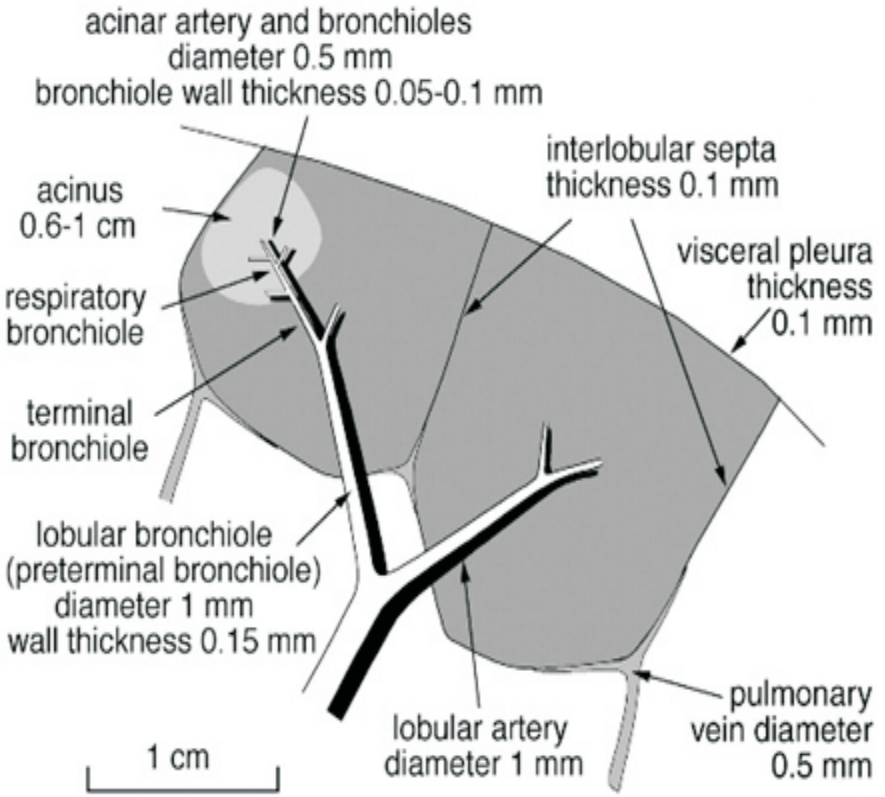


Fig.2.Anatomy and dimensions of secondary pulmonary lobule (SPL)and pulmonary acinus

Note: A side-by-side diagrammatic representation of two normal secondary pulmonary lobules.The lobule is fed by a terminal bronchiole and artery, the periphery is partly septated. In between are the primary lobules-acinus- fed by respiratory bronchioles where gas exchange takes placeVeins run in the septa. . The centrilobular structures, include pulmonary arterioles and their accompanying bronchioles, and peripheral structures, including the pulmonary veins and lymphatics within the interlobular septae.

Secondary pulmonary lobules in the lung periphery are relatively large and are marginated by interlobular septa that are thicker and better defined than lobules in other parts of the lung . Peripheral lobules tend to be relatively uniform in appearance, often having a cuboidal or pyramidal shape. Secondary lobules in the central lung zone are smaller and more irregular in shape than those in the peripheral lung and are marginated by interlobular septa that are thinner and less well defined. It should be kept in mind, however, that the size, shape, and appearance of secondary lobules as seen on thin-section CT images are markedly affected by their orientation relative to the scan plane, slice thickness and respiratory phase.

Interlobular septa are thickest and most numerous in the apical, anterior, and lateral aspects of the upper lobes, the anterior and lateral aspects of the middle lobe and lingula, the anterior and diaphragmatic surfaces of the lower lobes, and along the mediastinal pleural surfaces thus, secondary lobules are best defined in these regions. Septa measure about 100 μm (0.1 mm) in thickness in a subpleural location

Interlobular septa in the peripheral lung are at the lower limit of thin-section CT resolution, In healthy patients, a few septa are often visible in the lung periphery, normal septa are most often seen in the apices anteriorly and along the mediastinal pleural surfaces Occasionally, when interlobular septa are not clearly visible, their locations can be inferred by identifying septal pulmonary vein branches.Veins can sometimes be seen as linear, arcuate, or right angled branching structures 1.0–1.5 cm from the pleural surface

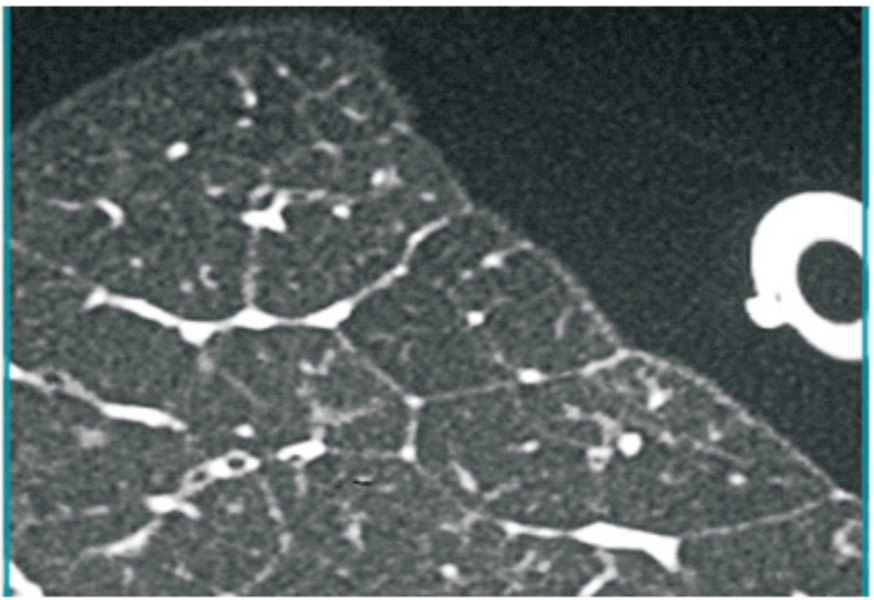
On thin-section CT scans, a linear, branching, or dot-like opacity seen in the center of a lobule or within 1 cm of the pleural surface represents the intralobular artery branch or its divisions. The smallest arteries resolved extend to within 3–5 mm of the pleural surface or lobular margin and are as small as 0.2 mm in diameter.

With thin-section CT, intralobular bronchioles are not normally visible, and bronchi or bronchioles are rarely seen within 1 cm of the pleural surface in most locations

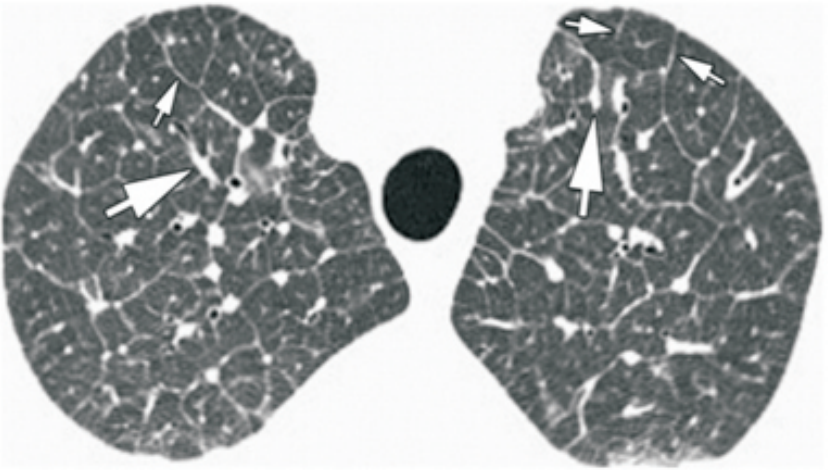
Physiologic ground-glass attenuation can be seen in the dependent lung areas.It is also a normal finding on the expiratory CT

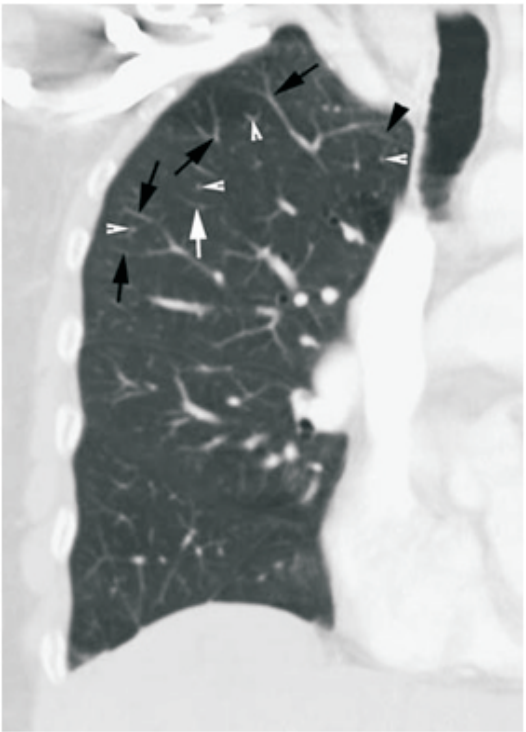
In many healthy subjects, one or more areas of air-trapping can be seen on expiratory scans, particularly in the lower lobes.

There is density gradient between the dependent and the nondependent lung, which is larger on expiratory scans than on inspiratory scans



CT scan of resected lung shows Secondary pulmonary Lobules
Centrilobular region Interlobular septal region
Lung parenchymal region. (Intrilobular)





Visible lobules vary in size, at least partly because of the position of lobules relative to the scan plane. Pulmonary veins (large arrows) in septa are visible as small rounded dots or linear or branching opacities. Septa are well developed in the apices (coronal reconstruction). Interlobular septa can sometimes be recognised anteriorly and along the mediastinal surfaces (arrowhead)
but can more often be inferred by locating septal pulmonary vein branches (arrows) presenting as linear, arcuate or branching structures approximately 5–10 mm from the centrilobararteriole (white arrowheads)

Image Plate 1: Normal HRCT of lungs

What are the HRCT patterns seen?

Generally, the diagnosis of lung disease on a chest CT is based on three elements. Recognition of the appearance pattern of disease, i.e. classifying the abnormalities in a category that is based on their appearance. Determination of location and distribution of the abnormalities in the lung: the distribution pattern. Careful analysis of the patient data that are available at the time the CT scan is performed

In chest x-ray, the Pulmonary patterns may be classified as alveolar, interstitial, bronchial, and vascular. Interstitial patterns on chest radiography have been described as linear, reticular, nodular, and reticulonodular. The interstitial patterns on HRCT include linear and reticular pattern, nodular pattern, decreased lung density, and increased lung density

Common HRCT patterns (Fig 3 & 4)

Generally, HRCT findings can be classified into four large categories based on their appearance:
(Table 1)

1. Abnormalities associated with an increase in lung opacity,

   i.e. increased lung attenuation (opacity).eg.ground glass pattern,consolidation,

2. Abnormalities associated with a decrease in lung opacity,

   i.e. decreased lung attenuation(lucency),egmicrocyst, emphysema,bronchiectasis

3. Abnormalities presenting as nodular opacities.

4. Abnormalities presenting as reticular /linear opacities.

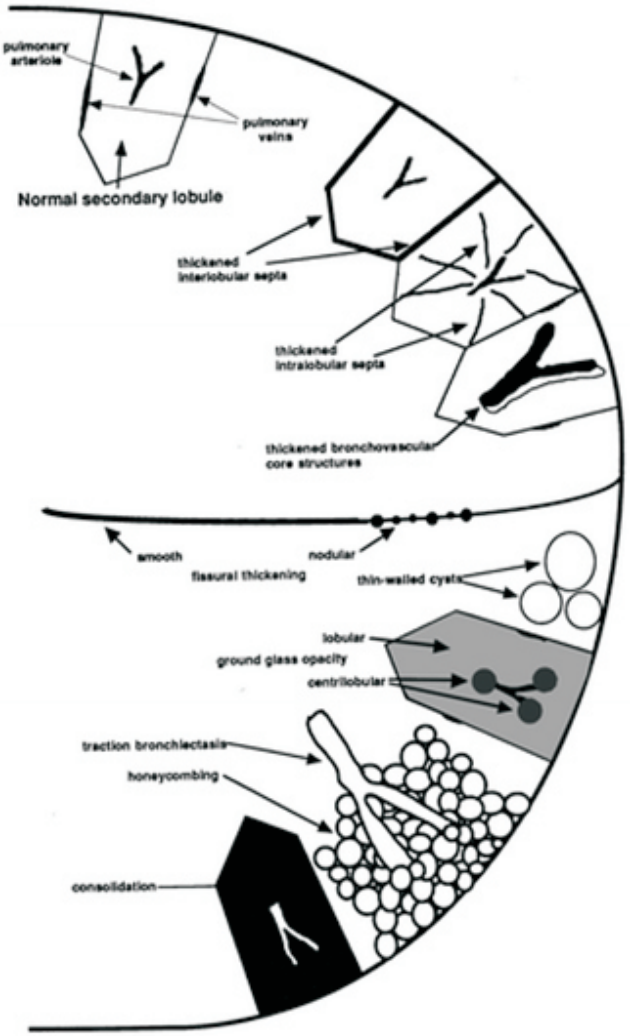


Fig.3 Line drawing of types of abnormal patterns found on high-resolution CT

showing normal secondary pulmonary lobule; linear marking--Interlobular septalthickening, Intralobular septal thickening, centrilobular-bronchovascular core- thickening; Nodules
cysts, bronchiectasis –traction type, honeycombing,; consolidation, ground glass pattern.

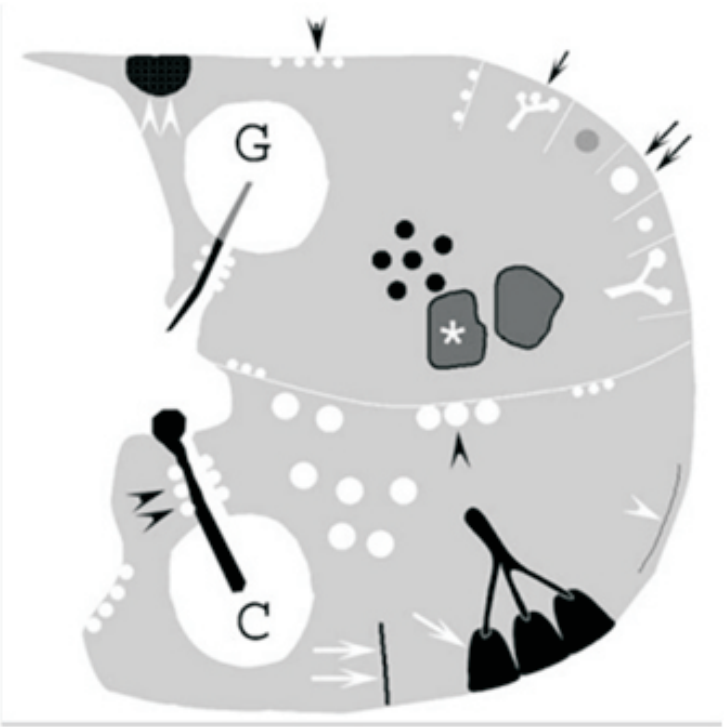


Fig. 4 Line drawing of types of abnormal HRCT patterns

White- increased attenuation –increased density

Black-decreased attenuation-decreased density

G-ground glass opacity

C-consolidation

White double arrow- parenchymal bands

White single arrow-Mosaic perfusion

White single arrow head-subpleural line

White double arrow head-paraseptal emphysema

Double Small black arrow-centrilobular nodule

Single Small black arrow-tree-in-bud appearance

Single Black arrow head-perilymphatic,fissural subpleural nodules

Double Black arrow head—peribronchovascular nodules, Asterix-lung cyst

HRCT finding	Further pattern subclassification	Diseases frequently implicated
Increased lung capacity		
Nodules	Centrilobular, perilymphatic, random	Bronchiolitis, sarcoidosis, Hematogenously disseminated infection
Linear abnormalities	Interlobular septal thickening, parenchymal bands, subpleural lines	Pulmonary edema, lymphangitic carcinomatosis
Reticular abnormalities	Coarse or fine reticulation, intralobular interstitial thickening	Idiopathic interstitial pneumonias, pneumoconioses
Ground-glass opacity	Must be based on clinical history and associated scan findings	Opportunistic infection, idiopathic interstitial pneumonia, pulmonary alveolar proteinosis
Consolidation	Must be based on clinical history and associated scan findings	Pneumonia, cryptogenic organizing pneumonia, pulmonary hemorrhage
Decreased lung capacity		
Areas of decreased attenuation with walls (cysts or ccystlike appearance)	Cyst shape, distribution, wall thickness, pattern of organization	Langerhans' cell histiocytosis, lymphangioleiomyomatosis, bronchiectasis, paraseptal emphysema, idiopathic interstitial pneumonias
Areas of decreased attenuation without walls	Emphysema, mosaic perfusion	Centrilobular or panlobular emphysema, diseases affecting small airways

Table 1 showing common HRCT patterns

Basic interpretation of HRCT scans

1. Interpretation of interstitial lung diseases is based on the type of involvement of the various components of a secondary lobule.
2. Identify the major or predominant patterns as - opacity,lucency,nodular or reticular.Then find out the zonal distribution as- upper,lower,central,orperipheral.Then locate the exact site of involvement in SPLie.centrilobular, ,perilymphatics or random.3.first the assess lesions by anatomic distribution and second by morphology.
3. Further Pathologic alternations in secondary lobular anatomy visible on thin-section CT scans may be described as
    1. perilobular when interlobular septa are involved (eg.interlobular septal thickening),
    2. Centrilobular when central bronchovascular part is involvedeg centrilobular nodules, and
    3. Panlobular (intralobular) when entire lobule is involved.random distribution eg.panlobular emphysema

Image Plate 2: Increased attenuation pattern

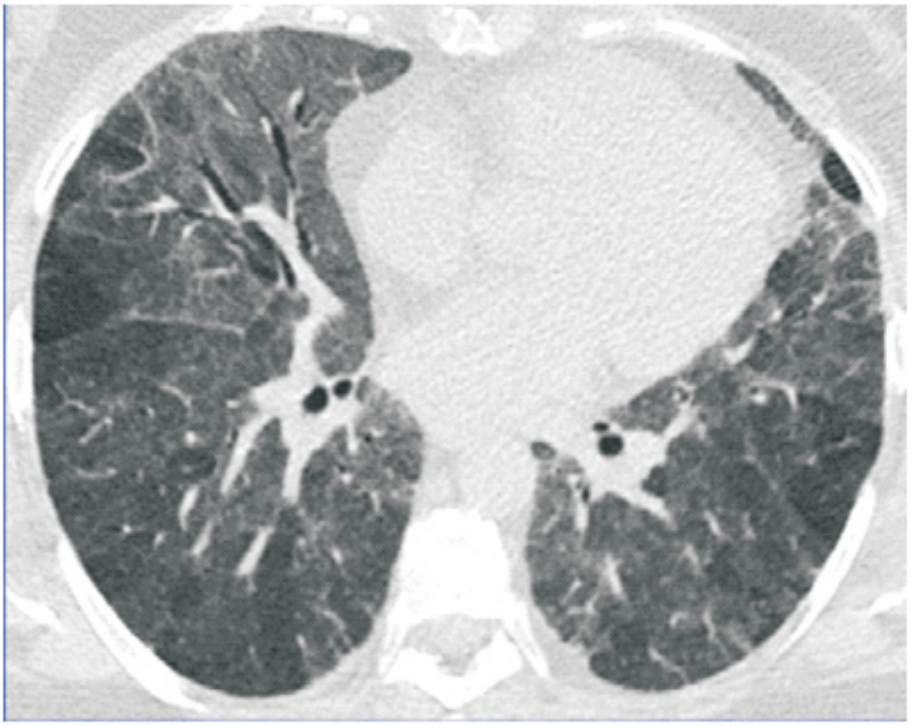
1.Depending on the degree of involvement, two types

a. Ground-glass opacityor ground-glass attenuation when involvement is mild--the of **increased lung attenuation (high density)**can be described:hazy increase in lung opacity with preservation of the bronchial and vascular markings

Ground-glass opacification/opacity (GGO) is a descriptive term referring to a hazy area of increased attenuation in the lung with preserved bronchial and vascular markings. It is a non-specific sign with a wide aetiology including infection, chronic interstitial disease and acute alveolar disease.This image pattern is related to interstitial thickening, partial filling of air spaces partial collapse of alveoli, increased capillary blood volume or a combination of all of these mechanisms

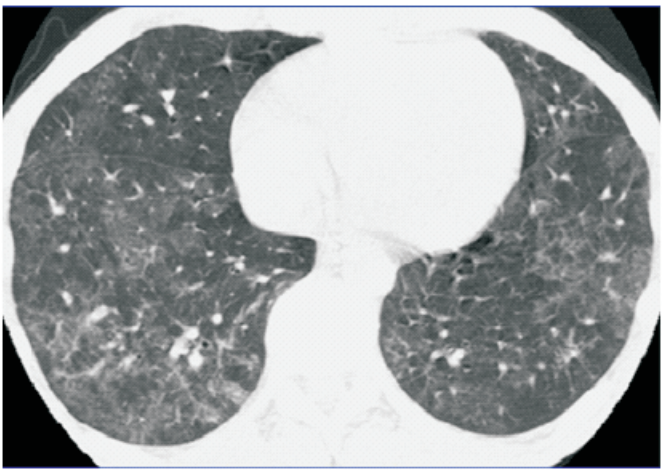
Ground-glass opacities have a broad aetiology:normal expiration,partial filling of air spaces,partial collapse of alveoli,interstitial thickening, Inflammation, oedema, fibrosis

b. Consolidationwhen involvement is more advanced, the increased pulmonary density obscures the vessels and the margins of the airways.Airspace consolidation or alveolar filling is characterized by indistinct margins, the tendency to coalesce, and the presence of air bronchogram or silhouette sign (effacement of an anatomical soft-tissue border. Airspace consolidation may be caused by accumulated water, blood, pus, cells, and other material. Diffuse alveolar infiltrates may be acute or chronic **(Table 2)**

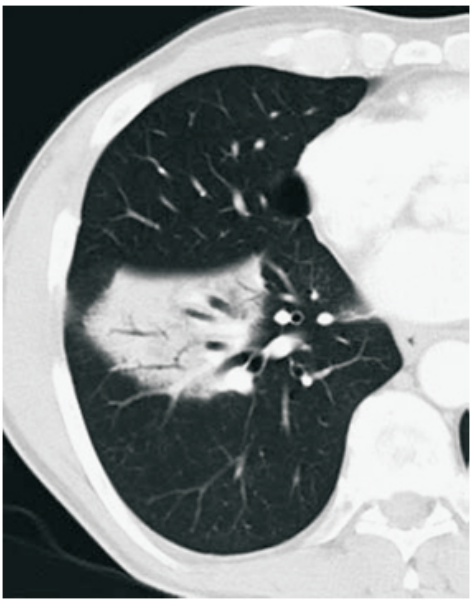


Ground Glass Opacity

Mild increase in radiographic density,
With preservation of vascular and bronchial Markings.



Pneumocystis jerovecii pneumonia
patchy/diffuse bilateral GGO
central or perihilar / upper lobe
septal thickening / crazy paving
upper lobe cysts centrilobular nodules
consolidation



Consolidation
It is increase in pulmonary parenchymal attenuation that obscures the margins of the vessels and airways.Although the margins of the airways are obscured, the lumen may be visible when it contains air, typically causing an air-bronchogram.
It is always a pathologic finding.
It can be focal, regional, multifocal, lobar or diffuse.
A sharp border often results from an adjacent normal anatomic structure causing the Silhouette sign.

Image Plate 2: Some examples of High-density pattern

HRCT pattern	acute	chronic
Consolidation	infection, acute respiratory distress syndrome,haemorrhage, aspiration, acute eosinophilic pneumonia, acute interstitial pneumonia, cryptogenic organizing pneumonia (also called idiopathic bronchiolitis obliterans with organizing pneumonia [BOOP])	chronic infections (tuberculosis, fungal), chronic eosinophilic pneumonia, cryptogenic organizing pneumonia, lymphoproliferative diseases, bronchioloalveolar carcinoma, pulmonary alveolar proteinosis,
Ground-glass opacities	infections (P carinii, cytomegalovirus), pulmonary oedema, haemorrhage, hypersensitivity pneumonitis, acute inhalational exposures, drug-induced lung diseases, acuteinterstitial pneumonia	nonspecific interstitial pneumonia (idiopathic or related to underlying diseases, eg, connective tissue diseases), respiratory bronchiolitis–associated interstitial lung disease,desquamative interstitial pneumonia, drug-induced lungdiseases, pulmonary alveolar proteinosis
Linear or reticular opacities	infections (viral, mycoplasma), pulmonary oedema	Idiopathic pulmonary fibrosis (IPF) or usual interstitialpneumonia, connective tissue disease–associated pulmonaryfibrosis, asbestosis, sarcoidosis, hypersensitivity pneumonitis,drug-induced lung disease
Thickened interlobular septa	pulmonary oedema	lymphangitic carcinomatosis, pulmonary alveolarproteinosis, sarcoidosis, pulmonary veno-occlusive disease

Table 2: Differential diagnosis in high density pattern

2. Nodular pattern (Image plate.3)

Multinodular disease is defined as a disease in which there are too many nodules to easily count on routine CT scan studies, with most of these nodules measuring 1 cm in diameter, presence of innumerable small rounded opacities with soft tissue density that are discrete and range in diameter from 2 to 10 mm.It is a focal opacity that is rounded, or at least partially delineated, smaller than 3.0 cm in diameter and generally presenting soft tissue or calcified tissue density. When the opacity is smaller than 10 mm, it is recommended that the term "small nodule" be used.

When the opacity is smaller than 3 mm, it is recommended that the term "micronodule" be used. When the opacity is between 10-30 mm the term solitary pulmonary nodule.

Nodules should be described according to the characteristics of their borders (well- or ill-defined), to their location or to their distribution (random, peri-lymphatic, centrilobular or pleural).

Nodules must be described as to whether they are 1.diffuse or focal or clustered;

2.central (peri- bronchovascular) or peripheral (subpleural or peri-fissural);3. upper or lower lung distribution. Most importantly, nodules also need to be characterized by their relation to secondary lobular anatomy.

For example, diseases such as sarcoidosis that localize within or adjacent to lymphatics predominate in those regions in which lymphatics are most extensive, specifically along the pleural and fissural surfaces, within the interlobular septae, and along the peri-bronchovascular axial interstitium**(**Table-3**).**

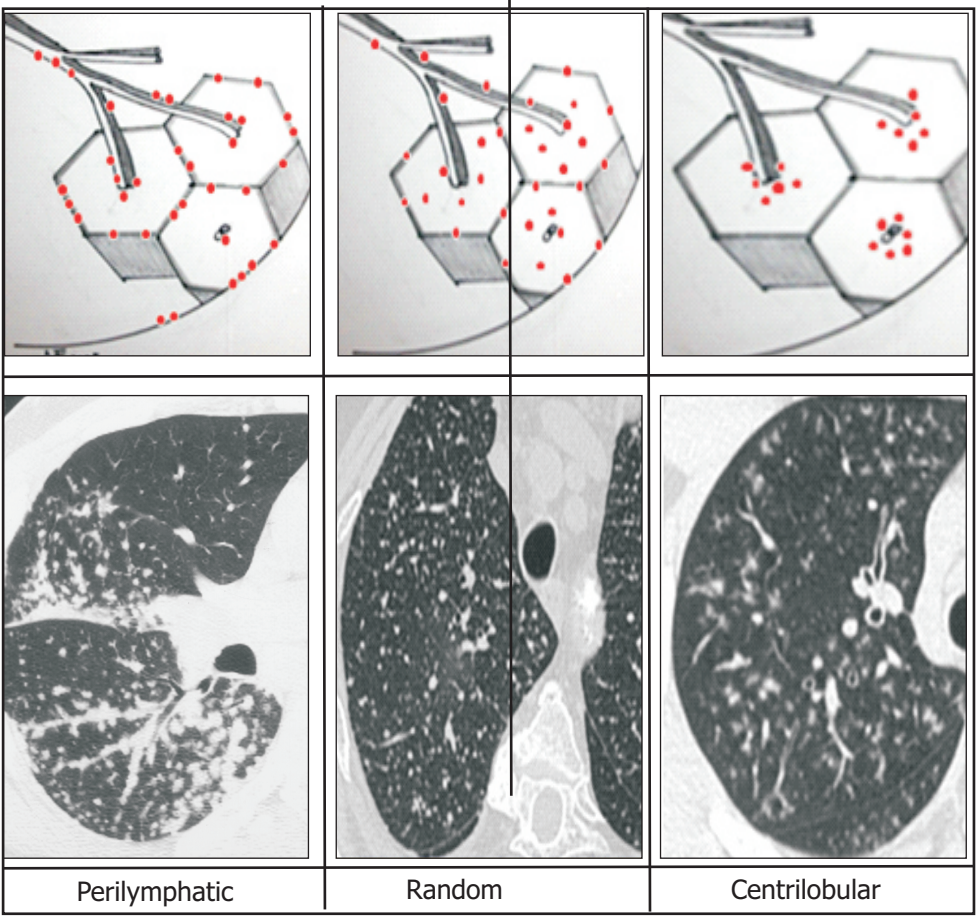
Diseases that are primarily hematogenous in origin, such as miliary infections or hematogenous metastases, give rise to nodules that are randomly distributed throughout the secondary lobule, with the greatest profusion in the lung bases

These patterns are clearly separate from nodules that result from inhalational disorders such as occur in patients with endobronchial

spread of infection or hypersensitivity pneumonitis (HP), in which nodules are predominantlycentrilobular in distribution, sparing the lobular periphery

Furtherassessing a number of characteristics including whether nodules are as follows: uniform or variable in size; sharply or poorly marginated; solid or subsolid in density (so-called ground-glass opacities) ; or have a so-called tree-in-bud appearance . Additionally, nodules may ei-ther be calcified, as occurs in fungal disease, or cavitary, as is seen, for example, in patients with septic emboli, metastatic disease, or Langerhans cell histiocytosis (LCH)

Nodule distribution on HRCT	HRCT Finding	Representative diseases
centrilobular	Centrilobular artery and bronchus centrilobular nodules spare the pleural surfaces. The most peripheral nodules are centred5-10mm from fissures or the pleural surface.	Infectious bronchiolitis, diffuse panbronchiolitis, hypersensitivity pneumonitis, respiratory bronchiolitis, lymphocytic interstitial pneumonia, pulmonary oedema, vasculitis, plexogenic lesions of pulmonary hypertension, metastatic neoplasms
perilymphatic	nodules are seen in relation to pleural surfaces, interlobular septa and the peribronchovascularinterstitium. Nodules are almost always visible in a subpleural location, particularly in relation to the fissures.	Sarcoidosis, lymphangitic carcinomatosis, amyloidosis
random	Nodules can usually be seen to involve the pleural surfaces and fissures, but lack the subpleural predominance often seen in patients with a perilymphatic distribution.	Hematogenously disseminated infections and neoplasms



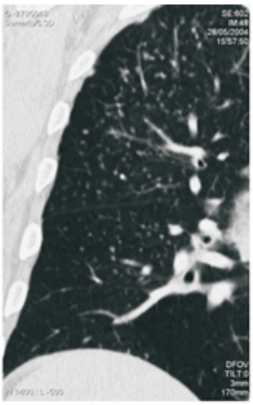
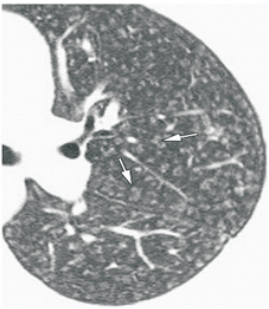


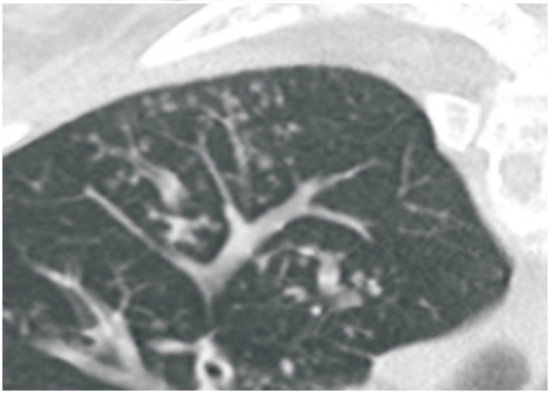
Image Plate.3: Nodular pattern

Coal worker'spneumoconiosis

Multiple well-defined nodular opacities with soft tissue density most pronounced in the upper area of the right lung caused by coal workers pneumoconiosis.



Hypersensitivity pneumonitis
scan shows small ill-defined centrilobular nodules separated from pleural surface and fissure by several millimetres. The nodules arise in relation to centrilobular bronchioles and appear as lobular rosettes (arrows).



Tree-in-bud sign
associated with bronchiolar infection.
a patient with airways disease and bacterial infection related to acquired immunodeficiency syndrome.
Multiple impacted centrilobular bronchioles result in tree-in-bud appearance (arrowheads).

Image Plate 3-A Some examples of nodular pattern

1. Linear /reticular pattern (Image Plate: 4)

Pulmonary disease occurring predominantly in relation to interlobular septa and the periphery of lobules is called "perilobulardistribution". Septae, easily seen on thin-section CT scans are abnormally thickened. In the peripheral lung, thickened septa 1.0–2.5 cm in length may outline part of or an entire lobule and are usually seen extending to the pleural surface. Lobules delineated by thickened septa commonly contain a visible dotlike or branching centrilobular pulmonary artery.Septal thickening can be seen in the presence of interstitial fluid, cellular infiltration, or fibrosis and can have a smooth, nodular, or irregular contour in different pathologic processes

EG. smooth- interlobular septal thickening-pulmonary oedema.Kerley B lines.

nodular-interlobular septalthickening- lymphangitic spread of neoplasm

(Table-4 & 5)

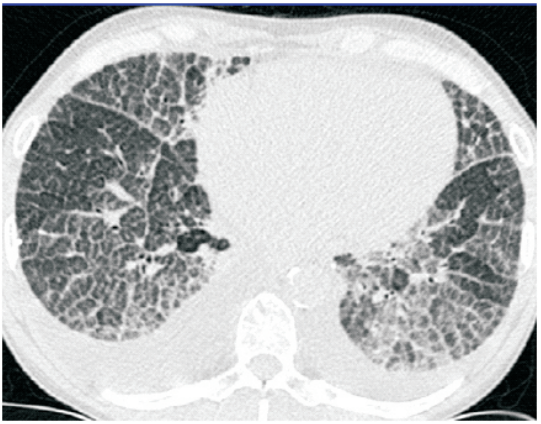
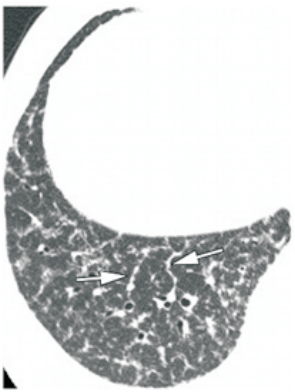
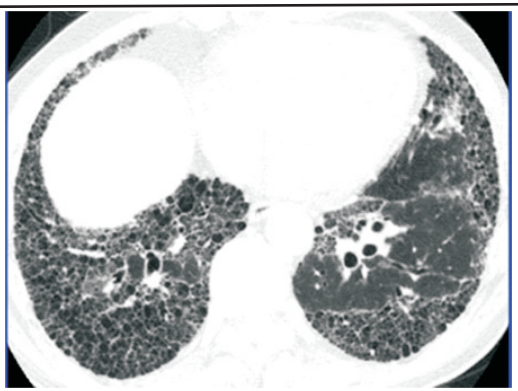
	**Pulmonary oedema** smooth thickening of the interlobular septae predominantly lower lung zones
	**Sarcoidosis** interlobular septal thickening associated with several septal nodules (arrows) central/upper/middle lung zones beading of the fissure
	**Idiopathic pulmonary fibrosis** reticular pattern honey combing

Image Plate. 4: Linear pattern

Linear/Septal pattern

Disease	HRCT Findings	Key Points
Pulmonary oedema (Classic)	Basic prototype pattern,classical smooth thickening of the interlobular septae predominantly lower lung zones GGO / consolidation perihilar pleural effusion (bilateral	Cardiomegaly Lower zone predominant
Lymphatic carcinomatosis	Septal pattern mimicker Nodular (or smooth) thickening of the interlobular septae * thickening of the peribronchovascular interstitium * central Or peripheral * pleural effusion (30%)	may be unilateral / focal lymph node enlargement – 40%
Sarcoidosis	Septal pattern mimicker nodular (or smooth) thickening of the interlobular septae * intralobular thickening / linear opacities * central/upper/middle lung zones * beading of the fissure	Lymphadenopathy,calcification beading of the fissure
Lymphocytic interstitial pneumonia	nodular (or smooth) thickening of the interlobular septae * ill-defined centrilobular nodules * diffuse / patchy GGO * lung cysts * lymphadenopathy	Lymphadenopathy,calcification beading of the fissure

Table 4: Differential diagnosis of linear pattern

Reticular pattern

Disease	HRCT Findings	Key Points
IDIOPATHIC PULMONARY FIBROSIS (IPF)	irregular interlobular septal thickening intralobular interstitial thickening traction bronchi-ectasis/olectasis honeycombing GGO w fibrosis subpleural/posterior	Lower and posterior predominance honeycombing
NON-SPECIFIC INTER-STITIAL PNEUMONIA (NSIP)	Mild reticulation GGO consolidation lower lobe predominant honeycombing (minimal) HRCT 66% diagnostic accuracy	more GGO less honeycombing
CHRONIC HYPERSENSITIVITY PNEUMONITIS	traction bronchi-ectasis/olectasis honeycombing GGO / centrilobular nodules patchy distribution no zonal predominance HRCT 50% Dx accuracy	Llobular decreased attenuation other than lower zone

Table 5: Common disease with reticular pattern

Decreased attenuation (Low density)

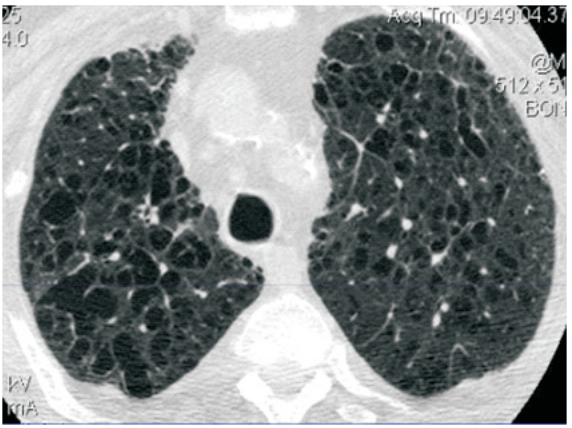
Generally decreased lung attenuation can be found if there is any of the following are present.Hypoperfusion,Air-trapping,Cystic and cyst-like lesions,Pulmonary emphysema

1. Pulmonary emphysema

Pulmonary emphysema is characterized by permanently enlarged airspaces distal to the terminal bronchiole with destruction of the alveolar walls. Emphysema is classified, using both histopathologic techniques and HRCT imaging,according to the acinar region affected: proximal (centriacinar or centrilobular emphysema), distal (paraseptal emphysema), or whole acinus (panacinar or panlobularemphysema). The tomographic findings are areas of low attenuation, typically without visible walls(TABLE 6) (IMAGE PLATE 5).

Emphysema type	HRCT findings
centrilobular	Upper lobe predominance. normal lung parenchyma almost completely replaced by abnormally low attenuation often abutting centrilobular artery
panlobular emphysema	shows either diffuse or lower lobe predominance. This is the pattern of emphysema commonly present in patients with a1-antiprotease deficiency. On HRCT, panlobular emphysema appears as extensive low attenuation that manifests as diffuse "simplification" of pulmonary architecture
Distal acinar, or paraseptal	commonly occurs in smokers and shows upper lobe predominance.characteristically peripheral in distribution, multiple areas of low attenuation with thin, definable, uniform walls distributed in the subpleural regions of lung, forming a single layer. Spontaneous pneumothorax may occur in association with paraseptal emphysema.

Table 6: Emphysema HRCT findings

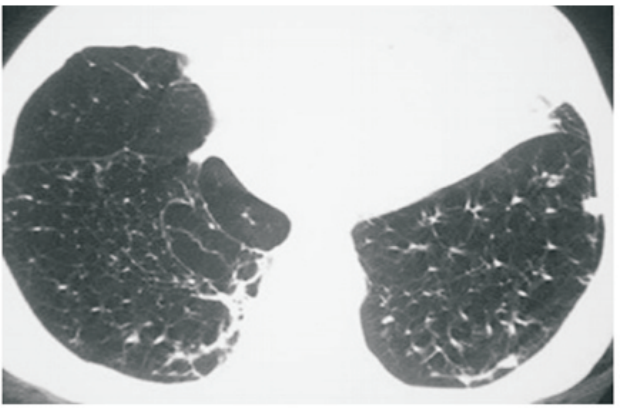


Centrilobular emphysema

scan through left upper lobe shows a centrilobular artery in many of the lowattenuating areas

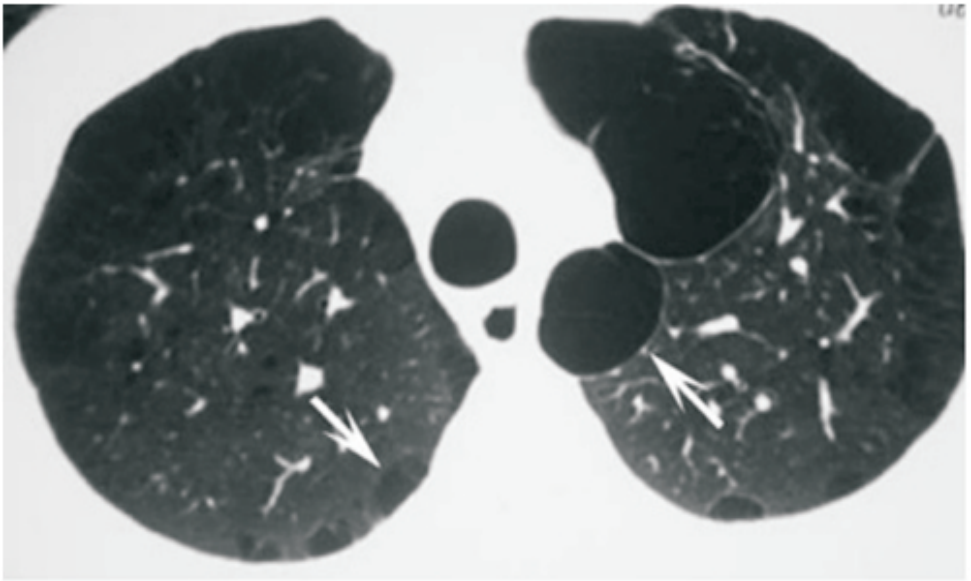
Normal lung parenchyma almost completely replaced by abnormally low attenuation.

The low attenuation, often abutting centrilobular artery.



panlobular emphysema

Axial HRCT image through the lower lobes shows diffuse low attenuation and simplification of pulmonary architecture. Note how the vasculature in the lower lobes seem stretched and attenuated. Discrete areas of low attenuation are more difficult to appreciate in patients with panlobular emphysema than those with centrilobular emphysema



distal acinar and paraseptal emphysema Axial HRCT image through the upper lobes shows subpleural areas of low attenuation with very thin, uniform walls (arrows) consistent with paraseptal emphysema. Note how paraseptal emphysema forms a single layer in the subpleural regions of lung

Image Plate 5: Emphysema-Common types

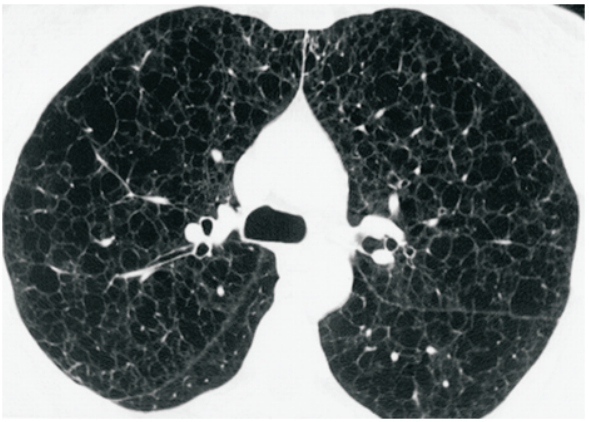
2. Cyst

A cyst is any rounded, well-circumscribed space surrounded by an epithelial or fibrous wall of variable thickness. On CT scans, a cyst is seen as a rounded area with low attenuation coefficient on the lung parenchyma, having a well-defined interface with the adjacent normal lung.The cyst wall is usually thin (< 2 mm), but it can vary in thickness. Cysts are usually filled with air but can also contain liquid (e.g., bronchogenic cyst) or even a solid material. Diseases accompanied by multiple pulmonary cysts include lymphangioleiomyomatosis(LAM), Langerhans cell histiocytosis (LCH), lymphocytic interstitial pneumonia and Birt-Hogg-Dubé syndrome.(TABLE 7) (Image plate 6)

Cystic lung diseases: distinguishing features on high-resolution CT

Disease	Clinical	HRCT features
Langerhans' cell histiocytosis	Smoker	Upper lobe predominance Centrilobular nodules Bizarre-shaped cysts
Lymphangioleiomyomatosis	Women of childbearing age	Diffuse distribution Pleural effusion Uniformly shaped cysts
Lymphocytic interstitial pneumonia	Connective tissue disorders (especially Sjögren's syndrome)	Cyst size range: 1–30 mm Septal thickening Centrilobular nodules
Postinfectious pneumatoceles	Children with *Staphylococcus aureus* pneumonia Severely immunocompromised patients (AIDS, *Pneumocystis jiroveci* pneumonia Infection in endemic region (coccidioidomycosis)	Cyst evolves with bronchopneumonia Multifocal ground-glass opacity, pneumothorax Cyst evolves from a nodule

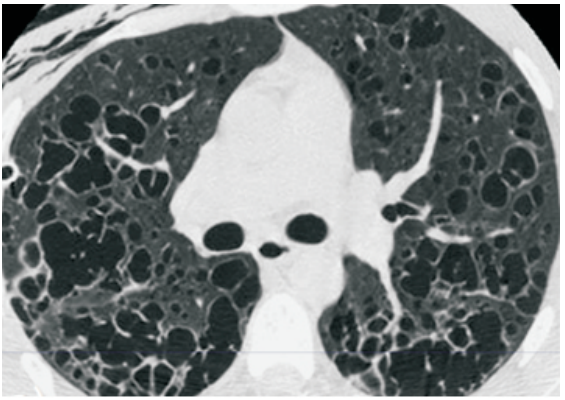
Table 7: Common cystic diseases



LAM

Mostly in woman lymphangioleiomyomatosis severe lung destruction, with almost complete replacement of normal lung parenchyma by cysts that were uniformly distributed throughout lungs.

Diffuse distribution Uniform,thin walled lung cysts usually round costophrenic angles+lung bases pleural effusion



Langerhans' cell histiocytosis (LCH)

thin & thick-walled lung cysts bizzare shaped (cloverleaf!) upper/middle lung zones

* sparing of costophrenic angles
* smoker
* associated nodules

GGO

Image Plate 6: Examples of cysts

1. Bronchiectasis

Bronchiectasis is defined as localized, irreversibledilation of the bronchial tree. HRCT findings of bronchiectasis include increased bronchoarterial ratios, lack of appropriateairway tapering, bronchial wall thickening and irregularity, mucoid impaction, and mosaic perfusionwith air trapping.Bronchial dilation (increased bronchoarterialratio). Bronchial dilation is the most specificfinding for bronchiectasis. In general, bronchiectasis is present when the bronchoarterial ratio (the ratio of the internal diameter of the bronchus to its adjacent pulmonary artery) exceeds 1. When an increased bronchoarterial ratio is seen in cross-section, it has been termed the "signet ring" sign. (Table 8)

Some signs of Bronchiectasis in HRCT	Explanation
1.Bronchial dilation	Increased bronchoarterial ratio exceeds 1 Bronchial dilation is the most specificfinding for bronchiectasis. When an increased bronchoarterial ratio is seen in cross-section, it has been termed the "signet ring" sign,seen best in cystic type
2.Lack of bronchial tapering.	The earliest sign of cylindrical bronchiectasis, lack of bronchial tapering, is often subtle,It is easiest to see in coronal.sagittal section ,seen best in varicoid type
3. Visualization of peripheral airways.	Visualization of an airway within 1 cm of the costal pleura is abnormal and indicates potential bronchiectasis. Air-ways may be seen within 1 cm of the mediastinal pleura, but should never be seen actually to abut the mediastinal pleura
4.Mucoid impaction.	Fluid- or mucous-filled, dilated bronchi are usually easily appreciated on HRCT. They may be seen as branching structures when imaged in longitudinal section(Finger –in –glove sign) or as nodules whenimaged in cross-section

Some signs of Bronchiectasis in HRCT	Explanation
5.bronchial wall thickening	Mucous gland hypertrophy.
6.irregularity	Corrugated appearnance,best seen in traction type

Table -8 Common signs in Bronchiectasis

Mixed attenuation pattern

A) Crazy paving refers to the appearance of ground-glass opacity with superimposed interlobular septal thickening and intralobular reticular thickening.It is a nonspecific finding that can be seen in a number of conditions. **Common causes of crazy paving include-**acute respiratory distress syndrome,bacterial pneumonia, acute interstitial pneumonia: essentially ARDS of unknown aetiology, pulmonary alveolar proteinosis (PAP)

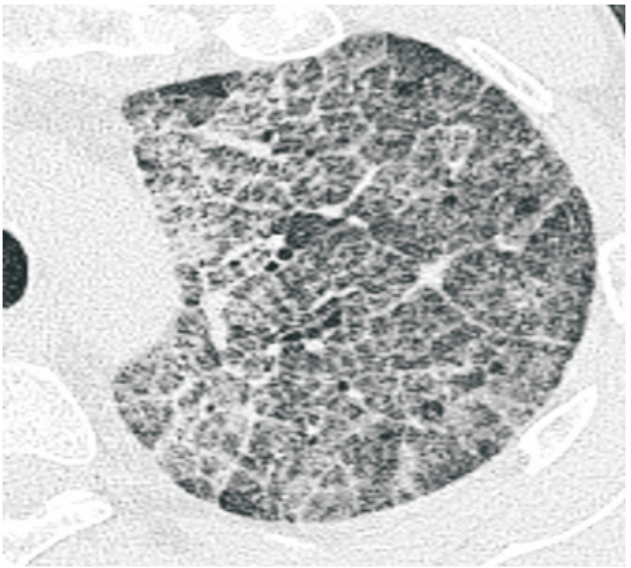
B) Honeycomb lung Honeycomb lung represents the presence of end-stage lung. Pathologically, honeycomb cysts consist of air-containing spaces with thick walls that are lined with bronchiolar epithelium and fibrous tissue. The HRCT demonstration of honeycomb cysts allows for a confident diagnosis of a fibrosing pulmonary process, and the specific distribution of the honey-comb cysts may be a clue to the aetiology of the fibrotic lung disease. Honeycombing suggests extensive lung fibrosis with alveolar destruction and can result in a cystic appearance on gross pathology. HRCT shows thick-walled, air-filled cysts, usually between the size of 3mm to 1cm in diameter.

C) **Tree-in-bud sign** describes the CT appearance of multiple areas of centrilobular nodules with a linear branching pattern.. Tree-in-bud sign is not visible on plain film [2] and is best seen on HRCT. Typically, they are composed of centrilobular nodules (which are usually 2-4 mm in diameter and peripheral, within 5 mm of pleural surface) connected by opacified or thickened branching structures extending proximally (representing the dilated and opacified bronchioles. **Pathogenesis -**bronchioles filled with pus or inflammatory exudates,e.g. pulmonary tuberculosis, aspiration bronchopneumonia ;bronchiolitis: thickening of bronchiolar walls and

bronchovascularbundle,e.g. cytomegalovirus pneumonitis, obliterative with mucus plugging bronchiolitis; bronchiectasis

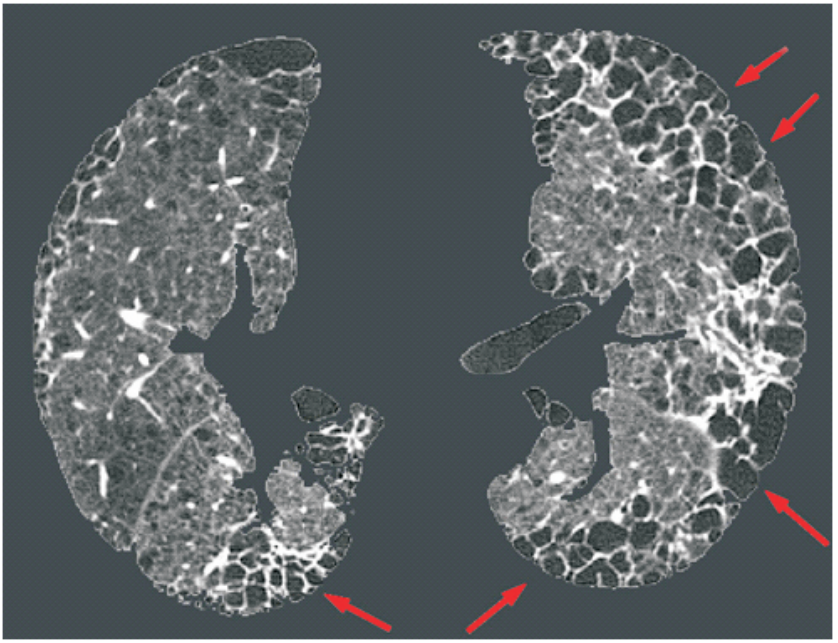
D) Mosaic attenuation is the description given to the appearance at CT where there is a patchwork of regions of differing attenuation. It is a non-specific finding, which may be seen in any of the following:

- **obstructive small airways disease:** low attenuation regions are abnormal and reflect decreased perfusion of the poorly ventilated regions, e.g. bronchiectasis, cystic fibrosis, constrictive bronchiolitis
- **occlusive vascular disease** (can be termed a **mosaic perfusion** pattern in this setting [7]): low attenuation regions are abnormal and reflect relative oligaemia, e.g. chronic pulmonary embolism
- **parenchymal disease:** high attenuation regions are abnormal and represent ground-glass opacity



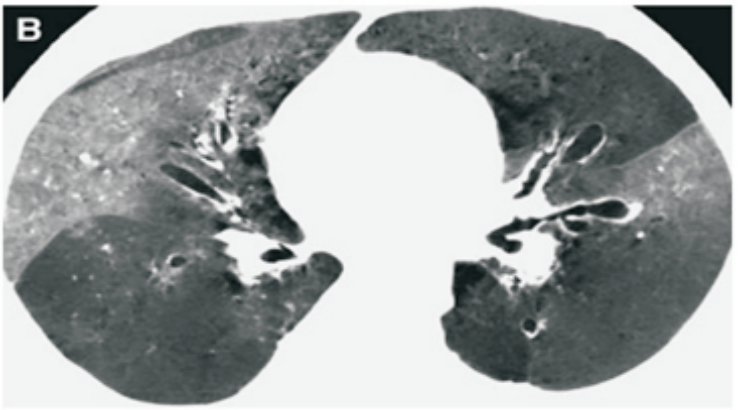
CRAZY –PAVEMENT

The combination of ground-glass opacity and intra- and interlobular lines creates the crazy-paving pattern



HONEYCOMBING

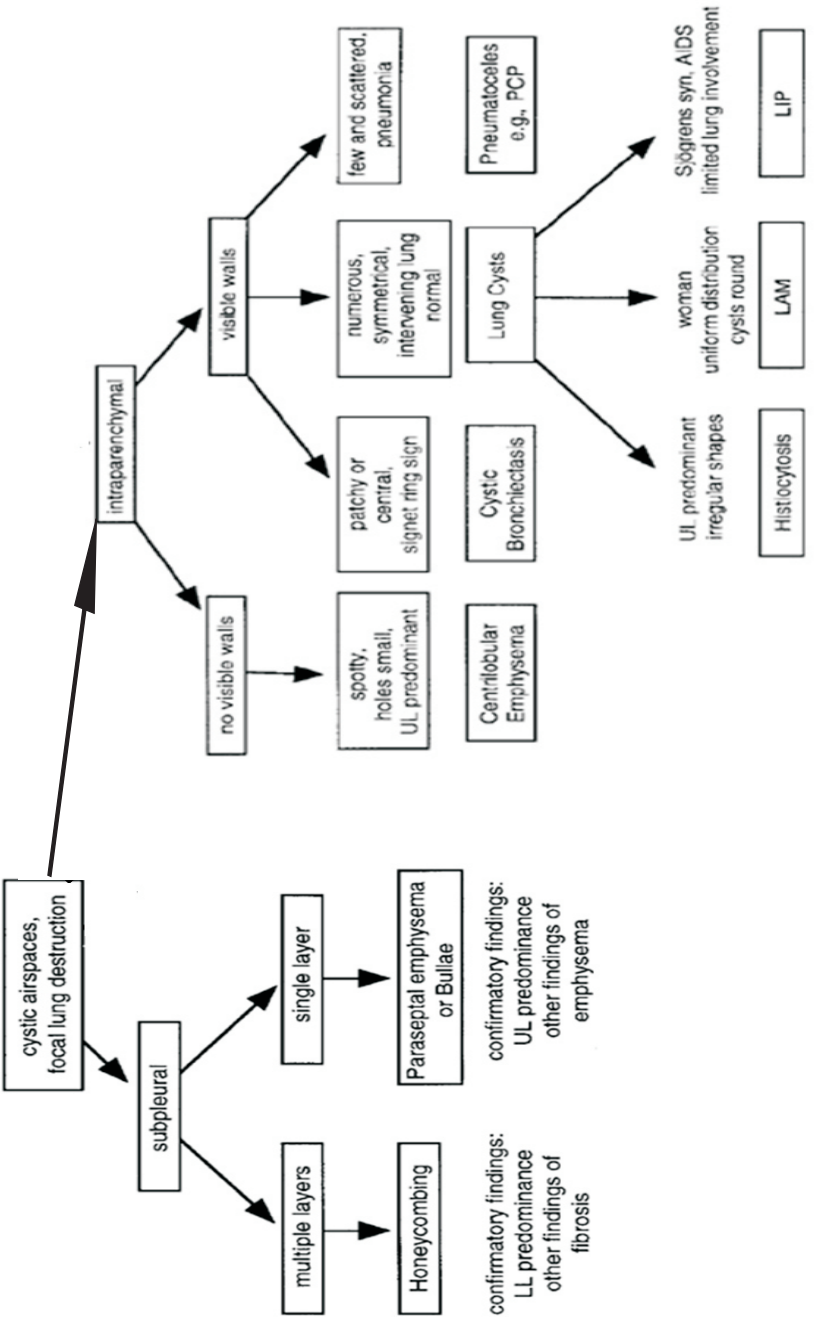
Honeycombing combines linear opacities and cystic lung changes (arrow)



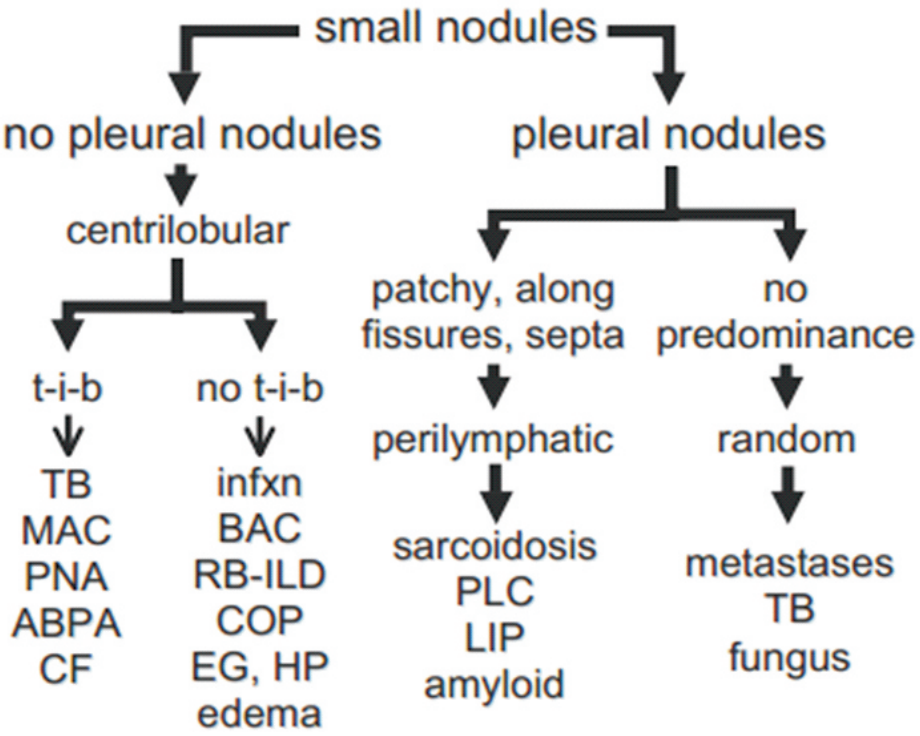
MOSAIC PATTERN

Central bronchiectasis with multifocal, bilateral inhomogeneous lung opacity. Note how the vessels within the areas of abnormally low attenuation are smaller than their counterparts in areas of normal lung attenuation

Image Plate- 7 Mixed pattern



ALGORITHM-1 FOR CYSTIC LESIONS



ALGORITHM-2 FOR NODULAR PATTERN

Anatomic nodule localization on HRCT.

Allergic bronchopulmonary aspergillosis (ABPA); Bronchio-loalveolar carcinoma (BAC)

Cystic fibrosis (CF); Cryptogenicorganizing pneumonia (COP);Eosinophilic granuloma (EG), Langerhans' cell histiocytosis;

Hypersensitivity pneumonitis (HP); infarction, infection (bacterial,fungal, or viral);

Lymphocytic interstitial pneumonia (LIP);,Mycobacterium-avium–complex (MAC); Pulmonary lymphangitic carcinomatosis (PLC); PNA, pneumonia (mostcommonly bacterial);

Respiratory bronchiolitis–interstitial lung disease (RB-ILD); TB, Mycobacterium tuberculosis;

tib, tree-in-bud

MR Spectroscopy and its utilisation in clinical practice

Contributor & Sectional Editor

P. S. SHANKAR

MR Spectroscopy and its utilisation in clinical practice

Introduction

Magnetic resonance spectroscopy (MRS) is a non-invasive diagnostic procedure to measure the biochemical changes in the brain especially in presence of tumours. Magnetic resonance imaging (MRI) helps in identification of the anatomical site of the tumour. MRS provides a non-invasive method of studying metabolism in vivo, and one can get information on its chemical composition of the structure by measuring the levels of different metabolites. MRS, a specialised technique, is considered as an extra sequence on MRI. It provides biochemical information of compounds present in the brain, prostate, breast and liver. It is also known as nuclear magnetic resonance (NMR) spectroscopy. Best results can be obtained when MRS is combined with contrast-enhanced MR perfusion. The test is a non-invasive analytical technique useful in the study of metabolic changes in brain tumour, stroke, multiple sclerosis, epilepsy, Alzheimer's disease and other disorders affecting the brain, and also tumours of prostate and breast. MRI gives information about the structure of the body (the distribution of water and fat) and gives information on the location of the tumour, whereas MRS gives information on the grade of the tumour. MRS compares the chemical composition of normal brain tissue with abnormal tumour tissue. It is also useful in the study of tissue changes in other neurological disorders such as stroke and epilepsy.

Basis of MR Spectroscopy

MRS is performed on magnetic resonance imaging (MRI). The MRI utilises powerful magnetic radio waves and a computer to create detailed images. The magnetic resonance signal produces a spectrum of resonances that correspond to different molecular arrangements of the isotopes being 'excited'. MRS imaging combines both spectroscopy and imaging methods to produce spatially localised spectra from the lesion in a patient (1). The tissue's chemical environment determines the frequency of a metabolic peak in an MRS spectrum. !.5 Tesla MR machine can

undertake MRS. Higher strength 3 Tesla are best for MRS result and quality.

Spectroscopy is a series of tests that are added to the MRI scan of the brain to measure the chemical metabolism of a suspected tumour. MRS results graphs, not pictures. MRS picks up signals from different chemical nuclei within the body such as hydrogen (proton), sodium (^{23Na}), or phosphorus (^{31P}). Proton spectroscopy is relatively easy to perform and it provides greater signal-to-noise than either sodium or phosphorus (2). Protons are used because of their high natural abundance in organic structures and high nuclear magnetic sensitivity. It can be included to conventional MRI protocols. MRS displays the quantities as a spectrum in routine MRI. The results of MRS have to be interpreted in association with MR images. ^{31}Pspectroscopy is utilised to study muscle pathology including that of cardiac muscle. ^{23}Na spectroscopy is utilised to study disorders affecting musculoskeletal system.

Nucleus with different chemical neighbours will have slightly different resonance frequencies. The small change in the resonance frequency referred to as 'chemical shift' is the basis of MRS. MR offers the possibility to 'visualise' the chemical environment via spectroscopy, examining the metabolism of an area in question.

Measurement of metabolites

Utilising MRS, various metabolites or products of metabolites from the lesions can be measured. MRS displays the quantity as a spectrum in routine MR imaging. The spectra in each voxel (the volume element that is being sampled) contain information about many metabolites. The signal from each voxel is divided into smaller number of chemically distinct species. The SNR spectra is lower than that of MR images to obtain an acceptable level of SNR in reasonable imaging times, much larger voxels are needed for MRS (voxel size of 1 to 8 cm3) than MRI (1 to 5 mm3).

The parameters that characterise each peak in MRS include its resonance frequency, its height and its width at half height. The resonance frequency position of each peak on the plot is dependent on the chemical environment of that nucleus. Presence of more metabolites is shown by presence of taller peaks or greater area under the peak. They include amino acids, lipids, lactate, alanine, choline, N-acetyl aspartate, and creatine. The resonant frequencies of nuclei are expressed in units as

parts per million (ppm, a dimension-less unit) and plotted along a graph as peaks of varying heights (table 1). The horizontal axis is NMR frequency of chemical shift in ppm relative to a reference chemical at 0 ppm and the vertical axis is signal strength in arbitrary units. Each metabolite appears at a specific ppm and each one reflects specific cellular and biochemical process. Each metabolite has a different peak in the spectrum. The results are compared to normal brain tissue. This helps in determination of the type of tissue present (3).

Table1. Proton metabolites

Metabolite	ppm	properties
Alanine	1.48	meningioma
Choline	3.22	marker of myelin breakdown
Creatine	3.2	reservoir of high energy
Glutamine/GABA	2.2-2.4	cell membrane marker, neurotransmitter
Lipids	0.9- 1.4	produced by brain destruction
Lactate	1,3	produced by anaerobic glycolysis
Myo-inositol	3.5	marker of cell membrane
NAA	2.0	marker of neuronal integrity

Acquisition of the data

To acquire the data, initially an MR image is to be obtained as a localizer image and a volume of interest is then selected. The total signal from all the protons in each voxel is used to make the image. While scaling the peaks fat and water are eliminated as they give huge peaks and are not playing any role in the diagnosis. If a single voxel is to be analysed, then a single 3D region of interest is selected. The spectrum is collected based on the number of protons in the voxel. The proton signals are detected and represented as free induction decay (FID). After application of a Fourier transformation to the FID, the temporal information is converted into frequency information. The data is presented as a series of peaks along an axis labelled in ppm. In normal adult brain the dominant peak is that of NAA with choline and creatine being the other large peaks.

MRS can be undertaken by two methods: single voxel spectrum (SVS) and chemical shift imaging (CSI or multi-voxel spectrum. It can be done in long or /and short TE (echo time) in single or/and multivoxel in

single slice. Normally the single voxel, short TE technique is used to make limited diagnosis as the signal-to-noise is high and all metabolites are represented. Single voxel spectrum gives a spectrum of a single sample volume. For SVS technique, two main acquisition schemes are used. They are spin echo (SE) or point-RESolved spectroscopy (PRESS) and stimulated echo acquisition method (STEAM). It is essential to suppress the water signal and for regions outside the central nervous system, also the lipid signal.

In multi-voxel spectrum system, the spectrum is obtained from multiple voxels in a single slab of tissue. If multiple voxels are to be evaluated, a region of interest such as a mass for evaluation and a region of normal brain are selected for comparison. Multi-voxel, long TE techniques are used to further characterise different regions of the mass and to assess brain tissue around or adjacent to the mass. Protons in different molecules resonate at slightly different frequencies. Multi-voxel, long TE technique is also used to assess response to therapy and to search for tumour recurrence.

SVS gives a better signal-to-noise ratio, but it gives only a single spectrum. It is possible to cover a much larger area with multi-voxel spectrum eliminating sampling error to a greater extent. There is a significant weakening in the signal-to-noise ratio and it takes a longer scan time. Both imaging techniques utilise specialised MR pulse sequences.

It is to be noted that by using long TEs the signal from most metabolites in the brain is lost except that of NAA, Cho, Cr and lactate. Short TEs allow identification of other metabolites such as myoinositol and glutamine. There are significant regional differences in metabolite destruction in both grey and white matter of the brain. The regions like blood, bone, air, metal, and cysts are to be avoided while making selection of voxels to prevent occurrence of artefacts. The areas like posterior cranial fossa and spinal cord, tumours containing cystic components, regions of calcification, cerebrospinal fluid, and blood pose difficulties to image and create artefacts (4). To get an accurate assessment of tumour chemistry, the spectroscope voxel has to be placed over the enhancing region of the tumour instead of the areas with calcification, haemorrhage and bone.

MR spectra are obtained from grey matter and white matter. The predominant metabolites such as NAA, creatine, choline and myo-inositol

are displayed from right to left. Neurosurgeon, Hunter Sheldon has formulated a line at 45^0angles on the spectrum formed by the metabolites on the white matter and normal peaks correspond to it (Hunter's angle). If the peaks strayed away from that the result is considered abnormal. A high-grade tumour has an abundant amount of LL and Cho and the amount of NAA is depressed. A low-grade tumour exhibits elevation of Cho but there is not marked elevation of LL. NAA is depressed.

Neuronal markers

Various metabolites can be studied utilising MRS. Several metabolites such as N-acetyl aspartate (NAA), choline (Cho), lactate and lipid groups (LL) are included in the spectrum of single voxel MRS. Though observable metabolites give useful information, but many other important metabolites are not represented in brain MR spectra.

N-acetyl aspartate: NAA is an acetylated amino acid found exclusively in neurons and myelin sheaths of nerve fibres. The neuronal health is determined by NAA. Hence it reflects the good part of the brain, and is considered to be a marker of neuronal viability. In normal spectra, NAA is the largest peak. N-acetyl aspartate resonates at 2.02 ppm chemical shift. Higher peaks reflect normal health of neurons, and diminished peaks are noted in presence of neuronal damage.

Creatine: Creatine phosphocreatine, Cr) is found in metabolically active tissue such as brain, muscle and heart. It is a reservoir for high energy phosphate for generation of adenosine triphosphate (ATP). It is involved in energy metabolism of brain cells. It plays an important role in storage and transfer of energy. Generally, it is maintained at a relatively constant level. It resonates at 3.2 ppm chemical shift. The level of creatine is reduced in gliomas.

Choline: Choline (Cho) is precursor of acetyl choline and it is a component of the phospholipid metabolite of cell membrane. It is associated with glial cell membrane integrity. It reflects cellular turn over. It resonates at 3.22 ppm chemical shift. Active growth of a tumour is associated with persistent elevation of Cho. Hence it is considered as a marker of cellular membrane turnover or tumour marker. Its presence is considered 'bad'. Cho level is also raised transiently in multiple sclerosis, acute infarction, and inflammatory conditions.

Lactate (lactic acid) and lipids: Lactate resonates at 1.33 ppm chemical shift and exhibits two peaks close to one another (doublet). Normally lactate is absent in the brain tissue. Lactic acid is produced as a by-product of anaerobic glycolytic metabolism. Lipids are also absent normally in the brain but can be increased in tumours and infections. Lipids are seen at a range of 0.9 to 1.22 ppm. Both these substances are released following destruction of cells or in presence of necrosis of cells. An increased level is encountered in necrotic tumours, and in stroke associated with destruction of cells (infarct) and in abscesses. They are also increased in mitochondrial disorders, and multiple sclerosis plaques. It is considered 'ugly' and is elevated in high grade tumours. Presence of lipids indicates tissue necrosis and of lactate, hypoxia. Both CSF and cysts contain lactate products and may lead to an inaccurate elevation of lactate or lipids.

Glutamine /GABA: Glutamic acid/GABA (Gamma amino butyric acid) (Glx) act as excitatory neurotransmitter and it resonates at 2.2-.24 ppm chemical shift. It is a cell membrane marker. Glutamine plays a role in detoxification and regulation of neurotransmitter activities. It is found in excess amount in glioma, stroke, lymphoma and hypoxia.

Myo-inositol: Myoinositol (mi) is a naturally occurring sugar and resonates at 3.5 ppm chemical shift. It is a cell membrane marker. It is elevated in Alzheimer's disease, Down syndrome and gliosis. Its presence shows cell destruction. Myo-inositol is markedly reduced in hepatic encephalopathy.

Alanine: Alanine is a non-essential amino acid and it resonates at 1.48 ppm chemical shift. It is raised in meningioma.

The metabolites such as NAA, Cho and LL have been considered as the good, bad and ugly respectively substances and are located on x-axis of the graph from the right side at 2.02, 3.22, and 0.9 to 1.33 ppm (4). Normally the analysis of the clinical spectra is made by looking at metabolite ratios such as NAA/Cr, NAA/Cho or Cho/Cr. It is possible to calculate absolute concentrations of metabolites by including a known reference solution when acquiring the MR spectra data. The normal metabolite ratios are shown in parenthesis NAA/Cr (2.0), NAA/Cho (1.6) and Cho/Cr (1.2). Any deviation from the normal value is considered abnormal.

Uses in clinical practice

MRS is used by medical physicists and biochemists to undertake medical research. It helps the clinicians to give clinical information useful in the diagnosis and treatment of a variety of neurological disorders. MRS may not add much information to MR study. But it does increase specificity and may help to improve the ability to predict histologic grade of tumours. MRS can be used to serially monitor biochemical changes in tumours, stroke, epilepsy, metabolic disorders and neurodegenerative conditions. MRS is used to determine the tumour types and their aggressiveness. It is also useful to distinguish between the recurrence of tumours and radiation necrosis. MRS enables imaging at the molecular level providing information about the brain tissue (4, 5).

Brain spectroscopy

Glioma: MRS is used to determine the degree of malignancy. As the malignancy increases in size, the level of NAA and Creatine decrease. The levels of choline, lipid and lactate are elevated. With the destruction of neurones or with the increase in tumour growth the level of NAA shows marked decrease (6). Very highly malignant tumours exhibit high metabolic activity and deplete energy stores thus reducing the levels of creatine. Hypercellular tumours with rapid growth cause an elevation in the levels of choline (7) (Fig 1 and 2). Lipids are commonly seen in necrotising tumours. Lactate is found in anaerobic situations when the tumour has outgrown its blood supply. A biopsy can be taken from a metabolically active region of tumour to grade the tumour accurately. Gliomas exhibit an elevated choline beyond the margins of enhancement due to infiltration of tumour into the adjacent brain tissue. Non-glial tumours exhibit little or no NAA.

Meningioma: Meningiomas are associated with elevated levels of alanine. Choline shows a high peak in meningioma with low or absent NAA and creatine. There is an unusually high ratio of alanine to creatine.

Cerebral ischaemia and infarction: In situations of ischaemia of brain, there is occurrence of anaerobic glycolysis and accumulation of lactate. It leads to markedly raised levels of lactate in spectroscopy. Choline is elevated and there is reduction in NAA and creatine. Lipids are considered marker of severe tissue damage and the liberation of membrane lipids leads to its increased level as in cerebral infarction.

Radiation necrosis: Radiation necrosis does not have elevated choline levels. Often there is need to distinguish tumour recurrence from radiation effects on the tumour following surgery or radiotherapy. Recurrence of tumour is shown by raised level of choline and radiation necrosis is associated with low levels of NAA, creatine and choline on spectroscopy. In presence of radiation necrosis the spectra exhibits raised levels of lipids and lactate.

Brain abscess: There is destruction or displacement of neuronal tissue in brain abscess. There is absence of NAA. The level of choline and creatine are reduced. The breakdown products of abscess cavity in bacterial infection are associated with raised lactate and alanine. Tuberculomas exhibit prominent peaks from lactate and lipids.

Metastases: Metastases in the brain show low choline levels because of vasogenic oedema and increased interstitial water whereas gliomas show an elevated choline levels due to infiltration of tumour cells. The level of lipid is high in metastases (6). Creatine peak is absent in metastases and it helps to differentiate a metastasis from a glioma.

Table 2: Abnormal spectra in neurological disorders

Disorder	NAA	Cr	Cho	lactate
Glioma	significant	moderate	elevation	
	reduction	reduction		
Meningioma	not contained		marked increase	

Multiple sclerosis: Multiple sclerosis shows a decrease in NAA and the level of choline is increased.

Hepatic encephalopathy: There is marked reduction in myo-inositol in hepatic encephalopathy. There is reduction in choline and glutamine shows an increase. The latter is because of raised levels of ammonia which cause an increased conversion of glutamate to glutamine. Hepatic encephalopathy is detected on MRS even before structural changes seen on MRI.

HIV encephalopathy: In HIV encephalopathy, there is significant diminution of NAA peak while MRI shows minimal changes.

Alzheimer's disease: In advanced stages of Alzheimer's disease, NAA is reduced. Myo-inositol level is increased. Such changes are not encountered in other types of dementia in adults (8).

Spectroscopy of Prostate

Prostate cancer is associated with proportionately lower level of citrate and higher levels of choline and creatine than are seen in benign prostate hypertrophy or in normal prostate tissue. The alteration in these chemical substances may be helpful in assessing response to treatment, most commonly with radiation and/or androgen deprivation (9).

Spectroscopy of Breast

Brain spectroscopy is usually performed with a single voxel technique. It may serve as a useful adjunct to breast MR imaging in distinguishing between benign and malignant lesions (10). The diagnostic value of MRS is typically based on the detection of elevated levels of choline compounds, which is a marker of active tumours.

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Figures

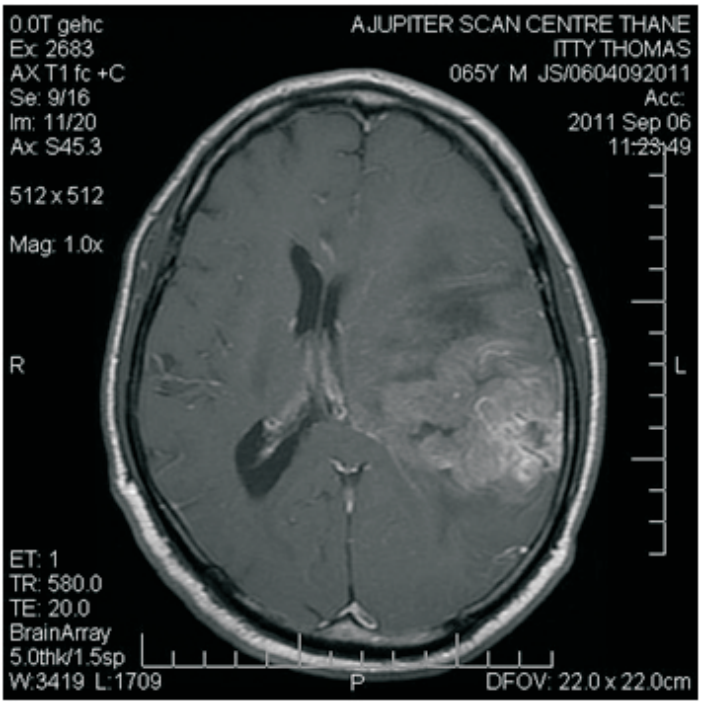

Fig 1. MRI Axial post-contrast T1 W images showing heterogeneous contrast enhancement by the mass lesion

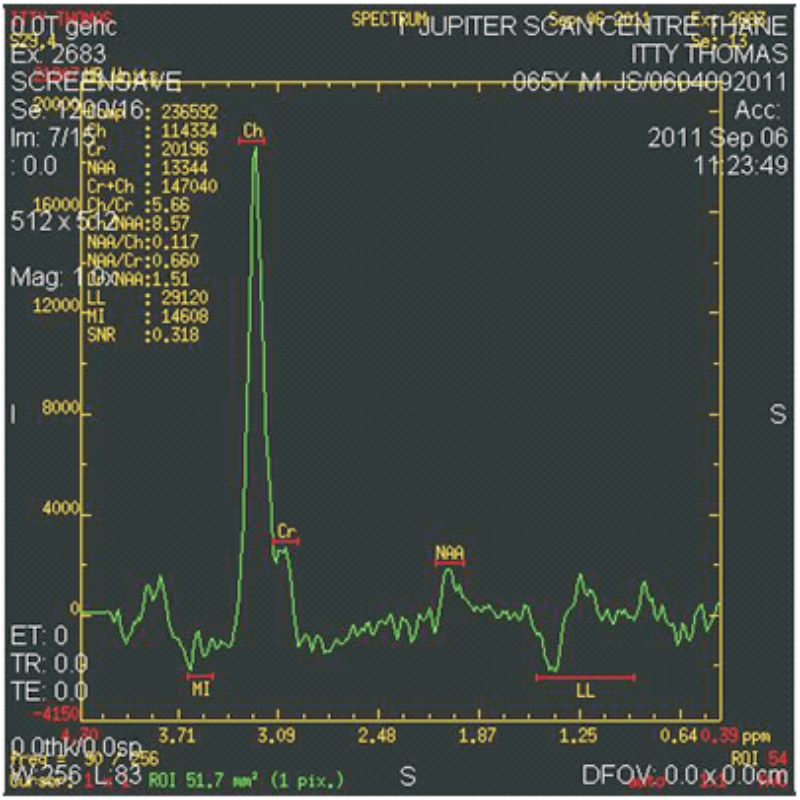

Fig 2. MRS showing high choline peak suggesting active cell multiplication /active mitosis in the mass lesions

Life Skills for Children

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Life Skills for Children

Every child during its growing period has to acquire many life skills to become independent and survive in the society. Practicing General Practitioners, Physicians and Pediatricians have to educate the parents about 10 Life Skills recommended by World Health Organization (WHO) and Basic Skills.

Ten Life Skills recommended by WHO

Taking into consideration of many skills which are required to live comfortably in life WHO has chosen 10 Life-skills and recommended to all 200 member countries to teach these skills to children and adolescents.

Skill 1 – CRITICAL THINKING

Skill 2 – CREATIVE THINKING

Skill 3 – PROBLEM SOLVING

Skill 4 – DECISION MAKING

Skill 5 – COMMUNICATION

Skill 6 – INTERPERSONAL SKILLS

Skill 7 – EMPATHY

Skill 8 – SELF-AWARENESS

Skill 9 – EFFECTIVE MANAGEMENT OF EMOTIONS

Skill 10 – EFFECTIVE MANAGEMENT OF STRESS

Let us understand what these skills mean and how to teach them to children.

1 & 2: CRITICAL THINKING and CREATIVE THINKING

Greatness of human beings compared to animals is the size of brain (1.30kg) and thinking ability. Animals thinking is restricted to getting food, self-protection and procreation whereas human beings have the capacity to explore the nature, understand the cause and effect, plan and execute, analyse good and bad, immediate and long term benefits, control actions and reactions, set goals, and select the convenient path to reach the goals, anticipate hurdles and plan to avoid them. Select a life

style which is convenient and profitable acquire property, name and fame, understand truth and false. Find explanations for successes and failures, do research and inventions, create new things…. The list goes on!

Growing child has to be helped to think, imagine, ask questions, explore, find solutions, and be creative. They should observe the events and changes and understand them. They should think critically, logically, meaningfully, try to find solutions for problems. Select the best solution which is cost-effective and practicable.

Thinking is of two types: Positive and Negative. Positive thinking increases optimism and self-confidence, whereas negative thinking decreases self-confidence and increases pessimism. Negative thinking leads to frustration which in turn increases negative thinking. Negative emotions generate sadness, fear and anger which further worsen the situation. Positive thinking makes a person to talk and behave positively. For example, if the child thinks that he is going to win, to pass the examination makes friendship with others, he will be able to do so. Think about all aspects of an issue and understand it.

3 & 4: PROBLEM SOLVING – DECISION MAKING

Every one of us faces problems every day. We have to find solutions. Every day we have to take decisions some are small; some are big decisions and we are expected to take right and good decision.
Any child/adolescent may face any of the following problems at any stage or time.

- Parents neglect, do not love, do partiality
- Sibling rivalry
- Severe punishments for minor mistakes
- Family quarrels, no peace of mind at home
- Bad habits of family members like alcohol abuse
- School problems:
  - Teachers are not good
  - Classmates bully, make negative comments, ridicule.
  - Learning disorders, inability to cope with academic pressures. Choosing hobbies, Attendance shortage, what to do during leisure

time, After SSLC / PUC, what to do.

- Financial problems – Constraints of resources
- Interpersonal problems – Starting – breaking of relationships
- If living in hostel – various problems with roommates, warden, staff, food, rules and regulation, home-sickness, pressure to yield to bad habits / unhealthy entertainments
- Health problems
- Choosing the career, course
- Whether to hide or confess about mistakes done with family members. How to deal with guilt.

It is the duty of parents to sit and discuss with the child about the problems and different ways to solve them. Merits and Demerits of different decisions have to be told. If problem cannot be solved, child has to be told how to cope with the problem. One should not worry or react to a problem with fear, sadness, or anger. Any problem has to be addressed in the following manner:

- Define the problem in simple terms.
- How it started? Slowly / Suddenly?
- Who is responsible for the problem?
- In what way the problem is disturbing?
- What are the possible solutions?
- Who can help to reduce / remove the problem?

Similarly, decision making is another skill child has to learn and master the skill when he/she becomes an adult. Decision taken should be good and beneficial both in the short and long run. It should follow ethical and moral values. Family and Society should appreciate the decision. Once decision taken has to be followed and implemented. Necessary minor changes have to be made if required. The effect of decision has to be reviewed periodically. If situation and reality needs are not congenial, decision has to be changed. Till adolescent age, parents, family members, teachers make decision for the child. Later an adolescent boy / girl has to and many times they want to take decisions on their own for example.

- When to study and how to study?
- When to start preparing for examination?
- Which sport activity they should pursue?
- What hobbies they should develop?
- Should they smoke and drink with friends?
- When parents reduce / refuse pocket money, whether to steal or take a loan from others?
- After SSLC, what course? Science / Commerce / Arts / ITI
- To take up a job part time or full time?
- To start or break relationship?
- When and whom to get married?
- To buy and use a vehicle?
- Goal setting and chose the path to reach goals
- To follow ethical and moral norms or not.
- To punish / pardon others

Children have to be told to acquire knowledge, understand reality, be aware of norms of the family and society, look at the resources and take decisions they have to be told that it is always better for them to take parents or other elders into confidence, discuss issues and get guidance before taking decisions.

When parents find that the child / adolescent has taken a wrong decision, instead of blaming him or commenting on his wrong decision, they should convince him how and why his decision is or was wrong. Educate him / her and see that it is not repeated. While taking any decision, the person should be relaxed. Decisions based on emotional issues should not be entertained. Let the emotion like sadness, anger, and fear, pass off and then make decision. Think about pros and cons and then decide.

5: COMMUNICATION SKILLS

All living beings communicate with each other through sounds and body posture or body movements. They communicate their needs, distress and their emotions. Human beings have developed language - a

complex method to communicate in addition to body language. Grown up children have to learn the language, use appropriate words to communicate their feelings, thoughts, opinions, needs and resentments. Some children have learning disorder and cannot learn language well. Their vocabulary is limited. Some children feel shy, fearful to communicate. They do not open up. There may not be coordination between body language and talking. They cannot effectively communicate their feelings or opinions. They cannot argue, persuade others. Now-a-days children lag behind in writing skills. They make grammar mistakes, incomplete sentences, spelling mistakes and fail to convey what they want to convey. They cannot put their ideas and views into written language.

So, both parents and teachers should make efforts to improve the communication skills of the child.

- Encourage them to talk on any issue. Express their feelings, opinions frustrations in words and also in written form. Talk slowly and clearly.
- Read general literature, listen to talks by language experts, literary people
- Learn as many languages as possible. Follow grammar
- Understand the differences in expression in spoken and written (bookish) language.
- How to convey information to illiterates, educated and well educated
- Do exercise to express feelings in different ways in front of mirror and know the body language.
- Participate in debates, on-the-spot talking, argue on issues, and talk for and against a topic one after the other.
- Increase the vocabulary learn 5 to 10 new words every day
- How to talk to elders, middle age and young people. Know the idioms
- Take part in writing contests, write and recite poems. Write small / short essays, opinions on current issues and send to newspapers and magazines for publication
- Review articles, books with friends

- Play word building game with other children. Keep a dictionary and increase vocabulary. Know the exact meaning and spelling

6: MAINTAIN AND IMPROVE RELATIONSHIPS

All of us come alone to this world and go alone at the end. In between we have to relate and interact with many people to work and survive. Some relationships come along with birth. For example, parents, grandparents, uncles and aunts, siblings and other relatives and family members. Many relationships are acquired and incidental, classmates, teachers, neighbours, housemaids, vendors, visiting friends and guests, known and unknown people, passengers while travelling in a bus / train. When we relate to people, we should have positive attitude and feeling like love, respect, sympathy, empathy which make them comfortable and happy. We should look into their needs like food, safety. If they are in distress, unhappy, sad, fearful, we should find out the reason, console them, and make them to feel protected and safe. We should not have negative attitude and emotions towards anybody like anger, hatredness, and disrespect. We should not make fun of them, pass negative comments or take advantage of their strength or weakness. Our talk and behaviour should be good. We should not react negatively if others talk and behaviour is not good. A growing child has to be taught and trained to maintain good and harmonious relationship with all. Children follow what others in the family do. Carry on instruction given to them. For Example:

"Say hello to uncle" "Do Namaste"

"Say thank you for the sweet / gift"

"Give this chocolate to that child"

"Show your toys to them"

"Ask aunty to come again and visit us"

"Say bye / Tata"

Involve children to serve the guests. Let them take and share what they have learnt / done

'Show your drawing to mama'

'Show the doll or drawing you have made'

'Show the prize you have won in the competition'

'Tell the story / sing the song / show how you dance'

Similarly, tell and teach children good social interactions when they are taken to a function / party or to a relatives / friend's house. Encourage them to interact with co-passengers in bus / train. Share food with other children, play with them. Appreciate if your child shows good social manners and interactions.

Social Roles

All of us have to play different roles. Role of parents, siblings, friends, spouse, member of sub group or group in the family / society / workplace. Each role has different role-responsibilities, obligations. Growing children get an exposure to all these roles in the family, school, and neighbourhood and learn to take up those roles later in life and follow the expected / prescribed norms.

A boy has to play his role as a son, brother later leader of the family. A daughter has to play the role of daughter, sister and carer of the family. Each one has to reduce the ego, selfishness, share the resources.

Unconditional love, affection, kindness, sympathy, concern for other person's comfort and well-being go a long way in maintaining relationships.

Different personalities

Each person's personality is different. Some are more selfish and self-centred. Some are open and don't hide their feelings and opinions. Some are closed book and do not reveal their inner feelings. Some are wicked and plan to harm others. Overtly they look like good people but inwardly bad, jealous. Some are suspicious and do not trust others. Some receive suggestions and advises; some do not like and get offended. As children are ignorant, cannot guess the personality of others behave and react similarly with all. They get into problems when they enter into adolescent age. They have to develop skills to assess a person and follow suitable ways to interact with him / her. When they become adults, they are required to have good interpersonal interactive skills to do well in marital life, occupational life and social life in a place where they have settled down.

Temporary / Transient relationships

Every day we have to meet people and interact with them. Vendors, shop owners, salesman, co-passengers in Bus and Train, people

in temple or parks in functions, theatre, music concerts, fairs and festivals. Some irritate us, some even behave harmfully, whom should be avoided. Some make unnecessary comments, give suggestions, advices when not required by us. We have to learn to manage them, we should not be upset, react negatively. We have to develop art of tolerance. Adolescent children have to be guided in this regard

Give more and expect less in relationships.

Don't hate anybody, Don't keep any grudge.

7: INTROSPECTION – KNOW ONE'S OWN STRENGTH & WEAKNESSES SELF-AWARENESS

How much we know about ourselves? Do we know our strength? (Physical and mental) Do we know our weaknesses? Do we know what we can do or we cannot do? In what many ways we are different than others? Do we have special talents? Do we feel and believe inferior or superior to our age mates, friends and relatives? Appropriate self-awareness is essential to live comfortably and be successful. A growing child has to learn to develop good self-awareness at every stage. He may be interested to play cricket but may feel that he will not be able to do it or others will not allow and accept him in the team. Another child wants to be a singer and perform on the stage but may not have talent to learn music.

Good examples are there in our mythology regarding self-awareness. Hanuman though he was very knowledgeable and had good physical strength believed that he may not be able to cross the ocean. Once others in the team make him to realize his enormous strength, he gathers courage, fly over the ocean and set fire to Sri Lanka and warn King Ravana.

Uttara kumara son of Virataraya of Mahabharat believes and boasts about his ability to fight against army of Kaurava. But as soon as he is taken to the battlefield, starts running away.

At every stage, the child should be told about his / her strength and weakness. Keep improving the strength and reducing the weakness. When any new activity / task is given, assess the child's strength and tell him that he can do it. Over-estimation or under-estimation of one's ability is harmful.

Adolescent boys and girls have to be told to do self-introspection at the weekend or month end. What they could do, what they could not do, whether they used their full potential or not. If failures why and how to prevent them. They should not compare themselves with others who are well off or strong and feel inferior. They should not also have superiority feelings and large ego, thinking all the time they are better / best without any evidence.

Tell them that many characters in our mythology and history were MEGALO-MANICS, believing that they are the strongest and wisest but perished. All demon kings, Hiranyakashipu, Jarasandha, Kamsa, Mahishasura, Ravana, Duryodhana. Historical kings like Alexander, Chengis khan, Gajani Mohammed, Hitler, Mussolini, Idi Amin, are examples.

8. EMPATHY

Understanding the feelings, emotions, suffering, thoughts, aspirations, frustration of others, is a virtue and skill. A person with good food and full stomach may not understand the suffering of a hungry person. A person with good eye sight may not understand the plight of a blind person. A person with both legs intact and strong may not know the difficulties of a paralysed patient. A rich person having every luxury of life may not be aware of the misery of a poor person. A person who has become a topper in the exam, may not know the feelings of a student who has failed in exam. The child may not understand the suffering of parents who have taken loans to meet the expenses of the family and may demand for some more costly toys or items.

Tell the child to talk to brother / sister who is sad, crying or angry and jealous and tired. The child should understand the feelings, initially sympathetic and later empathize. Expose the child to people who are facing hardships. Take them to a village, a slum area, old age home, an orphanage. Let them talk to people understand the living conditions; ask questions about their problems and sufferings. Ask the adolescent child to place him / her in their position and feel their suffering. Men should understand the feelings of women and vice versa. The child should learn to think beyond his viewpoint or experience and understand others' viewpoints and experiences.

9: EFFECTIVE EMOTIONAL MANAGEMENT

Children show instant emotional responses. They react emotionally to a stimulus or to a situation

They jump with joy. They laugh loudly

They cry bitterly. They sit with a gloomy look.

They abuse, beat, destroy articles, and become violent with anger and hatredness.

They hug, plead for protection or runaway out of fear

They may make bad comments, harm or hurt someone out of jealousy

They kiss, hug, and hold the hands with love without bothering about norms, obligations or consequences. They cannot delay expression of emotions.

We know that emotions are natural responses to a given stimulus or experience. But all of us have to learn to express emotions in a socially acceptable manner. Our emotional expression should not disturb others. We should feel comfortable and see that others are also comfortable. Children observe how the family members, others express emotions and follow it. Now-a-days visual media, TV Shows, cinemas, influence our emotional behaviour. Children follow the popular heroes, heroines, villains and other characters of the TV Serials and cinemas to express their joy, sorrow, anger. For example:

- They talk, laugh loudly, make noise, dance, shout slogans, drink alcohol and other uncontrolled behaviour
- They shout, scream, use very bad words, challenge, threaten, aggressive and violent, destructive, physically hurt / harm others.
- They may become inactive, lethargic, weep continuously, and try to commit suicide.
- They may run away, become very fearful, shiver, and faint out of fear / anxiety.
- They may hide the cause of their emotional distress. Parents are not told about issues which make them to feel helpless.

Every growing child needs to be trained to express any emotion appropriately in words, body language or later in written form. Music,

painting, drawing, dance, acting also to be used to express emotions, controlled expression. Keeping in mind the social norms is what they have to learn. Exaggerated and crude expressions have to be avoided.

10. EFFECTIVE STRESS MANAGEMENT

Stress is defined as an unpleasant feeling when one cannot cope with a problem, person, situation or any issue. Stress induces the following changes in different organ systems of the body.

- **Heart**: Increased beats, blood pressure, warm feeling, sweating
- **Lungs**: Hurried and difficult breathing, carbon dioxide level in the blood increases
- **Digestive System**: Decreased appetite and taste, indigestion, diarrhoea, alternating with constipation. Increase and decrease of weight.
- **Kidney Function**: Urgency and increased frequency of passing urine, bed wetting.
- **Hormone System**: Increased / decreased production of hormones
- **Sexual System**: Decreased desire / aversion / inability to do the act
- **Bones – Muscles-Joints System**: Pain-swelling of joints, weakness
- **Brain and Mind System**: Concentration, learning, memory, analysing, decision making, motivation, emotions, self-confidence are all disturbed.

Causes of stress in Children

- Bad / inadequate parenting. Too much love or discipline or punishment, confusing instructions
- Absence of one or both parents
- Disturbing family environment. Quarrels, groupism
- Sibling rivalry
- Discrimination, partiality
- Insecurity, threatening people or events

- Unfriendly school environment
- Academic pressures, low IQ, learning disorders, inadequate guidance and support by teachers
- Severe competitions and pressure / expectations to win
- Excess desire and unlimited ambitions
- Failures and frustrations
- Poor / inadequate money and other resources
- Establishing relationship / break up of relationship
- Ragging by classmates / schoolmates
- Inferiority feelings – poor self esteem
- Diseases and ill health, disability
- Inability to take decisions or past wrong decisions
- Guilt and shame about mistakes or wrong things done in the past and fear of doing them again in future
- Not getting recognition, rewards and appreciations.

Coping skills – Help the children to develop and improve the coping skills like.

1. Positive attitude and approach

   Let the child tell himself "I can do, I have the ability or acquire strength to do. I will do"
2. Get support and help from others
3. Increase knowledge and abilities
4. Understand the reality and make plans accordingly
5. Remain cool and calm. Relax
6. Properly analyse the problem, situation and people so that they are managed adequately
7. Not to anticipate / expect failure
8. Do self-introspection; look at the assets and weaknesses. Know your limitations.
9. Put a limit to the desire and ambitions.
10. Accept success and failure with equanimity
11. Share negative emotions with parents and friends
12. Have faith in God and pray to him at the time of distress.

13. Reduce the needs to minimum. Be contented with what one gets. Not to compare one with others, lead a simple life.
14. Put efforts to be comfortable in all situations as far as possible
15. Prepare for negative life events
16. Keep health at optimal level. Have good food; sleep, exercise and tranquillity which are the pillars of good health.

BASIC SKILLS

1. EATING SKILLS: All of us should select food items which are not only tasty, edible and also nutritious and healthy. We need to take carbohydrates, proteins and fats in the proportion of 50%-30%-20% respectively. Food should also contain Vitamins, minerals, salts and enough water. Children should take food 4 to 5 times in small quantity and adults 3 times a day. Fix the eating time and intervals between 2 meals should be 5-6 hours prolonged fasting, frequent eating have to be avoided. Food and water should be clean and un-contaminated. Food has to be taken in company of others and has to be shared. One has to chew food slowly and swallowed. Hot Spicy food, very hard food, very hot and cold (Fridge items) have to be minimized. The eating place should be clean and pleasant. Eating roadside, in dirty places has to be avoided. Food has to be consumed within one or two hours after cooking. Food items should not be wasted. There is hard work of farmers and others behind the food we take. One should learn to cook food and store it in a clean place. Over-eating and under-eating have to be avoided. Once in 3 months body weight have to be checked. Malnutrition or obesity leads to many diseases which are preventable. Right food is divine nectar, wrong food is poison. Right-good food is essential for growth of the body and functioning. Teach this knowledge to the children, promote good eating skills.
2. SLEEP-REST: Sleep is essential for everyone. During sleep our body and mind relax. In children Growth hormone is released. That is why children below the age of 5 years, sleep for more than 10 hours and those between 6 years to 12 years sleep for 8 to 10

hours. Uninterrupted sleep helps in relaxation and you become fresh in the morning. Going to bed early and getting up early is good for health. Now-a-days children go to bed late at night watching TV or using mobile which have to be curtailed. Emotional disturbances lead to sleep problems, nightmares, bedwetting, grinding teeth, etc… Therefore, every child has to be trained to go to bed by 9 or 9.30pm with relaxed mind. No worries. No negative thinking. No watching of horror movies / crime stories on TV. The environment in the bed room should be pleasant. Light a lamp in the room. Tell children good stories or make them to listen to melodious music before returning to bed. Do not scare them about the events of next day. Don't tell them ghost, monsters' stories!

3. Hygiene: Every minute body produces sweat, oil, urine, faecal matter. Dust, dirt collects on the body. Bacteria, virus, fungus are around us to enter our body. Every child while growing should learn to keep its body clean and dry. Brushing teeth both in the morning and night, rinsing the mouth with water after taking any food, especially sweets, bathing every day and wear fresh undergarments. Keep the house and surroundings clean, wash hands before eating and after defecation have to be taught and practiced. Tell children about proper disposal of waste and broken materials.

4. Clothing: Clothes are needed to cover the body and protect it from sunshine, wind and dust. Wearing appropriate clothes according to seasons and occasions have to be taught. They should become independent in self-decoration and present themselves to the public. Decent and good dressing and decoration is an art which has to be learnt by children.

5. Time Management: Everyone gets 24 hours a day, not one minute more or less! Child has to learn self-discipline and orderliness. The child has to be told how to make use of the available time. How much to study, play, watch TV, go out with friends and help family members in household chores. If not trained, the children spend more time in playing, watching TV or using mobile or doing

nothing. Time is precious. Time lost can never be gained again. Discipline helps in time management. Child should be helped and guided to write timetable and follow it meticulously. It should keep all materials in their right place in an order.

6. Social skills: Show to the child how to socially interact with different people inside the family and outside. How to relate to people with different personality and style of functioning. Love and trust, appropriate talk and behaviour, courtesy are essential for social skills. How to behave with elders, age mates and juniors. How to share food, play materials and other things. The child has to understand different roles people play. Some play their roles and follow the rules and regulations. Some do not and are selfish. Some have bad intentions. Children have to be told and guided in social interactions. Children should be encouraged to greet, serve, and talk to relatives and guests and strangers. They should learn good social manners. Courtesy is a virtue.

7. Day to day transactions: Shopping: Children should be taken to shops, malls, market and we have to teach them how to select items, buy them. How to negotiate regarding the price. How to assess-know the quality of things and assess the value. How to negotiate with shop owners, service renderers, auto-bus-taxi drivers. How to commute. How to use the public transport facilities. How to use the roads, follow traffic rules, etc.., How to use and safeguard various equipment, articles of daily use so that they last long and remain in good condition.

8. Self-protection and how to avoid dangers: Small children do not have self-protection skills. They fall, injure themselves. They do not know which animal is dangerous. They do not know to avoid moving vehicles. They do not know people who have bad intentions and try to sexually abuse. They do not know how to use sharp instruments or mechanical gadgets safely. They do not know how to protect them near water, fire, animals. They have to be trained to avoid these dangers.

Sexual abuse of children is increasing year by year. Every child should know that he/she should not go alone with known/un-

known person, should not allow any person to touch the body parts. The child should be told to raise the alarm if anybody does so. It should be told and not to accept any eatable gift by a stranger.

An adolescent boy/girl should be taught self-protection method. Carry a weapon, pepper spray or any other device. They have to avoid moving alone. They should always move and remain in group which can support them. They should avoid playing / teasing animals like cat, dog, cattle who can injure them. They should be taught to use sharp instruments, kitchen equipment, and small machines carefully. They should not go to new/strange places alone. In Deepavali festival they should not fire crackers alone. They should do it when an adult is next to them who can guide and prevent injuries. They should be taught about how to cross a busy road, the traffic rules. Adolescents start using scooters and bikes which should be stopped. They have to ride a bike only after getting D.L and strictly follow road safety and avoid reckless driving. They should be taught about First Aid Procedures.

HUBRIS SYNDROME

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Hubris Syndrome

English poet T.S. Eliot has said, 'most of the trouble in the world is caused by people wanting to be important'. Man is born to seek power, and immense power is at the root of most ailments. People would like to have power and trouble others without any thought or purpose. Everyone would like to express their power and often it becomes companion of rudeness.

Meaning

Dictionaries refer Hubris as an extreme and unreasonable feeling of pride and confidence in yourself. The word has its origin in ancient Greek which referred to 'outrage'. It meant a personality quality of extreme or foolish pride or dangerous overconfidence and may develop with arrogance. It was considered a behaviour abnormality defying the norms of behaviour. Their actions violated natural order. The word 'hubris' has found a place in new Testament parallels and it represented 'a sense of false pride that makes a man defy God.' It affected Prometheus, the putative benefactor of mankind who challenged the supremacy of Zeus by stealing the fire from the heavens for which he was punished. In Greek tragedy, hubris was the 'pride that comes before the fall.'

It has found a place in proverbs also: 'pride goes before destruction, a haughty spirit before a fall'. Pride blinds them to act in foolish ways that belie common sense. The person exhibiting excessive pride and arrogance ultimately finds his downfall.

Definition

Lord Owen, the former British Foreign Secretary and neuroscientist, has drawn the attention to Hubris (abuse of power) syndrome (1). Some of the individuals in a position of authority, fail to exercise their power with wisdom, tolerance, sympathy, understanding and common sense (2). The term has its origin in ancient Greece, to describe a hubristic act wherein those in power exhibited pride and self-confidence and treated others with insolence and contempt. Looking at a predisposition of individuals to such a tendency of hubris, Greek philosopher Plato in his Phaedrus, has stated 'when desire irrationally

drags us toward pleasures and rules within us, its rule is called excess'. The moral is that one should not allow power and success to go to their heads, and should not lose touch with reality.

David Owen and Jonathan Davidson, a Professor of Psychiatry and Behavioural Sciences at Duke University Medical Centre, after studying the psychological profiles of US Presidents and UK Prime Ministers in office over the last 100 years, proposed the creation of a psychiatric disorder who exhibited "impetuosity, a refusal to listen to or take advice and a particular form of incompetence when impulsivity, recklessness and frequent inattention to detail predominate." Hubris is a condition characterised by grandiosity and an exaggerated sense of self-importance.

After studying the behaviour and medical records of many political leaders they found a tendency among some otherwise high-achieving persons to close themselves off from critics and to overestimate the odds of success.

Owen and Davidson have considered hubristic behaviour as a syndrome, consisting of a cluster of symptoms evoked by power (triggering agent), and usually remitting when power fades. They have considered it as an acquired condition that is different from most personality disorders persisting throughout adulthood. The condition is a disorder of possession of power particularly power which has been associated with overwhelming success, held for a period of years and with minimal constraint on the leader (3).

Men desire power, prestige and enjoyment. Hubris syndrome is an illness of position (power) and of persons. Hubristic behaviour may be exhibited in persons placed high in the Society in different walks of life such as politics, business, industry, military, or education. Not everyone succumbs to such behavioural abnormality. But the hazard is noted more frequently among political leaders. There is also a likelihood of other psychiatric abnormalities which have an established genetic linkage, such as adult attention deficit/hyperactivity disorder (ADHD), substance abuse, alcoholism, hypomania, bipolar(manic-depressive) disorders, paranoid personality disorder and narcissistic personality disorder (NPD) may coexist with hubris syndrome.

Business world has recognised the 'hubris hypothesis' as early as 1986 when Richard Roll made the study of business houses undertaking mergers and acquisitions. Since Hubris syndrome is related to power, Chief Executive Officers of many corporations having substantive power can suffer from this condition.

Pathogenesis

Hubris syndrome is not yet an established clinical entity. However, it appears to be a genetically codetermined predisposed personality trait (1). It may result from an interaction between genes and environment. The upbringing of the person forms the basis of personality and the opportunities met later in the career bring about changes in their personality that plays a role in the human drive. The condition is also linked to the influence of adrenaline or dopamine. The stress associated with noradrenergic and dopaminergic systems in the top leaders of the country may predispose to the development of Hubris syndrome. The neurotransmitters such as glutamate and gamma-aminobutyric acid (GABA) may bring about modulation of the intensity of dopamine response either to drugs or to other stimuli.

English philosopher Bertrand Russell in his reference to "the intoxication of power" has said, 'men desire to be in control because they are afraid that the control of others will be used unjustly to their detriment.'

English political scientist Herald Laski has said, 'grim experience taught men that power is poisonous to its possessors; that no dynasty and no class can exclusively control the engines of power without ultimately confusing their private interest with the public wellbeing'. Man is born to seek power, and the love of power is at their root. Often it is felt that justice without power is ineffective; power without justice is tyranny. That's why it is said tyrants are both evil and powerful. When they die, their rule is over and power is relinquished. The martyrs are both good and powerful; when they die their rule begins and power enhanced.

Hubris is an acquired personality change in people in positions of power. They exhibit a narcissistic propensity to look their world as a field to exercise power and seek glory. They try to act in such a way that seem likely to show them in a good light. They tend to speak in the third person and show contempt for the advice or criticism made by others.

The behaviour of politicians, business leaders, and other people in power, changes for the worse as they come to enjoy increasing power and influence. The condition brings about change in their brains bringing about a number of undesirable changes and make them suffer. They lose touch with reality, take excessive pride on their actions, display lesser empathy towards other individuals and take arrogant decisions or undertake actions without sufficient thought.

Clinical presentation

Hubris syndrome presents itself in a variety of symptoms late in life, and often the position which they are occupying is conducive to such a behaviour. Hubris syndrome is associated with power, more likely to manifest itself the longer the time the person exercises power and the greater the power they exercise. (1) It develops in a person with normal behaviour. This power-induced syndrome shows remission when the person loses the power. Such a disorder is less likely to appear in individuals exhibiting personal modest with a sense of humour.

Lord Owen has listed the symptomatology of Hubris syndrome as follows. One can make a diagnosis if anyone in power shows three or four behavioural symptoms:

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01. a narcissistic propensity to look the world as an arena in which they can exercise power for self-glorification
02. a predisposition to take action which are likely to show them in good light and enhance their image
03. an almost obsessive focus on personal image and presentation
04. a boasting tendency of their action and a tendency to exaltation
05. a tendency to equate themselves with the Nation or organisation
06. a tendency to talk themselves in pleural in an exalted fashion
07. an overconfidence in their judgement and contempt for advice or criticism of others

08. too much self-confidence, and a sense of omnipotence
09. disregard advice of colleagues and public opinion
10. exhibit restlessness, recklessness and impulsiveness
11. often isolated and loss of contact with reality
12. a tendency to follow their conviction
13. an inability to carry out a policy
14. too much self-confidence leading to inattention to details

Seven of the above symptoms noted by Owen and Davidson in Hubris syndrome overlap with other personality disorders such as narcissistic personality disorder (NPD). Two symptoms are shared with antisocial personality disorder (APD) and histrionic personality disorder (HPD).

However, five of the symptoms such as equating themselves with the nation or organisation, talking in pleural in an exalted fashion (use of the royal 'we'),an unshakable belief that a higher court (history or God) will vindicate, exhibition of restlessness, recklessness and impulsiveness, and moral rectitude of a proposed course, to obviate the need to consider practicality, cost or outcome are unique to the hubris syndrome (3)..

Often heads of Government, dictators, religious heads, and academicians exhibit Hubristic tendency. The position of power may corrupt their ability to behave in a rational way. Most of them are intoxicated by power. Often it is noted in heads of government who are either democratically elected or dictators. Their unwillingness to surrender power has been considered the curse of civilization. Their appetite for power is irresistible, and often they cling to the power by sacrificing everything. Power is an emotionally charged word. The condition is considered an occupational hazard to leaders (4).

English philosopher Francis Bacon has said, 'nothing destroys authority so much as the unequal and untimely interchange of power, pressed too far and relaxed too much'. Lord Acton, an English historian, politician and writer in a letter written to an Anglican bishop, has aptly said that, 'power tends to corrupt, and absolute power corrupts absolutely. Great men are almost always bad men'. However, Harry Shearer has raised doubt about that by saying 'if absolute power corrupts absolutely, does absolute powerlessness makes you pure?'.

Diagnosis

Hubris syndrome is a difficult condition to diagnose. Many persons affected can appear totally normal in their social life. Even those individuals who are in close contact may fail to recognise a change in behaviour.

It may be noted that Hubris syndrome can be related to many Illnesses from bipolar disorder and anxiety disorder to alcohol and drug abuse.

Unlike most personality disorders, which manifest by early adulthood, Hubris syndrome makes its appearance only after power has been held for quite some time, and can develop at any age (3). Hubris syndrome is an acquired personality disorder comprising a variety of behavioural characteristics. To make a diagnosis, there should be a certain number of features. The individuals afflicted by the hubris syndrome consider the world as an arena to exercise power and glory, undertake actions to cast them in a good light, exhibit a disproportionate concern for their image, and develop an exaltation in speech using the royal 'we' in their conversation. They show that they have the same interests as those of the nation. They place excessive confidence in their own judgment and display contempt for the advice and criticism and exhibit a feeling of omnipotence. One should take care not apply this term to individuals with existing mental illness or brain damage. Those who do not exhibit a defined number of criteria can't be labelled as having the syndrome, but can be considered as individuals exhibiting hubristic traits or behaviour.

Hubris syndrome is looked as an acquired personality trait rather than as an acquired personality disorder. It is acquired in leaders when in power which recedes after loss of power. Thus, the condition appears as a 'syndrome of position' encountered in a person. It can be encountered at any age.

Manfred Kets de Vries in the book "The intoxication of power" wrote, that hubris syndrome can lead to a false sense of invulnerability and to a kind of self-imprisonment. These individuals ignore all moral counselling and shared judgment. Thus, they become "the authors of their own doom". These persons are a "dangerous mix of pride, ego, delusion, resistance to criticism, and group thinking (in case of a company or institution).

There are no warning signs of the condition. It is difficult to predict who will develop this syndrome. The electors of the legislators or parliamentarians, or board of directors of banks and industries will not have any hint.

The electors are mesmerised by their leadership qualities and their grand vision. They fail to look the features of great pride and overconfidence, and their contempt to others.

The key difference between those with the hubris syndrome and NPD, is that those with the syndrome gradually usually settle down once they are no longer in office. They can then regain good judgment and a balanced perspective. Those with NPD, however, are more likely to remain self-aggrandizing to such a degree that it can impair their functioning. Many of the defining features of the hubris syndrome also apply to those with NPD. (3) People with either condition have:

1. a narcissistic propensity to see their world as an arena in which to exercise power and glory
2. a predisposition to take actions to enhance image
3. a disproportionate concern with image and appearance
4. a messianic way of talking about current activities and a tendency to exaltation
5. excessive confidence in their own judgment and contempt for the advice or criticism of others
6. Exaggerated self-belief, bordering on a sense of omnipotence
7. A belief that rather than being accountable to the mundane court of colleagues or public opinion, the court to which they answer is History of God.

There are other features which are more characteristic of hubris syndrome than NPD (3). They include

1. Restlessness, recklessness and impulsiveness
2. A tendency to speak in the third person, or use the royal 'we'
3. An identification with the Nation, or organization to the extent that the individual regards his/her outlook or interests as identical

4. An unshakable belief in that in that court they will be vindicated
5. A tendency to allow their 'broad vision', about moral rectitude of a proposed course, to obviate the need to consider practicality, cost or outcomes

Treatment

The symptoms of Hubris abate when the person ceases to be in position exercising power. It is unlikely hubristic individuals seek any psychological or biomedical treatment. They may take treatment for complications such as depression, alcohol-related problems or related family difficulties (3).

Ryan Holiday, US author and entrepreneur, author of "Ego is the enemy" states that 'What I've found in my research is that realism and self-honesty are the antidote to ego, hubris and delusion. Usually symptoms abate when the person no longer exercises power.

Hubris among doctors

There are problems of hubris and overweening confidence among medical men. Somedoctors exhibit hubristic personality.

Hippocratic dictum says 'Do no harm to the patients' (primum non nocere). However, we encounter medical mistakes in the diagnostic, therapeutic and preventive domains.

As doctors climb in their career, they develop excessive pride and self-confidence in their hi-tech armamentarium and gradually lose insight to 'the laws of Medicine'. They believe in their own invincibility. They think that they can treat every disease and its complications. They forget human fallibility and uncertainty. Shelley has suggested an antidote to hubris and it is developing intellectual/cognitive humility (5).

Medical errors pose a threat to patient safety. One of the major causes is physician overconfidence, referred to as error of hubris. It can be avoided by developing exemplary qualities such as compassion, altruism and empathy (5). The Doctors should learn to accept the limitations and powerlessness of our modern science.

Prevention

Though many individuals do not exhibit the features of Hubris syndrome when they assume office, they are likely to succumb to it as

years roll. The individuals who retain their personal modesty while in power, maintain their previous lifestyle and show a tendency to avoid the trappings of power will be able to avoid Hubris syndrome. They remain open to criticism, and consult before taking decisions. They follow the rules and regulations that have been framed by the authorities and try to follow them without making any attempt to circumvent them. They have access to valued confidents, and maintain their humility, self-criticism, and sense of humour.

Practicing the art of love, they can carry out the task more effectively. Quite often these persons are attracted by other things than power.

Hubris is encountered in all walks of life and all professions. It is also found among high-level executives who exhibit excessive levels of confidence, self-potency, and the conviction that they will prevail. George Dunca in an editorial on 'Hubris-a moment in history' writes, 'a healthy dose of innate hubris is a necessary ingredient for success in leadership, business, research, or politics.'(6)

There is a story in Greek mythology where Daedalus warns his son Icarus against flying too high or too low on the wings which were prepared by him to allow them to escape captivity. Experience of flight intoxicates Icarus and his ignores the advice and pays the penalty.

John Milton in his 'Paradise Lost' gave an example of hubris by referring to Lucifer. Lucifer tried to compel other angels to worship him. He was cast into hell by God. Even them he proclaims before innocent angels, it is 'better to reign in hell than serve in heaven.'

Swami Vivekananda has said, 'Each work we do, each thought we think, produces an impression (samskara) upon the minds. The sum total of these impressions becomes the tremendous force (character). The character of a man is what he has created for himself. It is the result of the mental and physical actions that he has done in his life.' It should be the guiding spirit to maintain the humility.

Douglas Preston, American Journalist and author, has said, 'Hubris and science are incompatible'.

Lord Owen has cautioned that Hubris syndrome is a greater threat than conventional illness to the quality of leadership and the proper government. English clergyman and writer Charles Colton, has viewed

such a situation as follows: To know the pains of power, we must go to those who have it; to know its pleasure, we must go to those who are seeking it. The pains of power are real, its pleasure imaginary.

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